Investigating Aga Khan Foundation (AKF) Initiatives in Teaching-Learning Skills Development on STEM Subjects in Secondary Public Schools in Shughnan, Afghanistan

By

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Master of Education in Educational Leadership & School Improvement

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Declaration

It is hereby declared that

The thesis submitted is my/our own original work while completing degree at BRAC University.

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.

The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.

I/We have acknowledged all main sources of help.

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Ethics Statement

Taking ethical points into account is one of the main responsibilities of the researcher. This study attempted to consider the ethical aspect in the following ways:

At the very beginning, the FGD guidelines, the interview guidelines, and the consent letters for the participants were developed in an authentic manner. This research was planned to pay more attention to developing the data collection tools. In this regard, the tools underwent a pilot phase and peer debriefing in order to ensure that they were clear enough to obtain the required data. In the meantime, consent letters were sent to individual participants to seek their permission and inform them about the objectives of the study, their role, and their expectations. The aforementioned points were made due to maintaining ethics, credibility, and rigor.

In addition, sensitive language was avoided during the research. Likewise, the consent letters and data collection tools were translated into the Dari language in an understandable manner so that the participants were able to express their feelings. Meanwhile, during the research, the informants were given equal opportunity in terms of their gender, talking time, and respecting their perspectives.

After the data collection, I paid more attention to conveying the messages of each participant while transcribing the data to avert misconceptions. Afterward, according to the request of the participants, I suppressed using the participants' names and instead used their pseudonyms, such as interview# 1 or #2 for interview participants and P# 1 or #3 for Focus Group Discussion (FGD). Furthermore, the collected data would be filled out in a separate document protected by a password, and confidentiality would matter at all times.

Abstract

This investigation was carried out on "professional development in STEM education". The initiatives were taken by the Aga Khan Foundation (AKF) in the farthest part of Afghanistan, Shughnan. The study aimed to investigate the initiatives that the institution has taken to conduct STEM training. Meanwhile, the research was wandering to discover the approaches that fostered the teachers' capability to conduct a good learning environment. In this regard, it was invaluable to understand the views of the informants.

The participants were selected based on their expertise and background in STEM training with AKF. The study was conducted using qualitative methods, and I used purposive sampling. Eventually, the research was conducted through online interviews and FGD.

This research revealed that the training of STEM educators was implemented in collaboration with other NOGs and governmental organizations (national, provincial, and district levels). The institution trained the instructors to enable them to utilize the laboratory and get familiar with pedagogical skills with which they could launch learner-centered approaches. The finding also revealed that AKF assisted the teachers through a wide range of strategies across its coverage establishments, both in academic and material provision. Last but not least, the institution had predominant observation and mentoring from its coverage schools and supported them in empirical and academic aspects.

Key Words: Professional Development, Aga Khan Foundation, STEM education, Teaching-learning skills, Training Initiatives, Follow-up Support.

Dedication

Hereby, I want to dedicate the thesis to my beloved mother, Nazia Adeem, who has been motivated for my studies and walked me through my initial education in the primary school.

Acknowledgement

I would like to express my heartfelt gratitude to my advisor. MS. Hridita Islam for being such a patient advocate who walked me through every single point of this study. I concede that without her guidance and useful feedback, this research wouldn't achieve its goals. I also acknowledge all the constant support and help I received from BRAC institutions. I concede that the faculty members were always flexible and assisted me during this journey. I would like to declare my sincere acknowledgment to the ITREB institution and the Institute of Ismaili Studies (IIS) for all the unfettered support I have received from them so far.

I am thankful for the great courage of my participants, who positively showed interest and attended this study, irrespective of the current obstacles, particularly the female informants, who were generous with their time. I would like to take this opportunity to thank all my family members, including my guardians, siblings, and namely my brother Jalaluddin Hussaini, who have continuously supported me through this research. Eventually, I will also opt to thank the scientists, specifically Thomas Edison, who have enlightened our lives physically and eternally through his unique invention (electricity).

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List of Acronyms

AKES	Aga Khan Education Services
AKF	Aga Khan Foundation
BRAC	Bangladesh Rural Advancement Committee
CBE	Community Based Education
DoS	Department of Science
ECD	Early Childhood Education
FGD	Focus Group Discussion
ICT	Information and Communication Technology
IIS	Institute of Ismaili Studies
IPD	Institute of Professional Development
ITREB	Ismaili Triqa Religious Education Board
KT	Key Teachers
MoE	Ministry of Education
MoHE	Ministry of Higher Education
NESP	National Education Strategic Plan
NGOs	Non-Governmental Organizations
NSF	National Science Foundation
OECD	Organization for Economic Co-operation and Development
P# 1/P# 6	Participant# 1/ Participant6# 6- used only for FGD
PC	Personal Computer
PCK	Pedagogical Content Knowledge
PD	Professional Development
QDA Miner	Qualitative Data Analysis

SDC	Swiss Development Cooperation
SDG4	Sustainable Development Goal 4
STEM	Science Technology Engineering & Math
SM	Science and Math
TED	Teaching/ Teacher Education Development
TPACK	Technological Pedagogical and Content Knowledge
TLC	Teaching Learning Circle
TTC	Teacher Training College
TVET	Technical & Vocational Education and Training
UNICEF	United Nation Children's Fund
US	United States
USAID	United States Aid

Chapter 1: Introduction and Background

1.1 Introduction

The importance of STEM education (Science, Technology, Engineering & Math) for students is liken to recipe for a starving person to survive (interview #6). The prominence of these subjects is remarkably realized across the globe and countries like US is allocating more budget to provide high-quality STEM education (Li, 2014).

Coming to the context of Afghanistan, science, technology, engineering and math are regarded as theoretical subjects. Student mostly memorize the formula regardless of their application. This way of teaching-learning does not enable students to obtain 21st century skills (Halimi, 2013). This study referred to a wide range of studies in global context and few available studies on importance of STEM education for "socio-economic development" (Samady, 2007, p. 17). Hassan (2020) contends that STEM students would develop the skills like critical thinking, problem-solving, creativity, team building, digital literacy, entrepreneurship, and communication.

This study was carried out about (AKF) initiatives on STEM Education at secondary public school in Shughnan district in Badakhshan, Afghanistan. This research ascertained different enterprises which were implemented by the institution for conducting the training of STEM education and explored the approaches of constant support in its coverage establishments. The study figured out that teacher benefited the training approach which improved their teaching-learning skills compared to previous years.

The study operated qualitative approach an employed online FGD and interviews as a research method. This study was conducted in three public secondary schools with 9 teacher participants, two trainers of the (AKF), and one program manager of the institution.

1.2 Research Topic

Professional development in all fields but particularly in STEM subjects is one of the key elements, especially in public schools for teachers. Professional development could result in quality education. Therefore, quality higher [and secondary school] education in STEM subjects is a prominent issue for the future betterment of conflict-affected areas like Afghanistan in terms of reconstruction, stability, and socio-economic improvement. In the meantime, focusing on STEM education in the curriculum could assist to meet the present and future demands of the country. This approach could enable the country to get rid of dependency on outside assistance (Baha et al., 2019). Likewise, professional development in STEM education at the secondary level can aid the pupil in having more success in preparatory STEM courses at college (Gearns et al., 2018).

It was my personal interest to recognize the initiatives, approaches, and methods by the Aga Khan Foundation that have been taken for the first time, for teachers in far-flung areas like Shughnan. At the same time, a great deal of research on STEM education has stimulated me to understand the approaches and methods in terms of teaching and learning STEM subjects, introduce them through this study, and raise the importance of STEM education in my community.

It can be seen from the above discussion that the topic of this study is "professional development in STEM education," and that this initiative was taken by the Aga Khan Foundation at secondary public schools to scale up the teachers' knowledge skills in science subjects. So that, the title of this research is "Investigating Aga Khan Foundation (AKF) initiatives in teaching-learning skills development on STEM subjects in secondary public schools in Shughnan, Afghanistan."

1.3 Statement of the Problem

The sad truth is that Afghanistan, as a result of war and nearly 40 years' endemic conflicts, did not have any significant achievements in education, particularly in science subjects. However, during the last two decades, the government of Afghanistan, in collaboration with international NGOs, including the US government, took some initiatives in STEM education, but the quality was not as high as it was expected. For instance, the approaches were not quite enough to promote students' knowledge and skills. Due to this fact, the graduates were not able to pursue their higher education in these subjects at university level. (Baha et al., 2019). A study carried out by Hashemi et al. (2021) on STEM education, demonstrates that challenges at the school level stem from a lack of 21st century skills in school teachers and particularly in pre-school tutors. These teachers mostly lack dexterity in communication and collaboration skills while teaching.

In this regard, Samady (2007) recommends that there should be a long-term strategic policy for capacity building along with conducting training and research in science and technology that could address the existing challenges in Afghanistan. He emphasizes that the focus of this approach should be on creativity and innovation amongst young generations, where the teaching of science and technology constitutes the bottom line. He also suggests that creative teaching requires science training, the provision of resources, a laboratory, and modernized [teaching] methods. He indicates that creativity can be nurtured via experiments, project work, and field work in STEM subjects.

As a matter of fact, almost all of the teachers in sequestered areas of Afghanistan are encountering adequate knowledge, skills, and resources in STEM education. AKF aids the Afghan teachers in terms of providing PD in the remote areas, and one of its focus is on the

training of STEM subjects (AKF, 2016), which is the main attention of this study along with its opportunities and obstacles.

1.4 Research Questions

As we know, in conflict-affected areas like Afghanistan, as a result of obstacles like "economic deficiency, lack of resources, and disqualified teachers (Azam et al., 2014), the government cannot afford to provide quality and skill-based education. Therefore, the ministry of education, in collaboration with international NGOs, is implementing a number of professional trainings for public school teachers (Goddard et al., 2018). One of these international contributors was AKF (MoE, 2017), which took some initiatives in terms of conducting STEM education training.

This study was conducted in underprivileged locations in Shughnan, Afghanistan. As it was mentioned, the quality of education is very low, and there are non-professional teachers at schools. In this regard, professional training is very critical, particularly for STEM teachers. On the positive side, the public school teachers were lucky enough to get the aid of AKF for maximizing their teaching-learning skills through conducting practical subjects. This study sets out to investigate the enterprises plans for the implementation of training, laboratorial resources, and approaches. Hence, it continued with its support of teachers and eventually explored the consequences of the initiatives that enabled the pupils to apply their knowledge and skills in the real world. The following are a bunch of questions for further investigation of the above points:

- How does AKF implement the professional development initiatives for the teachers in Shughnan, Afghanistan?

- What are the curricula and teaching modules utilized by AKF in their professional development initiatives of secondary public schools' STEM teachers in Shughnan?

-How does AKF provide support to teachers in facilitating STEM subjects in Shughnan to effectively implement the curricula and modules provided in their professional development programs?

-How can the current practice of STEM teaching and learning be improved?

1.5 Purpose of the Study

The purpose of this qualitative research was to investigate the Aga Khan Foundation (AKF) initiatives in teaching-learning skills development on STEM subjects at secondary public schools in Shughnan, Afghanistan. This research aimed to realize the approaches used for conducting professional development in the mentioned district at public secondary schools. The study explored to know how the institution succeeded to implement need-based training. Meanwhile, the research intended to know which initiative was more effective for teachers to enhance their skills in teaching-learning of STEM education.

The bottom line was to understand how the training upskilled the tutors and enabled them to create a good learning environment where students could express their knowledge, creativity, and thoughts, particularly in experimental subjects. Afterward, this research also aimed to know in what ways the mentioned learning environment emphasized on modern pedagogy that considered pupils' insight into account.

Last but not least, the study desired to know the teachers' view about the training they received and how it helps them to easily come up with challenges like class management in STEM subjects. Indeed, this study wanted to investigate the perspectives of the informants

about the training and the whole initiatives they were witnessed as well as how the NGO sustained its initiatives in the long run.

1.6 Significance of the Study

Advancement in STEM subjects fostered the development of education in many part of the globe, which in turn results in quality of life (Baha, Diakoumi, & Waizya, 2019). More importantly, STEM education could aid the students to master the 21st century skills. For instance, it could help them to apply their knowledge in the real world that in turn prepare them for the job market to have productivity and consequences (Hashemi, et al., 2021). This approach will definitely assist the economic improvement of the any country in the far-flung area like remote part of Afghanistan.

This study was conducted in one of rural and impoverished areas where AKF implemented a wide range of initiatives in STEM education. Secondary public schools in disadvantaged areas of Afghanistan are struggling with lack of professional development, particularly in STEM subjects. Therefore, this investigation intended to address the effective approaches executed in STEM education. The investigation aimed to figured out some tips for conducting of teachers' training. The study expected to recognize what part of the training stimulated STEM teachers and their pupils to explore and learn in an effective way. Also, the study will touch up on the methodology and pedagogy for teaching STEM subjects, and teaching modules for professional development. So that the research will enlighten the governmental education authorities to realize the techniques and approaches of teachers' skills development on science subjects to expand the training to other areas. This could also assist the curriculum developers both at private and public schools to incorporate skill-based approaches in science subjects in order to address the innate talent of students. Likewise, the findings could help schools' authorities to consider the methods and skill-based teaching

learning in their policy and persuade their teachers to focus on creative thinking in STEM subjects and apply it in their lesson plans.

Chapter 2: Literature Review and Conceptual Framework

2.1 Introduction

As it is vividly understood, in any study, the investigator is required to refer to other scholars and writers to realize their ideas, approaches, and methods, which could assist in having a better understanding of the study and make it more reliable. Due to this fact, I have gone through a range of articles, journals, reports, conferences, and books in order to figure out more ideas about STEM education.

Through studying the above resources, I encountered some approaches that assisted me in finding a clear understanding of the topic and, at the same time, enabled me to establish my research. This also enabled me to gain a better understanding of the study. Meanwhile, this will help me apply them in the context of my country in my future studies. In the meantime, I understood the teaching of STEM education in Afghan, regional, and global contexts.

The reviewed literature obviously provided more clarification and shed light on different dimensions of the topics, which enabled me to categorize them easily. As a result, I have organized the core themes accordingly: 1) STEM education 1.1) What is STEM education? 1.2) Needs for STEM education; 1.3) Practice of STEM education in a world education context; 1.4) Practice of STEM subjects in the context of Afghanistan; 1.5) Challenges in the way of teaching STEM education; 2) AKF initiatives; 3) Teaching-learning skills development; 4) professional development; 5) Secondary public schools

2.1 STEM Education

STEM education is one of the main themes that constitute the central component of this study. This theme gives birth to other subtitles, which are going to be discussed in the forthcoming pages.

2.1.1 What is STEM Education

The acronym STEM is taken from science, technology, engineering, and mathematics. This term includes pupils from kindergarten to postgraduate education level. This term was created by the National Science Foundation (NSF) in 1990. The above acronym does not only comprise people who are studying this field but also entails people who are involved through working in this area (Marrero et al., 2014, p. 1).

"S" stands for science, which focuses more on the natural world and tries to prepare the students for real action as scientists to inquire, explicate, and explore nature. "Science" includes subjects like Physics, Biology, Chemistry, Astronomy. "T" stands for Technology and it is concerned about the substances in nature and tries to employ the materials of nature to meet the desires of humans. This subject persuades the human being to create, design, and develop things to be satisfied in life. "E" stands for Engineering and it focuses on how to utilize materials by integrating the knowledge of mathematics and nature to improve economics. Meanwhile, "M" represents mathematics, which serves as a fundamental part to provide language for the aforementioned components (Hasanah, 2020, p. 1). Therefore, there are critical needs for STEM education in all parts of our lives, which are going to be discussed in the coming pages.

2.1.2 Needs for STEM Education

There is an extensive demand for STEM education not only in professional life but also in personal life. Technological advancement, health challenges, political issues, climate change, and other hot topics give rise to STEM education's importance and its role in terms of tackling these challenges. STEM education can aid from fundamental aspects like developing a mosquito net for preventing malaria to studying about germs and tsunamis, which equip humans to think logically and develop critical reasons for solving lives' problems (Marrero et al., 2014, p. 2).

Research conducted by Sahin et al. (2014) uncovered that pupils' attendance [in STEM classes] stimulated them to select STEM subjects as their future major, which assisted them in developing their 21st century skills. This study further states that students at the college level conceded that their interest stems from their science tutors in secondary school. The researchers in the mentioned paper believe that STEM teachers provide more opportunities for their students through observation, intimation, and role modeling.

According to Kereluik et al. (2013) (as cited in Beswick & Fraser, 2019), 21st century skills are divided into three parts: basic knowledge, meta knowledge, and humanistic knowledge. Foundational knowledge contains digital literacy, core content knowledge, and cross-disciplinary knowledge. The core knowledge is deeply influenced by technological advancement. Improvements in technology have not only assisted in the availability of core knowledge but also changed the way it is presented. For this reason, teachers and pupils, in terms of employing digital technology, both have the duty to master new knowledge and skills to obtain disciplinary knowledge to comprehend it. The mentioned researchers also assert that content knowledge requires meta-knowledge to enable the learners to use technology to find access to broader information and think beyond the basic content, which

will prepare them for the future workforce. These authors then introduce skills like critical thinking and problem solving, creativity and innovation, collaboration, and communication. They also indicate that in a rapidly globalized culture, working with a diverse background and tackling socio-economic challenges, either online or in person, requires some sort of skill; they call it humanistic knowledge. The above authors recommend that teachers prepare students in such a way that they can comprehend ethical, job, and life skills and cultural competence in order to cope with future issues.

Furthermore, STEM education can assist in achieving the SDG4 ideal goals. In fact, the SDG4 emphasizes future economic, social, and environmental progress. These advances require components like policy, assistance, monitoring, finance, regulation, and education. Although the other principles play an important role in development, education has the potential to increase awareness and facilitate the readiness of stakeholders for change. The above writer further suggests that education can provoke creativity, ideas, ability, and enthusiasm (Sterling, 2016). In this regard, STEM education would be the main trigger to nurture the skills mentioned in the learner that could assist the human capital to attain the SDG4 goals.

In the meantime, STEM education encourages students to be creative, develop ingenuity, work in teams, be resilient, examine and experience things, employ technology, and apply knowledge in real life (Hassan, 2020). Considering the above points, it would be important to take a look at the practice of STEM in global education.

2.1.3 Practice of STEM Education in Global Context

There are a variety of concerns among the authorities and educators. For instance, economic and educational competitiveness and a lack of professional people for future careers in the global market could play an important role in the workforce. In the meantime, there is an

increasing demand for math and STEM at school. Because, people believe that by studying STEM, they could meet the advanced skills of technology and get well prepared for the job market (Brown et al., 2011).

Developed countries like the USA are paying more attention to STEM education improvement. For example, Obama once said that he ordered the nation's governors and education chiefs to develop an assessment that not only focused on exam days but rather prepared students to master 21st century skills like critical thinking, problem-solving, entrepreneurship, and creativity (Hassan, 2020).

STEM education increasingly came to prominence at the international level. As fundamental subjects, they give rise to productivity, economic competitiveness, and societal wellbeing. Governments across the globe attempt to elaborate and define policies for STEM at the school and higher education levels. (Freeman et al., 2019, p. 2).

There are many factors impacting students' participation in STEM education globally. Triggers like self-efficacy, interest, ability, gender, socio-economic situation, and place of living For instance, students in Singapore and Japan showed more interest and performed well in science and mathematics. The season for high performance in Singapore was students' participation in academic courses at the school level. Similarly, in Japan, more school hours are allocated to STEM education, and students are highly motivated by instructors. Meanwhile, in the United States, the high majority of students who completed the early math course as well as school graduates who completed Biology, Chemistry and Physics have significantly increased. Whereas US school participation was at its peak, both primary and secondary schools in Australia experienced a long-term decline.

In the meantime, the Organization for Economic Co-operation and Development (OECD) conducted a study in 2015 under the name "Program International Student Assessment.

“program international student assessment". Their findings suggest that there are dominant countries in STEM education, mostly in South Asia (Singapore, Japan, China, and Finland), Western Europe, and Canada. Teenagers in the OECD countries expressed proficiency in STEM education in terms of collaboration and problem-solving. (Freeman et al., 2019, p. 6). As we had a quick look at a brief summary of STEM education in a global context, now it would sound great to take a look at science subjects in the context of Afghanistan.

2.1.4 practice of STEM Education in Context of Afghanistan

Science subjects are important components of the school curriculum in Afghanistan. In general, the school is divided into two levels: primary and secondary. Primary level is from grades 1-6, and secondary level is from grades 7–12. Science subjects [except numeracy] are not applied at the primary level, whereas in secondary school STEM education is taught (Hemat, 2015).

Students in first grade up to fourth grade learn some primary numeracy, including whole number calculation, addition, subtraction, multiplication, and division. From fifth grade up to ninth grade, they learn topics like algebra, which includes topics like equations, statistics, probability, etc. After grade nine, pupils learn higher levels of mathematics and other STEM subjects (Halimi, 2013, p. 6).

A study carried out by Baha and Waizy (2019) demonstrated that the teaching of STEM education in Afghanistan is not based on internationally recognized standards. Their finding suggests that even in the majority of STEM schools, students do not have access to electricity, and therefore there is no integrated technology in STEM education. In the meantime, STEM education is required to be updated, but in Afghanistan, students do not have this opportunity to learn about the recent changes in STEM subjects. Apart from that, these subjects need to be taught in an international language, but in Afghanistan they are

taught in the local language, which does not give students the chance to explore more about STEM subjects in English. Alongside that, students do not have access to laboratory-experienced teachers or sufficient equipment in STEM education, and due to this, they cannot do any experiments. Hence, the learners only acquire theoretical knowledge, and this means that most of them cannot pursue STEM education as their future expertise.

2.1.5 Challenges in STEM Education Practice

Although initiatives have been taken in terms of improving STEM education in a global context, there are still challenges in science subjects. This part will concentrate on the prevalent barriers that STEM education is confronting.

When we look at the general situation of acquiring STEM education, there are numerous obstacles. First of all, the economic issue pushes back the quality of STEM education. Second, in under-resourced rural and urban areas, the quality of education in general and STEM education in particular is now low. Thirdly, there are other barriers, including underrepresented groups of race and ethnicity and a traditional academic structure that does not meet the expectations of today's generation (Honey et al., 2020, p. 14).

Apart from the mentioned challenges that exist in the context of the entire world, Afghanistan has more challenges as a result of socio-economic and long-term conflict. In fact, a lack of professional teachers and a high ratio of students per teacher are two important challenges. The disqualified instructors are not able to instill the lesson in a meaningful way to enable their pupils to apply the lessons in their lives. Therefore, students even do not have the notion to believe that mathematics [and all STEM subjects] could be applicable in their lives (Halimi, 2013).

Despite the challenges mentioned, political issues are another major problem, which brought about the secondary school ban for girls. But, organizations like UNICEF are working for the

betterment of education and other sectors. According to UNICEF (2022), this organization is currently working on community-based education (CBE) and also supports the public schools with materials and resources. This organization claims that through CBE, they could enroll nearly a million students, as well as 800,000 students in public schools. (UNICEF, 2022). At the present time, there is no official report disclosed regarding STEM education, neither from the government nor from the NGOs. According to UNICEF (2022), there are some NGOs still active in the country, and one of them is the Aga Khan Foundation, which provides different services, one of which is in the education sector, which will be discussed accordingly.

2.2 AKF Initiatives

NGOs support for education goes back a long time in Afghanistan. As it was earlier discussed, the conflict displaced the population of the country. In this regard, non-governmental organizations (NGOs) have been involved in providing education for displaced people in nearly 20 provinces since 1980. After the year 2000, more NGOs shifted to Afghanistan and assisted people in many aspects, including education. The NGOs provided technical and financial support for the improvement of basic education. This assistance consisted of skills training and constructing schools in far-flung areas (Samady, 2007, p. 26–27).

In terms of the goals of AKF initiatives, the institution collaborated with the ministry of education and some NGOs and worked at different levels. For instance, AKF at the national and provincial levels supported schools in terms of policy development and staff capacity building. This organization also assisted the MoE with the operational plan for NESPIII. This operational plan was developed in STEM education after the revision of science subjects and then implemented in the coverage areas of the institution. The institution is working for

qualitative teaching and learning at the secondary public school level to improve the capacity of the instructors, custodians, and mentors. The ultimate goal of these enterprises was to persuade the teachers to execute a learner-centered approach to teaching. Therefore, AKF concentrated on empowering public schools in order to enable them to provide education of high quality.

AKF has nearly 28 district coverage areas where it also implements STEM education training both at the provincial and district level for tutors and supervisors due to providing efficient teaching and learning in governmental schools. Meanwhile, AKF assists secondary school STEM teachers with pedagogical techniques. So, it trains the teachers to upskill them with new approaches in STEM education. In the meantime, AKF provided the supervision program, where the emphasis was on learning-led teaching and incorporating activity-based lessons in science subjects. The main goal was to assure that secondary students had obtained the lessons in an effective manner, which could guarantee their future success. It is mentionable that these initiatives were prepared on the basis of need assessment and straight feedback of teachers, headmasters and other beneficiaries (AKF, 2016).

As it was mentioned, staff development is one of the most important points in education because it guarantees the quality of education and helps to have skilled teachers who can prepare productive students. The coming topic will discuss the importance of teaching and learning skills in general, and then it will refer to AKF initiatives.

2.3. Teaching-Learning Skills Development

A study conducted by Beswick and Fraser (2019) suggests that pupils wish to study less challenging math because they find it boring at the senior secondary level. This requires the custodians and governments to make it possible to go beyond the specific content knowledge. The paper also indicates that a lack of enthusiasm and capability among math instructors

affects learners' achievements. Likewise, non-professional teachers, even in the developed world, including the US and Australia, are still a challenging issue because they lack relevant expertise. Similarly, the lack of opportunity between urban and rural areas also influences students' performance in STEM education because underprivileged areas have less access to the required equipment.

The above researchers recommend that STEM subjects be taught according to specific methodologies. They also suggest that teachers assign students project-based work. In addition, instructors should ask learner-centered queries to foster students' critical thinking. They also emphasize that challenging-based tasks, such as investigating problems, designing solutions, testing, and evaluating, will assist students in terms of problem-solving skills and real-life experience. The above authors believe that we are living in a technological era, and it is paramount that teachers integrate technology into their lessons to prepare the young generation for the future workforce (p. 956–957).

When it comes to Afghanistan, for upscaling the school teachers, the Islamic Republic of Afghanistan constructed a variety of Teacher Training Colleges (TTC). Beside teachers, school graduates who did not pass the entry exam for higher education were given the chance to get enrolled for two years' professional education. Studying at TTC gave them the chance to pursue higher education. Participating in TTC served as pre-service training for the baccalaureate graduates. The percipients had access to libraries, training centers, science laboratories, videos, the internet, radio equipment, and other facilities, although there were not balanced facilities in all TTS across the country (Goddard et al., 2018, p. 9). In addition, the graduates are in need of more skill-based training, which is provided by some organizations like AKF.

AKF aims to improve the quality of teaching and learning at all levels of government schools. Therefore, it works with instructors, educators, school heads, and teacher training center

faculties through training and mentorship. The institution assists the instructors and school authorities to work effectively. One of these approaches is providing training for secondary science and math teachers in order to ensure that adolescents are taught STEM pedagogy at secondary school. This initiative is taken as a result of straight feedback from tutors and education authorities at provincial and district levels who witnessed weaknesses in the quality of teaching in STEM education (AKF, 2016). However, this organization provided training from preschool to high school with an emphasis on skill-based training for teachers, but in terms of sustainability, it requires teacher-led professional development, which will be discussed in the upcoming pages.

2.4. Professional Development

In fact, tutors are required to reflect on their practice, which lacks sufficient skills. Teachers must have this knowledge to see the methods from the student's perspective. This requires the teacher to collaborate with colleagues and even pupils. In the meantime, providing support through modeling, coaching, and collaborative support will be effective for teachers' professional development (Hammond & Laughlin, 2019, p. 2-3).

Professional development will help the teachers improve their capacity for teaching and content knowledge. This in turn will assist and address relevant problems and issues with which teachers are currently struggling in classrooms. For effective professional development, it would be essential to consider some sort of approach, including assessment, observation, and reflection. Meanwhile, in order to become effective teachers, the instructors should allocate sufficient time to get involved in the program and learning practices. Effective professional development must go beyond routine work; it instead needs multiple, continued, and sustainable approaches to bring about change (Hammond & McLaughlin, 1995, as cited in Wilson, 2011).

In the context of Afghanistan, for professional development, there are some in-service trainings. These trainings are regarded as incentive factors for instructors to increase their interest and enthusiasm. There were qualified trainers who presented the content for teachers, and the instructors at the end had a final test to realize the knowledge gap. In the meantime, they received constant feedback during the training and got support post-training through class observation, the Teacher Learning Circle (TLC), sample teaching coaching, and mentoring activities (Safi, 2015). Despite the fact that initiatives have been taken by the government of Afghanistan, there are still challenges at all school levels, particularly in secondary school.

2.5. Secondary Public Schools

An emerging body of research illustrates that secondary school is the level where students select their future careers. This period is a highly influential moment in pupils' career lives, and therefore having the knowledge to select their future major is very prominent. The future of countries depends on how they are able to improve their STEM education and increase enrollment in STEM careers. Selecting a future career path on the basis of STEM subjects will enable the pupils to prepare for a challenging life. Future generations could overcome the forthcoming challenges if they have complex communication skills, the ability to solve critical problems, creativity and constant learning, technology and life skills, and career skills, which are required in the global economy (Sahin et al., 2014, 789–790).

The above overview implies that countries like Afghanistan are struggling with teaching STEM subjects. Although in the past two decades the government has taken some initiatives in terms of increasing access to education, the poor quality of education remains a big challenge. Meanwhile, students are lacking technical knowledge and necessary skills, and this

is rooted in a lack of laboratories, an outdated curriculum, and cultural values that disregard STEM subjects (Baha et al., 2019).

2.6 Conceptual Framework

The below framework is the consequence of profound searching of different ideas, thoughts and theories which I could establish my study on the basis of it.

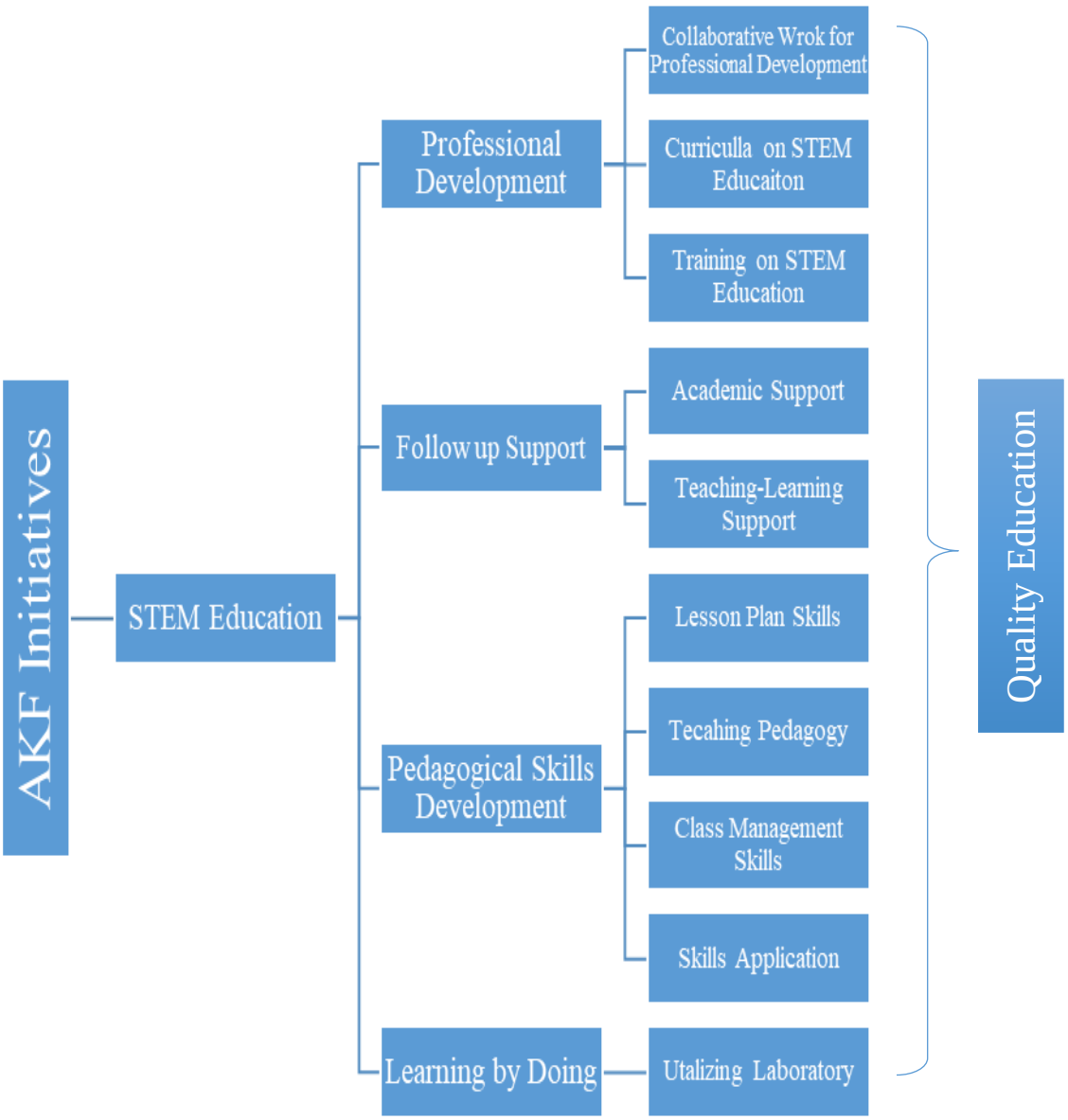

Figure 1. All in all, the above conceptual framework is designed as (T & ED) from left to right in its shape. “T” stands for Teaching, “E” stands for Education and “D” stands for Development. In the above figure, the NGO initiatives on STEM education is considered in three major areas (Professional Development, follow up support, and Pedagogical Skills development and learning by doing). Each of these components are split up into their own categories, which absolutely assist the quality education.

Chapter 3: Methodology

Generally, conducting research in today's world requires a systematic approach that makes it more rigorous and reliable. Research methodology is one of the core points of any study, which guides the researcher to establish the study in light of it as a milestone. Therefore, this part will discuss the following components: the research approach, research participants, research site, data collection method, credibility and rigor, data analysis, sampling procedure, ethical issues and concerns, the role of the researcher, and the limitations of the study.

3.1 Research Approach

Undoubtedly, conducting a study in any field requires an approach to figuring out the answers to the research questions. This research employed a qualitative approach and conducted interviews and FGD with the participants. As mentioned, the study was conducted about AKF initiatives in STEM education. So, I wanted to understand them both from the teachers' and organization's viewpoints, and this required conducting qualitative research. This approach gave me the chance to have a better understanding of different perspectives on the topic. The qualitative study also gave me the chance to understand the feelings, perspectives, and facial expressions of the targeted population. The qualitative approach is mostly interested in creating meaning from insight, experience, and the behavior of the involved group. This characteristic in turn gave rise to unfettered data, which is not feasible to obtain from quantitative methods (Wong, 2008, p. 14). This study provided me with more opportunity to interpret the assembled data. The aim was to understand the perspectives of the participants about the training conducted and the approaches implemented by the Aga Khan Foundation (AKF). Therefore, the focus of the study was more on detailed interpretation (Creswell, 1994).

3.2 Research Site

This study was conducted in Badakhshan, Afghanistan, in the northern part of the country. Most specifically, the research was launched in three locations in Shughnan district (Sarchishma, Wiyer, and Bahshar) at secondary public schools with nine teachers' participants from three public schools. Although there were a variety of schools, these were selected because of their accessibility to the internet and availability of participants. The above schools' teachers were trained by AKF in collaboration with the government of Afghanistan to upskill them in STEM subjects. The mentioned destinations are located in sequestered areas of the country where they do not have access to professional training or resources for teaching. In this regard, the study was conducted with nine teachers, two AKF trainers in Shughnan, and one program manager in Faizabad through online platforms. So, this study aims to realize inclusive training for teachers in STEM subjects.

3.3 Research Participants

This study had three categories of research participants. First and foremost, secondary public school teachers who attended AKF initiative training on STEM education The tutors were chosen from three different areas of Shughnan. Three instructors were chosen from each school, and overall, there were nine participants. Although there were several other teachers who participated in the AKF training, only these three destinations were targeted. The rationale behind this was having access to a proper connection to the internet by the teachers, so I could approach them bitterly. All the participants came from a minority language group called Shughnani, but they can also communicate in one of the national languages called Dari. It should not be forgotten that in this study, they communicated in Dari. Among the teacher participants, four were female and five were male. Meanwhile, these people were selected to get more insight from them on what they had learned from the training. Six of these teachers participated in an online focus group discussion, and three more instructors

(one from each school) were interviewed. Although there were nine participants, three of them who had more teaching experience were selected for an online individual interview to give me more details in order to realize their reflections and viewpoints.

Secondly, two male participants were interviewed and shared their experiences about conducting the training on behalf of AKF. The trainers also gave their interviews in Dari. Last but not least, this research launched an online interview with the program manager at AKF. Overall, there were 12 participants in this study.

3.4 Sampling Procedure

All in all, there were three categories of participants: teachers, trainers, and managers. The underlying fact behind the above participants' selection in this research was their direct involvement in the training. For instance, the manager handled the entire program, and the trainers implemented the training and had adequate knowledge about it. Meanwhile, the teachers received the training as a targeted population. It is mentionable that I employed purposive sampling in this qualitative study. As it was mentioned, the participants were chosen based on their complete attendance at STEM trainings provided by AKF. The informants were all selected among secondary public school teachers who were teaching only STEM education. In addition, years of experience teaching STEM subjects was another criterion for participants' selection. This study was facilitated by a person who was also selected on the basis of his understanding of both the context and the participants. In the meantime, he has expertise in education. He has sufficient experience in this field and could better communicate with the superintendents of the schools. He has conducted multiple educational programs, including training for teachers.

3.5 Data Collection Methods

Generally, a researcher uses methods used in the research process to give the researcher the chance to obtain the needed data. This study employed two methods: interviews and focus group discussions. For the interview, I created an interview guideline, and for the focus group discussion, I followed an FGD guideline.

3.5.1 Interview

There were six semi-structured online interviews: two with the trainers, three with the teachers, and one with the manager of AKF. I sent a consent letter to each participant before conducting the individual interview, and once I had their contact information, I scheduled the interview for a time that was convenient for them. On the day of the interview, I began this study by building rapport and asking about their profession and work conditions in Afghanistan. I organized the interview guide from general queries to more specific questions, and this made it feasible for the participants to adjust themselves and elaborate more on their insights. I also indicated to them not to hesitate to share the new ideas linked to any questions, even if that question had already been answered. It is noteworthy that each interview lasted a minimum of 25 minutes.

As a result, I could manage to see the participants face-to-face, which gave me a gist for more explication. The interview with the teacher gave the chance to understand the views of the participants about what occurred in the real practice and how they privileged the opportunity. Meanwhile, the interview with the trainers helped me understand how they implemented the training and what approaches they employed after the training. I could also have obtained valuable data from the manager, where I perceived the long-term goals and objectives, successes, and failures in some areas in a comparison manner from his coverage establishment. This study used the Zoom application for gathering the data. At the same time,

I used field notes during the interview and recorded the voices of the participants through a computer recorder and Zoom.

3.5.2 Focus Group Discussion (FGD)

Almost the same process was being followed for conducting the FGD as well. For instance, sending the consent letter would compromise with the participants. On the day of conducting the FGD with the participants, the regulations, like how to consider their talk time, respect others ideas, and other relevant points, were shared in a polite manner. During their speech, he persuaded them to confidently share their contemplation, irrespective of their hesitation. Hence, I got several ideas about teaching STEM education and utilizing laboratories from the teacher, and it provided the chance for each one of them to share their insight as they got the gist from their colleagues. In the meantime, there were some contradictions that the teachers raised, which enabled me to look at the facts from different angles. FGD participants were joined through Zoom, and their voices were recorded simultaneously. Thus, I have used field notes to get more in-depth information from the participants. The length of the FGD with the participants was 85 minutes.

3.6 Role of the Researcher

As an investigator, I had a couple of responsibilities in this study. First and foremost, I was responsible for developing the consent letter, interview, and FGD guidelines in English and getting approval from my supervisor. After that, it was my duty to translate it into the Dari language for all the targeted population because I was aware of the people's knowledge at my research site. Then I sent the consent letter to my participants, and I received their approval on it.

Coming to the FGD and interview guidelines, it was my task to organize the items from general to main, and I also eliminated the sensitive language.

I sent an official email to the AKF regional coordinator and communicated with him to seek his permission to conduct my study at the institution. Meanwhile, I coordinated with the coordinator of Aga Khan Education Services (AKES) in Badakhshan in order to provide PCs and space for my participants. I was in close contact with the facilitator at the site and guided him through the technical steps he had to follow. When I conducted the interviews and the FGD with my participants, I tried my best to avoid imperative language and treat them in a polite manner. Alongside this, elaborating on the items in my own words made it easier for the participants to better understand the concept.

3.7 Data Analysis

After the data collection, I transcribed all the records very carefully and avoided ambiguity points in order to avoid misinterpretations. For this reason, I listen to each recording very carefully several times, along with reading my field notes. Then, I prepare separate reports from the assembled data. For instance, an individual report for the manager interview, trainer interview, teacher interview, and FGD with instructors

This study employed a qualitative approach, and I had six interviews and one FGD. In this regard, I was seeking and exploring more to have an in-depth interpretation. Due to this reason, I was looking for non-textual materials like the emotions and backgrounds of the participants. Likewise, I categorized the data as the final version and reduced the amount of primary coding I found after the first analysis. After that, I reduced the volume of raw data, changed it into meaningful facts, and developed the categories and themes. Thus, I was looking for the relationship between the categories, interpreting the findings, and finally coming to a conclusion about this study (Wong, 2008).

3.8 Ethical Issues and Concerns

It is a recognized and prevalent rule to take ethical values into consideration when conducting a study. Due to this fact, initially I developed the consent letter, reviewed it extensively, and also had the approval of my supervisor on it. After that, I sent the consent letter with detailed content to my participants in order to let them know their function. Besides, at the beginning of the letter, I have given a short background about myself. The paper also clearly mentioned the objectives of the study and all the necessary details.

In the meantime, it required me to send a separate consent letter to the AKF to seek their permission to conduct the interview with their employees. On the days of conducting the interviews and FGD, I introduced myself and again briefly touched on the objectives of the study for more clarification. The FGD required me to politely request that the participants consider the time in order to give everybody an equal opportunity. I had two genders of male and female participants, and due to the tough political atmosphere, I avoided using sensitive words. Meanwhile, I tried to consider the local values and culture, such as calling the participant "teacher, sir, or madam".

Additionally, I tried not to influence the participants, and as has been said, I did not argue with them except to ask for repetition of the points that seemed ambiguous to me. Last but not least, I did all I could to avoid plagiarism. For this reason, I double-checked each citation and tried to quote it in my own words.

3.9 Credibility and Rigor

It can be explicitly understood that for conducting research, the investigator needs potential knowledge to acquire the necessary data to respond to the research questions. I have already completed my undergraduate studies and am familiar with some of the preliminary aspects of conducting a study. Aside from that, I participated in one of the international programs with

the Institute of Ismaili Studies (IIS). However, it was in Dari, but I managed to learn the tips for conducting research in terms of citation, reference, and ethical points. The above quality assisted me in disclosing some papers in Dari.

More importantly, the individual assignments at BRAC University helped me find my feet in implementing a study. For instance, I learned about approaches, methods, tools, sampling, and other relevant topics. Furthermore, I got the chance to take two research courses at BRAC University. Through these two courses, I received individual, peer, and group assignments along with my colleagues to comprehend the process in a proper manner. In addition, I moved through plenty of research papers while searching related literature reviews and took a look at the approaches. Notably, triangulation of sources was used to ensure the validity and reliability of the analysis. This involved comparing the findings from focus group discussions and interviews with other documents, including academic journals and curriculum guidelines, to ensure that the findings were consistent. Afterward, I had the consistent support of my supervisor on every single point of this dissertation. To sum up, I can say that all the aforementioned aspects helped me overcome the challenges and complete my research.

3.10 Limitations of the study

As it is clear, every research project will have its own obstacles and limitations. One of the most challenging issues for me was approaching my participants. Because the research was conducted online, and due to a lack of signal and an unstable internet connection, some of the participants were offline. The research needed to be investigated from students' viewpoints as well, but I could not do that because of a time limitation. Meanwhile, some of the participants had a very busy schedule, and it took me a month to reach out to three of them. Apart from that, because of the restrictions on female participants, it was really hard to communicate

with them. Likewise, the majority of the teachers who participated in this study had baccalaureate degrees, although a bachelor's degree would be suitable for this research.

In addition, I was planning to review a bunch of documents, but the institution did not make them accessible due to some limitations and internal policies. Nonetheless, I was lucky enough to get sufficient data about the curriculum from the participants. Moreover, the teachers did not have an appropriate connection to the internet and confronted challenges in terms of PC, although I resolved this issue in collaboration with AKES. As a result, communicating with the targeted population plus the other mentioned barriers, made conducting this study take a bit longer to get done.

Chapter 4: Results

4.1 Introduction

Prior to all, it will be necessary to have a general overview of the schools and education in Shughnan district. Shughnan is a district located in the north-east of Badakhshan, Afghanistan. Among all the districts of Badakhshan, Shughnan has the highest percentage of a literate population. Moreover, there are 25 public schools with approximately 11,300 students. Additionally, 670 staff members have been working at these schools, 550 of whom are teachers. Likewise, the vast majority of the instructors have baccalaureate or bachelor's degrees (Sayar, 2010). There is a department called the Department of Science (DoS), which is part of MoE and works at the national, provincial, and district levels (NESP3, 2017). This institution, in coordination with NGOs and contributors, develops science-related handouts and materials and supports the public school teachers in different parts of the country, including Shughanna district. The district agency of DoS has close collaboration with AKF in all parts of Badakhshan, particularly in Sghughan district. It oversees the public school teachers in terms of qualitative and quantitative teaching of STEM education and contributes to AKF to upskill STEM teachers (Sayar, 2010).

The main focus of this study was STEM education at secondary schools in Shughnan district and the initiatives conducted by AKF for professional development (PD) on these subjects. Therefore, the study intended to explore the teachers' opinions on the teaching and learning of STEM education and their satisfaction with the training. In addition, the finding sought to ascertain the approaches and supports of that institution with teachers and the respective schools. The overall points discussed concentrated on professional support, pedagogical support, STEM teaching-learning skills development, and learning by doing through the laboratory. This study was carried out with six teacher participants through online Focus

Group Discussion (FGD), two trainers of AKF via online interviews, and the regional manager of AKF through an online interview. The study operated on the Zoom application, and therefore the data was assembled through zoom recoding.

The obtained data was gathered from the participants through a qualitative approach in Persian. Therefore, I transcribed the participants' responses from Dari to English, which resulted in plenty of initial subcodes. I went through these codes in detail, amalgamated them, and then categorized the data on the basis of the primary codes. Then, the authentic study of the previous coding resulted in the development of some initial themes. Finally, after I figured out the primary themes, I refined them in a more proper manner and created polished themes that were prepared for analysis and extending the interpretation. The results of this thematic analysis are now going to be discussed in this chapter in an elaborative manner.

4.2 Professional Development

The Aga Khan Foundation (AKF) has taken some initiatives in terms of professional development and teacher capacity building in public secondary schools in Shughnan district. This institution could manage to conduct some research on STEM education in collaboration with other sectors, which is going to be discussed below.

4.2.1 Collaborative Work for Capacity Building

AKF, in collaboration with Swiss Development Cooperation (SDC), conducted the training in STEM education. For instance, the manager stated in his interview that "the training on STEM education was supported by the SDC of the Swiss government to conduct the training for science teachers" (interview# 6). AKF had implemented the program in its coverage areas like Badakhshan, Baghlan, and Bamyan. The trainers from the mentioned locations gathered

in Kabul and reviewed subjects related to STEM education. For instance, participant number 4 clarified in his interview:

Trainers from Bamyan, Baghlan, and Badakhshan were asked to go to Kabul. Then the trainers reviewed the curriculum [in science subjects] and found the challenges, and then we shared it with the head of the math department. We sat with him, discussed the problems and what was new in the curriculum, and we had training on it (interview# 4).

In addition to SDC, the Department of Science (DoS) of the Ministry of Education, in collaboration with AKF, provided the training: "The education sector of AKF was the only sector that worked with the Department of Science." The training was conducted in collaboration with the Department of Science (DoS) of the Ministry of Education (interview #5).

4.2.2 Curriculum and Module on STEM Training

Initially, AKF sought the cooperation of the Institute of Professional Development (IPD) of Kharugh, Tajikistan. This institution had a contract with AKF of Kharugh and assisted AKF in terms of teachers' professional development in Badakhshan, Tajikistan. It is critical to mention that Shughnan is one of the mountainous locations, and because of the geographical challenges, both the government and AKF could not properly support the schools as there was no street that could link this district to the center of the province of Badakhshan. Therefore, according to interviewee 6 "AKF first asked for the assistance of the IPD of Tajikistan, and the teacher training was conducted under the name of cross-border district training". He further stated that "Before the collaboration with DoS, AKF commenced STEM education training with IPD, and the IPD trainers were asked to develop the training manual and then implement both theoretical points as well as the experiments."

After preparing the handouts of the training, as participant number 6 indicated, "The IPD trainers were officially invited and were given the lesson plan for 12 days in three phases. We gathered the teachers from our cluster schools and conducted the training in TTC construction because we had laboratorial materials in that center" (interview number 6).

Participant 6 also declared that "[when the streets were constructed], AKF became able to coordinate with DoS, and in this regard, the organization sent the trainers to review the national curriculum." After the joint revision of the national curriculum by trainers and DoS, the department of science prepared the manual except for math. For example, participant 4 said, "As far as I know, other trainers have conducted the training based on the manuals that were provided by the ministry of education. In math, I can say that we did not have any specific manual" (Interview# 4). In his interview, he also mentioned that after the revision of the national curriculum, the trainers had training with the ministry of education: "We also had training with the ministry of education in these topics [updated science topics], and then as trainers, we provided training for the instructors to well comprehend the [new] topics" (Interview# 4).

Meanwhile, after receiving the training in the capital, the trainers conducted their training as a pilot phase at the provincial level. For instance, participant number 5 said: "Initially, we [I] participated in the department of education at the provincial level and got the experience there" (Interview# 5, 19, 12, 2022). The aim of conducting this initial training at the provincial level was not only piloting, but the institution trained the supervisors as well, as participant 4 said:

We also conducted the training at the department of education in the presence of AKF authorities and the head of the department of education for college lecturers as well as education supervisors. Because the supervisors are observing the work of teachers, we trained

the supervisors to enable them to make sure how much the method is being implemented by the teachers (Interview# 4).

The interviewee in this study further stated that he was part of the team that reviewed the science subjects, and they have solved the challenging and vague points: "There were some ambiguous activities. For example, their objective was not clear in the teacher guide book, so we went and talked on those points and then came to a conclusion on it." (Interview# 4). As a result of the collaborative work, there was no contradiction between the national curriculum and the handout from the AKF. For example, P# 6 of the focus group discussion asserts that: "The manual was designed in collaboration with DoS, and there was indeed no difference between the curriculums" (Focus Group, P# 6).

4.2.3 Training on STEM Education

When the Afghan government updated the national curriculum, particularly in the far-flung areas of the country, it became hard for teachers to teach the updated curriculum. Therefore, the AKF took this initiative to train the instructors in STEM subjects. For instance, participants 4 said, "Since 2013, the ministry of education has completely updated its curriculum. There are many topics such as derivatives, limits, integrals, statistics, and others that were recently incorporated, and therefore, baccalaureate graduate teachers were not familiar with them." (Interview# 4).

Although the whole curriculum was updated, the priority for training was given to STEM education only. Participant 4 added in his interview that "the problems in other subjects like English can be solved through attending courses or self-study, but in math it is not that easy if the students do not see it practically" (Interview# 4). Moreover, the importance of STEM education is a matter of future success, as participant 5 said: "STEM education entails key subjects that open up the chance for pupils to get admission to their interested field, like

medicine." Also, these subjects enable the students to correlate their study to their lives" (Interview# 5).

Likewise, participant 6 in his interview specified that they initially provided the training at the primary level, and after they saw the demand for secondary education and got the proposal of teachers and school leadership, they ran the training on STEM education: "They argued that secondary school is the time students are getting prepared for the Kankor exam. After their suggestions, we commenced our work with secondary teachers" (Interview# 6).

As it was mentioned, the initiative was incepted by Tajiki trainers in science subjects such as biology, chemistry, math, and physics, and the trainers in each subject had experiments to instill the lessons for the instructors. For instance, P# 1 stated that: "They [the trainers] showed us the heart, kidney, and nervous system. They also operated the frog and showed experiments" (Focus Group Discussion). This training was conducted in three phases. According to P# 6, "In biology, we [I] received it twice in one year and once in the next step, and it was beneficial" (Focus Group Discussion).

The overriding aim of conducting the training on the mentioned subjects at the secondary level was to professionalize the secondary teachers. Participants 6 also contend that "we had few professional teachers, and if we had, they were professional in name only. If you inquired about their expertise, they would not respond to you. Our trainings and workshops took them from theory to practice" (Interview# 6).

According to the participants, while the training was conducted, the trainers first delivered the theory and then did the experiments: "Teachers first taught us about the substances and then executed the experiments. We did many experiments, and the main objective of the training was understanding the materials, because understanding the [experimental] materials is very crucial" (Interview# 2). The teachers got the chance to examine and get experience.

For instance, participant 3 said, "I had an experiment in Charlize law, but the experiment failed because of a lack of experience. For the second time, I did it well, and I realized that there was something wrong with my method the first time" (Interview# 3). It is mentionable that the trainers incorporated their participants' viewpoints into the training. For example, participant 2 declared that:

During the training, when we had any difficulties, like how the materials could be mixed, we called the instructors to help and guide us on how to do the experiment, and based on their instructions, we did that. The training [focus] was on the practical aspect, where we had more problems (Interview# 2).

This approach met the participants' satisfaction, and almost all of the participants confessed that they benefited from that training. For example, P# 3 said: "Previously, geometric shapes had only images in the book, but in the training, the shapes were developed in a very good manner. When we presented that to our students, it was very beneficial" (Focus Group Discussion). The training also gave the teachers insight into 21st century skills through practical steps, as participant 4 asserts: "We told the teachers to group the students to empower their communication, collaboration, and other skills. In the 21st century, we also persuade pluralism and diversity amongst students and teachers" (Interview# 4).

Afterward, the training encouraged the teachers to leave root memorization and shift to implementation and real-life practice, as P# 1 says: "The objective was not only memorizing the facts; rather, the aim was implementing them." I am able to practice it" (Focus Group Discussion). As long as the teachers attended the training, they were promoted from one stage to the next, as P# 3 acknowledged in this study: "Well, from one step to the next step, we [I] felt changes" (Focus Group Discussion). The findings suggest that the training enabled the participants to implement it in real life. For instance, participant 2 indicated: "In that seminar,

the trainers instructed us and taught us. Then we transferred it to our students and delivered it to them" (Interview# 2).

4.3. Follow up Support for Empowering the STEM Teachers

After providing the training, the institution prolonged its support with the respective schools so that it could assist the teachers, and at the same time, it was wandering to make sure the instructors were well prepared and would pursue the insight they got from the training. Therefore, AKF assisted the schools with logistical issues as well as academic support.

4.3.1 Academic Support

AKF provided consistent support for the teachers in its coverage schools. For example, participant 6 stated in his interview that: "Once we provide the training, then the trainers have the duty to go to the classes and observe the teachers' lessons" (Interview# 6). This mentorship program was done for a particular time in each respective school by the trainers: "According to our observation form, we observe the quality and quantity, and the class environment. Once we observe the classes, we are able to find out the extent of implementation of the practical lessons by the teachers" (Interview# 5).

Participant 6 in this study pointed out that the trainers are not only accountable for observing the classes, but they also become role models for teachers: "Once the mentors realize the teachers are not well understood, then they work with them again. If necessary, they will conduct a model class for the teachers to show them practically" (Interview# 6). The mentorship strengthened good relationships and motivated the teacher to share their problems, as participant 4 stated: "The teacher hesitated and did not share their problems, and then we encouraged them to share their obstacles with us. This caused us to build trust and enhance our communication" (Interview# 4).

Meanwhile, the mentors observed the classes from different perspectives to better assist the instructors. For instance, participant 4 asserts that: "I considered one hour of math subject and then observed the lesson to realize whether the teachers have challenges in content knowledge, method, and class management. Then, we practically overserved the question of whether teachers follow it or not" (Interview# 4). The mentorship program was prolonged until all the teachers were promoted to mentor: "This process is continuous until the teachers are promoted to mentor level, and then, through collaborative working, all teachers find the chance to improve their knowledge and get mentored" (Interview# 6).

In its coverage, AKF had registration books for implementing the experiments for each teacher to ensure whether the training objectives were pursued or not. For instance, participant 6 says:

Each teacher in our coverage school had a registration book, and when they did the experiments in each subject, they wrote down the date along with the experimental materials. When our mentors went on field observations, they looked at the registration books, and based on that, they measured what the teachers implemented in their classes. (Interview# 6).

In addition to the above approach for ensuring the implementation of the training objectives, students' performance was also one of the ways. For example, participant 4 stated that "we also evaluated the pupils' results to address the changes from the previous years. Meanwhile, we measured the seminars' impact through students' rates of success in the Kancor examination" (Interview# 5).

In addition to the mentorship program, the institution operated another approach called Teaching Learning Circle (TLC). For instance, participant 6 continued in his interview by saying, "We have another approach called the Teaching and Learning Center. Our mentors

went to the schools and asked the teachers to write down their problems. Then [our mentor] assigns the experienced teachers to lend a hand and assist their colleagues" (Interview# 6).

According to P# 3 of FGD, the TLC assisted the teachers to improve their knowledge through sharing ideas with each other: "In each school, it [the TLC] is created based on the subjects, but teachers can extend this circle and incorporate teachers from different expertise" (Focus Group Discussion). Similarly, participant 6 confirmed that mentorship and TLC were the two invaluable programs: "As long as they come together in a year, they could solve their challenges. Honestly, we benefited more from these two programs" (Interview# 6). He also prolonged that through an approach named reference school, they involved teachers to train their colleagues. "We brought teachers from other schools [reference schools] to be trained in order to solve their difficulties" (Interview# 6).

Furthermore, the institution assigned experienced teachers to train the newly hired teachers on empirical issues. For instance, participant 6 in his interview said: "We had some teachers called Key Teachers (KT) who were reliable teachers and taught other teachers the laboratory. Once we ensured that the other teachers got enough knowledge of the laboratory, then they went to their schools and did the experiments" (Interview# 6).

Thus, these approaches ended in a good outcome, particularly for newly hired teachers to get more experience: "As a result, those teachers who were experienced improved, and those who were less experienced at least learned something about their expertise and became able to utilize the laboratorial materials, such as in math and physics subjects" (Interview# 6).

4.3.2 Teaching-Learning Materials Support

AKF, in addition to proving academic support, also supported its coverage establishments with teaching and learning materials via a variety of approaches. For instance, participant 6 contends: "We had resource centers in all schools where everything was available for

teachers" (Interview# 6). Interviewee 2 also appreciated the institution's assistance: "They came to school and motivated us, as well as providing the materials like test tubes" (Interview# 2). In addition, the organization employed another approach called reference schools," which could assist the schools' in their proximity that had little material: "Reference schools had good teachers and active students and were equipped with resources" (Interview# 6).

In the meantime, AKF opened some experimental schools called Up Schools, which were equipped with more resources. For example, participant 6 said, "We had some experimental schools, and they had more resources, which called up schools. We aimed to ask other teachers to come to these schools and solve their challenges" (Focus Group Discussion). In addition to the above-mentioned approach, AKF used another approach called cluster schools: "We had cluster schools equipped with materials, whereas some of the schools did not have that much adequate material" (Interview# 6). According to participant 6, for schools that lacked enough materials, their prescription was to use low-cost materials, which he believes result in active learning:

We encourage the teachers to bring sand and [shade] leaves and show them practically. Even so, we tell the instructors to take their students to the garden, teach them in an open area, and integrate the local materials. This approach, in turn, results in active learning when students see, touch, hear, and have real-life experiences. (Interview# 6).

Eventually, the institution had a partnership with Teacher Training College (TTC), which was also equipped with adequate laboratorial materials: "We had contributions from four TTCs, and through this program we asked for their assistance. Sometimes, the school teachers went to them to solve their problems, and sometimes they were asked to go to the schools" (Interview# 6).

4.4 Pedagogical Skills Development in Facilitating STEM Subjects

The study uncovered that the initiatives taken by the institution benefited the participants in terms of lesson planning, pedagogy, and class management.

4.4.1 Lesson Plan Development

Almost all of the participants in this study acknowledged that they learned essential points about lesson plans in the training. For instance, P# 1 acknowledged that "the experience we [I] have from previous years from that training, [I believe] if we [I] did not have that training with the support of respected AKF, I would face challenges while implementing the lessons" (Focus Group Discussion).

Similarly, interviewee 3 confessed that he realized the importance of the lesson plan for the readiness of the teacher in implementing the lessons: "Also, [using the new method] in the lesson plan and how it prepares the teacher to completely implement the lessons were interesting indeed" (Interview# 3). At the same time, P3# said that developing the materials was one of the crucial points he got from the training: "In my view, in terms of lesson planning and providing the materials, it was beneficial, and the trainers also emphasized that" (Focus Group Discussion).

The aforementioned point in turn confirms the declaration of participant 6, who asserts that their emphasis was on sustainability in their coverage establishments: "The aim of this program was to enhance the capacity of teachers and education authorities at the district level. Because the mentioned hierarchy has always existed in the school, they can proceed with their work even in our absence" (Interview# 3).

4.4.2 Pedagogy of Teaching and Learning

The sustainable goal for the instructors resulted in a learner-centered approach and the incorporation of useful pedagogies for teaching. For instance, P# 2 said: "Before these trainings, the practice was more teacher-centered. That approach has been changed, and teachers are playing the role of facilitator, and the students are active" (Focus Group Discussion). Apart from the training, when the mentors visited the schools, they emphasized the teachers' need to employ a learner-centered approach: "They [the trainers] check if the teachers implement a learner-centered approach and work with all students or not". (Interview# 6).

This frequent observation by the institution gave the teachers insight into involving their students in the lesson. According to P# 1: "[as a teacher] I work on only one question with students, and then I group them and ask them to learn from each other. Because students do not learn only from the teacher" (Focus Group Discussion). Meanwhile, interviewee 3 specified that the training enabled him to employ different methods to engage his students: "I use different methods. I use question and answer and group work" (Interview# 3).

Moreover, the training assisted the participants with the very fundamental aspects of teaching and learning. For instance, interviewee# 1 said:

Before the training, I did not know how to enter the class, how to behave with the students, or how to begin the lesson. I just entered the class, took the book and taught the students, and then left the class, but from that training I learned more about group work and assessment (Interview# 1).

In the meantime, according to participant 4, the views and skills of the teachers stem from the consistent work of the institution with the instructors: "We told the teachers to employ different methods to involve the students. We suggested they run individual work, pair work,

and group work and also conducted an activity-based approach in our training" (Interview# 1).

4.4.3 Class Management Skills

The training on STEM education enabled the teachers to differentiate their students' capacities based on the insights they gained from the training. For example, P# 1 of FGD contends: "In a class, we have different capacities." We [I] categorize the students into top level, middle level, and lower level, and then we shuffle these three categories" (Focus Group, 08-12-2022). Participant 3 also raised categorizing his students, and he perceives this would be a better way to stimulate the learner to get engaged: "I divide the class into three different categories. We encourage the students to discuss with each other" (Interview# 3).

Interviewee 2 in this study stated that the main target is to involve the learners in different ways: "In that lesson, those who are a little weaker, we put them in groups and ask them to come in front of class, and we [I] instruct them" (Interview# 2). The participant further contends that she works step by step with the learners: "We [I] introduce them to the equation and assign a person as a representative of the group. Our focus is more on lower lever students by considering their capacity when we work with pupils" (Interview# 2).

The teachers learned in that training how to behave in class so that the students feel comfortable in a comfortable environment. For instance, participant number 3 said, "Now we [I] motivate the students. We [I] follow the steps like greeting with a smiley face and assessing the homework of the students. If they did not learn, then I will explain the lesson again" (Interview# 3). Similarly, teachers are working with their students with more tolerance and patience to make them understand: "If the students do not learn well, they receive homework. If the students do their homework at home, it is good, if not, they will tell us that they did not learn, and then we will work with them again" (Interview# 2).

Nonetheless, this study uncovered that teachers lack 21st century skills, and even they have a negative perspective on some of the skills, like critical thinking: "We told the teachers that the main goal of critical thinking is not challenging others, rather it is positive and can reform the students, school, and community" (Interview# 4). More surprisingly, this study figured out that the skills obtained by teachers in STEM education were applicable to non-STEM subjects.

4.4.4 Skill Applicability in Non-STEM Subjects

Although the training focused on upgrading the skills of teachers in STEM subjects, they could manage to apply it while teaching non-STEM subjects. For example, interviewee 3 said, "I found the methods applicable to other subjects too. For instance, when I teach minerals in geology, there are things I studied about in chemistry that could assist me" (Interview# 3).

Similarly, P# 2 and P# 3 of the FGD raised the point that as long as they have practiced the received methods, it has made them contemplate their application to other subjects that are not their expertise. For instance, P2# said that she has taught the subject culture and asked the students to practice it, which was enjoyable for the students. Similarly, P3# said when he teaches any subject outside of his field, he presumes how to bring the theory into practice: "For example, in Dari language and particularly in Islamic studies, the topic was about Istanja, and I asked my students to take ablution" (Focus Group Discussion). He also continued in the training and realized the usage of some of the mathematics formulas in real life. He said that: "The formula, (a+b)2 = a2 + 2ab+b2... In the training, I learned that this can be used to measure the acreage, and students can measure the length and width of a room with it" (Focus Group Discussion).

Nevertheless, there is an instructor who disagrees with the above point:

I think teaching out-of-the-field subjects will not be that suitable, even though, exceptionally, it is true that we can show our culture or other things practically. Therefore, I assume if the teacher did not get the [detailed] training in any subject, it would be hard for them to implement each lesson through practice (Focus Group, P5#).

4.5 Learning by Doing in STEM Education

4.5.1 Utilizing Laboratory

The underlying aim of the training on STEM education by AKF was to prepare the teachers in order to implement practical lessons with their pupils. For instance, Trainer 2# said: "The objectives of STEM education were to prepare the teachers to integrate materials in order to make the students well understand the theory through practical lessons" (Interview# 5). The participants in this study expressed that utilizing the laboratory introduced the students to technology that was unprecedented. For example, P6# stated: "This approach familiarized the pupils with technology like microscopes, which they did not know about" (Focus Group, P# 6). P# 2, with the same view, said that: "The students before only studied about convex mirrors, concave mirrors, and telescopes, but when they observed them practically, it improved their cognitive development, their skills, and their perspective" (Focus Group Discussion).

Likewise, executing the laboratorial experiments facilitated the teaching-learning process and allowed the instructors to let their students interact with each other: "Now, when we take the students to the laboratory, if the students ask a question, we elaborate, and they learn more through practical lessons than theory" (Interview# 3). Meanwhile, interviewee 5 perceives that this approach will make the students feel the lesson in their everyday lives: "This will make the students believe that what they study exists in real life as well" (Interview# 5).

Similarly, participant P# 2 of FGD said that her learners are very pleased when she takes them to the laboratory: "I am teaching physics, I use the materials, and my students are very pleased and satisfied" (Focus Group, 08-12-2022). Even the practice of the laboratory galvanized the student to explore on their own. For instance, P# 1 said of FGD: "When we implemented it [the experiments] in our class, that motivated the students, and even they went to the butcher and brought the animal's body to class" (Focus Group Discussion). In the meantime, practical lessons at schools would assist the local and national economies. For instance, P# 5 in the FGD said: "We always read about making soap in the books, but now we practically examine it. If there is good condition, it can help the rural economy [development] and even the country" (Focus Group Discussion). He further stated that his students' intent is to create soap in their locality, but they lack the required tools: "We have only access to some simple things in the laboratory, which are not available in our village. Although we have the material in the village, there are no tools to create it".

The interviewee 6 also said in his interview that the students privileged this opportunity and successfully passed the Kankor exam: "If there was no support for us from the teachers, I assure you that students would not succeed. Even if they succeeded, they would have gotten admission in TTC or other fields, which do not prepare them for the job market" (Interview# 6). Interviewee 4 also expressed his experience in his own village as an exponential consequence of the training: "Years ago, in our [my] village, only I passed the Kankor exam and succeeded in education faculty, but now we have many engineers and other fields graduate" (Interview# 4).

This training not only benefited the learners, but also the instructors. For example, interviewee 3 indicated: "I have attended other seminars, but I found the science training provided by AKF the most beneficial, and I can say, it had 95 to 100% impact on me" (Interview# 3). The same point was also voiced by interviewee 6: "The training enabled the

teachers in grades 10, 11, and 12 [secondary level] to do the experiments as they had access to the resources and participated in practical trainings" (Interview# 6).

Consequently, the approaches motivated the instructors to explore more about their expertise. For instance, FGD P# 1 said: "Well, personally, the seminar enabled me to explore more about my [expertise] from the internet and other resources" (Focus Group, P# 1). Despite the fact that the students who participated in this study conceded their achievements and appreciated the training, they also raised some obstacles in their way.

4.6 Challenges of STEM Teaching-Learning

4.6.1 Lack of Resources

Almost all of the participants acknowledged that they lack sufficient materials in their schools. Therefore, they suggested that AKF support them with materials and a laboratory. "Please support us with the laboratory as well as provide us with the training again (Focus Group, P#1, P#2#, P# 3, P# 4, P# 5#, P# 6). Interviewee 3 also declared that because of inadequate resources, he is not able to execute the experiment: "We cannot do experiments nowadays that much. I can tell you that now I have no stationery, not even a piece of chalk" (Interview# 3).

However, interviewee 5 said that in the absence of the materials, teachers can improvise with low-cost materials; on the contrary, interviewee 4 perceives that in the long run, it would be a hard task to do. "Overall, in math, we lack adequate materials compared to the other subjects. For example, it is hard for the teachers to learn how to create from paper" (Interview# 4).

4.6.2 Human Resources Challenges

According to interviewee 6, one of the challenges the organization faced was a lack of professional teachers in the remote areas: "In some isolated areas, there is no expert teacher

to implement the experiment with the students" (Interview# 6). Even after the training, when the teachers got enough knowledge and experience, they moved to another organization, and this put the institution in trouble: "We found out in our assessment that when we scaled up the teachers, they shifted to other organizations, and then there was no expert teacher to use the laboratorial materials" (Interview# 6). He also said, "The materials became obsolete, and there was no expert teacher to utilize them.".

Lack of professional teachers was really challenging for the institution because it was sometimes even risky: "We noticed that in one of our coverage schools in [X district of Badakhshan], in one experiment, the chemical materials exploded, and as a result, students were about to be poisoned" (Interview# 6). Meanwhile, the Trainer1# stated: "Some of them [teachers] were not able to execute the experiments right after the training." (Interview# 4).

In addition, the lack of female teachers is also serious, as interviewee 6 said: "In particular, we have problems with female professional teachers in remote places" (Interview# 6).

4.6.3 Outside Barriers

Moreover, the predominant change in position was another problem that caused even non-professionalism. For example, interviewee 3 contends: "In my point of view, change of position is occurring frequently, which results in non-professionalism. Because there are teachers, they teach the subjects they are not experts at" (Interview# 3). Meanwhile, participant 6 contends that AKF was able to cope with this challenge, but still, it is serious: "Then again, for the second phase, we followed the same approach and trained them for nearly 20 days. Likewise, we conducted the third phase and were able to cover all teachers in [secondary] school" (Interview# 6). Furthermore, the teachers are suffering from economic issues. For instance, interviewee 3 said in his interview that "I believe teachers require financial and physiological support" (Interview# 3).

The program was stopped because of the pandemic and subsequently the political changes: "The first years due to the pandemic and then the collapse of the government posed a delay in our implementation of the program. Then our partners [the donners] told us that they could not support us" (interview# 6).

Chapter 5: Discussion and Conclusion

5.1 Discussion

This study is intended to scrutinize the Aga Khan Foundation's (AKF) initiatives in teaching and learning skills development in STEM subjects in secondary public schools in Shughnan. Moreover, the study also aimed to realize which approaches have been executed by the institution to conduct the training for the tutors in one of the most deprived areas of Afghanistan. In addition, the study ascertained how the approaches gave the teachers insight into creative learning, which reflected students desired learning and requirements. So, the research revealed that the most noticeable thing the organization concentrated on, was conducting the training, and then it provided follow-up support via a variety of approaches. Nevertheless, in terms of teaching-learning skills and 21st century skills, teachers still need assistance to nurture their learners with future-demanding skills.

Research carried out by Jong et al. (2021) attests that prior to implementing professional development, the superintendent should communicate well. Apart from that, STEM education requires clarified and evidence-based goals and objectives in each school. The above study specifies that the school leadership should have more interaction in conducting the PD and work to design a curriculum containing pedagogy and learning activities for STEM subjects.

Another study conducted by Custer et al. (2007), as cited in Avery & Reeve (2013) asserts that if schools are to develop effective PD programs, they have to consider the following aspects:

Initially, conducting any training or PD requires a research plan that provides a clear picture of the topic and, as a milestone, assists the trainers in implementing the STEM training. The second thing that should be taken into account is providing a targeted plan and content that provide a meaningful picture for the beneficiaries. Furthermore, the trainers, in collaboration

with the stakeholders, should go for an updated curriculum that matches the international frameworks.

In addition to up-to-date curricula, there should be advanced materials available. So, this in turn could provide the opportunity for the participants to benefit from the training, and later the STEM students would obtain the updated knowledge. Moreover, as the STEM subjects are interlinked in some ways, there should be a correlation between their disciplines. For better alignment between these disciplines, schools have to have good collaboration with experts in order to reach this goal. Alongside that, the curriculum developer will also need to define a clear and proper model for effective PD, which could be simplified and considered relevant practices.

In light of the above prerequisites for conducting PD training, according to MoE (2017), in the context of Afghanistan, there is a collaboration between the Ministry of Education (MoE) and the Ministry of Higher Education (MoHE). The ministries concentrate on providing different parts of PD for teachers. Their collaboration includes developing the curriculum for PD, removing the overlapped points, and facilitating proficiency for tutors to proceed with their higher education. The MoE is focusing on resource provision and conducting in-service training for school teachers, which was also mentioned in the study of Jong et al. (2021). The MoE concentrates on recruiting professional teachers for Technical and Vocational Education and Training ("TVET") (MoE, 2017, p., 22) and conducts the training based on the strategic plan that matches the needs of the beneficiaries. Nevertheless, considering plenty of obstacles, including war and economic deficiency, the curriculum is not based on internationally recognized standards, which is contrary to the findings of Custer et al. (2007). In spite of that, the MoE endeavors to improve the quality of its curriculum as part of its mission. It is mentionable that the main barrier would be far-flung areas where the MoE is confronting lack of professional teachers and particularly female teachers. Therefore, the

ministry would recruit highly competitive school graduates and support them with preservice and in-service trainings (MoE, 2017).

As it was pointed out, STEM subjects are interconnected, and this requires the schools to incorporate all components while developing PD for teachers. A study conducted by Chai (2019) declares that engineering is one of the most important elements of STEM, but little attention is paid to this subject. The writer further argues that engineering is not yet a core part of STEM education in the school curriculum. In this regard, teachers are more likely to be well aware of it. So, the school can ask the engineering faculty to train and coach the teachers. In addition, the schools can fill this gap by taking tutors on field visits to laboratories and industrial manufacturers. The author suggests that schools could focus on the paramount topics like earthquakes, agricultural engineering, nanoscience, material science, biomedical engineering, and engineering in health (p. 8).

Additionally, integrating technology is another prominent thing that should be considered in STEM education. Almost all STEM teachers need to master the necessary aspects of technology for better implementation of their professions. For instance, the person who is teaching biology has to master bioinformatics, and the tutor who is teaching engineering has to enhance his or her knowledge of computer design. Eventually, STEM teachers should boost their knowledge and skills in Technological, Pedagogical, and Content Knowledge (TPACK), (Chai, 2019, p. 6).

A study conducted by Safi (2014) acknowledges that while providing PD for teachers in Afghanistan, the MoE conducts a need assessment in order to prepare a need-based model for the training. The author states that the MoE allocated time to develop a well-defined curriculum for PD in consideration of pedagogy. He further declares that the curriculum focuses on developing related activities and models for teachers that enable them to apply them in their classes. In contrast, he specifies that engineering is the least focused subject in

Afghanistan. It is only being taught in higher education, and therefore only a few students get the chance to get admission in this field, though my participants did not mention this point. He also indicates that both at the secondary and higher education levels, technology is not integrated, and because of that, university graduates face challenges in the job market. Therefore, the education system of Afghanistan lacks the two main components that are present in most other countries. On the contrary, what was emphasized about the comprehension of TPACK by each teacher in the study of Chai (2019) shows that it is not yet applicable in Afghanistan.

Meanwhile, as was earlier discussed in an international context and at the level of Afghanistan, my study revealed that some of the criteria were addressed. Firstly, there was a rigorous collaboration among the Aga Kahn Foundation and Institute of Professional Development, as well as the Aga Khan Foundation and Department of Science, and the Aga Khan Foundation and Swiss Development Cooperation. The collaboration was in resource allocation, developing a curriculum and models, removing the ambiguous points, and defining the objectives for training, which resulted in a demanding curriculum that met the needs of the participants. The findings of this study put forward that there were mainly three types of training modules developed in light of the national curriculum for conducting STEM training. The first one was developed by AKF-Afghanistan, and then it was sent to AKF's cross-border agency in Khrugh for further review and enhancement. The second module was exclusively created by AKF trainers in statistics, which was more challenging for teachers and had scarce resources. The third one was developed by the Department of Science (DoS) and implemented by AKF trainers in Science and Mathematics (SM) (S = Chemistry, Biology, Physics, and M= Mathematics). The findings also suggest that the main goal of the training was to equip the teachers with proficiency in STEM subjects. Therefore, the tutors were trained to comprehend STEM-related topics through empirical and real-life practices in

the training. As the majority of the teachers had baccalaureate degrees, it was necessary to enhance their content knowledge and teaching skills simultaneously. The institution also aimed to professionalize the participants, which could give rise to a high rate of student admission to higher education. Meanwhile, this study exposed that the AKF trained the supervisors and maximized their skills, which helped them observe their subordinates in a professional manner. The participants in this study declared that the real practice of STEM, provided by IPD teachers, was relevant to their interests and needs. On the other hand, as it was already mentioned, Shughnan, as part of Afghanistan, does not have access to technological tools to be integrated into STEM subjects. As it was earlier noted, engineering is also not part of the school curriculum in Afghanistan, and as the training of AKF was implemented in light of the national curriculum, engineering was not part of the training. Eventually, based on the findings, it can be argued that, from the acronym "STEM" the participants in this study only witnessed "SM". As per my participants' declaration, only Science (Chemistry, Physics, and Biology), and Mathematics were incorporated in the training and follow up support.

I went through a rage of studies and found that their findings suggested that follow-up support was part of PD, which could bring about sustainability and was also considered by AKF. One of the ways to follow up could be through mentorship. This approach has been defined as the exchange of knowledge between experienced people and less experienced people. The mentor provides mostly support, guidance, and feedback that assist the mentee both in their professional and personal lives (Fifolt & Searby, 2010).

Chia (2019) specifies in his study that the mentorship and follow-up support they provided for teachers witnessed a significant change in tutors' careers. This author indicates that prior to implementing the mentorship program, they trained the mentors in a proper manner. The mentioned writer further states that after preparing the mentors, they developed a yearlong

PD training for teachers as a sustainable process. In the meantime, they asked the experts to lend a hand during their program of scaffolding and coaching the teachers. The above study emphasizes that, in terms of sustainability, it would be viable to create a teachers' community that can prolong working together and swap knowledge, skills, and ideas.

The mentioned study points out another corresponding study conducted in South Korea in which STEM teachers came together, developed a PD plan, and worked on areas where they felt a lack of dexterity. For instance, the teachers have worked on lesson plan development in STEM education. Likewise, the teachers assisted each other in terms of content knowledge and incorporating teaching-learning materials in STEM subjects. Meanwhile, the teachers had the opportunity to reflect on each other's views and practices.

According to the MoE (2017) in NESPIII, the MoE of Afghanistan intended to utilize the mentorship program in order to skill up the teachers after the provision of training. Therefore, it desires to operate the mentoring program at the following three different levels. The minority of teachers who have less than a 12th grade degree need constant support and mentorship. Similarly, the majority of the school teachers have high school certificates and baccalaureate degrees, and therefore they also require support to become qualified to teach STEM subjects. whereas another minority is teachers with a bachelor's degree who could support the two mentioned groups in their schools where they are available. Apart from that, the MoE tends to equip the mentors with enough knowledge and skills to prepare them for implementing the follow-up support through mentorship and creating Techer Learning Circles. This approach is somewhat identical to that of Chia (2019), and the research has been conducted in South Korea. The reason for this correspondence could be because of the different initiatives and international experiences applied by the MoE of Afghanistan.

A study carried out by Halimi (2013) showed that the mentorship program in Afghanistan is focusing on teachers' empowerment to enable them to apply STEM-related skills in real life.

Despite this, the mentioned study found that teachers' success is not always the same in all schools. In their study, the writer found that only a small number of the teachers responded that they were capable of incorporating real-life practice into STEM education. The study particularly mentioned that statistics was one of the topics in math that was applicable to a small number of students. The mentioned finding indicates that students showed more interest where they found the topics relevant to daily life. Meanwhile, according to the aforementioned study, the less aligned the topics in students' routine lives, the more boring it is for them and demotivates them, which is true for all STEM subjects.

Another study conducted by Guskey, and Yoon (2009) addresses some of the effective approaches to PD that could be useful at the school level in Afghanistan. One of the enterprises could be building bridges among different schools. The above authors argue that if there is regular discussion between the instructors, they could maximize their knowledge and proficiency. The above writers claim that when teachers from different establishments encounter their counterparts, they can exchange ideas, experiences, unique values, and attitudes. In the meantime, this approach could provide the opportunity to address the real problems and provide solutions after discussing the issue across the board.

A corresponding study carried out about professional development in Turkey by Yabas and Boyaci (2022), demonstrated that teachers, after participating in training in STEM education, got the yearlong support of their mentors. The above study attests that during the training, the teachers obtained both theories related to STEM subjects and classroom practices. But after the training, the tutors were assigned STEM-related projects with the incessant support of the mentors. The mentioned study states that the instructors designed their lesson plan and the required materials in light of what they had studied in the training and then submitted them to their mentors. For the second time, the teacher, with the assistance of their mentors, again worked on developing the content, activities, and practices. In the meantime, they also

worked on integrating teaching-learning materials, and incorporating 21st century skills into their lesson plan and the whole project. Eventually, after the completion of this process, the teachers implemented the project, and in each session they were supervised by their mentors and got feedback on how to put the theory into practice and improve their lesson plan to create a better learning environment.

My study uncovered that the follow-up support by AKF demonstrated similar results to the studies of Yabas and Boyaci (2022), although there were some noticeable differences, which will be discussed as follows: The follow-up support was done in terms of academic support and teaching and learning materials in accordance with the policy of the MoE. This approach benefited the schools regarding the quality and quantity of STEM education in Shughnan district. The follow-up support was implemented through mentorship in three forms. The first form was done by mentors of AKF and school teachers. The second form was done teacher to teacher as a group named TLC, and the third form was done teacher to teacher as an individual named Kay Teachers. For example, the trainers at AKF first observed the class and discovered the flaws. Then, they approached the teachers and closely worked with them to raise their skills and knowledge. They also provided role-model classes for teachers to make it more practical and make the teachers well-versed in STEM practices. So, these approaches feed into good relationships between the teachers and the mentors and the teachers and students. In addition, the mentorship of teacher to teacher as a group through TLC assisted the instructors to solve their challenges and get promoted as professional mentors.

Moreover, the institution bridged the schools through mentorship by experienced teachers, whom they called Kay Teachers, and a similar approach to connecting schools was also addressed in the findings of Guskey and Yoon (2009). The Kay Teachers trained their mentees how to execute the experiments, which could give the other teacher the chance to learn and look for the same opportunity in the future. Likewise, the organization connected its

coverage schools through different enterprises such as up schools, cluster schools, and reference schools. This, in turn, assisted the schools in helping each other with the resources, as well as visiting the schools and learning from each other's experiences. All the above quests in turn resulted in the good performance of the students in classes, and eventually this facilitated the majority of learners getting significant admission in the Kackor exam.

Afterward, a study carried out by Stohlmann et al. (2012) indicates that STEM education requires teachers with a high level of skills and knowledge who could come up with brilliant ideas that could motivate pupils. The mentioned study specifies that when there are capable teachers who can embed effective pedagogy in their lesson plans, it will result in students' performance, self-esteem, and positive attitudes.

The above study found that teachers were considering the following things while teaching STEM education:

Firstly, tutors focused on the alignment of their lesson and its correlation with students' daily lives. Teachers were capable of understanding their students' knowledge gaps, and based on that, they could differentiate their students, which enabled them to provide need-based lessons. Secondly, the instructors considered the prior knowledge and skills of students that could enable them to deliver their lesson on the basis of the learners' existing knowledge. In addition, tutors created student-centered lessons where students expressed themselves and became more involved in the teaching-learning process. Likewise, teachers provided the opportunity for their learners to relate each lesson to their daily lives and cultures through inquiries and incorporating technology.

Another study conducted by Lavi et al. (2021) showed that teachers incorporated particular activities and teaching pedagogies in order to strengthen STEM students' knowledge and skills. The most prevalent thing everywhere is teaching through lecture. But this method

would not work all the time because students are more likely to learn in different ways. Therefore, teachers in the mentioned study utilized individual work and asked students to use their meta-knowledge. Besides, teachers used pair work, and project work to make the students think beyond their content knowledge, because through project work and group activities, learners could maximize their skills and knowledge. Moreover, STEM teachers assigned their pupils to do some research in order to familiarize them with the research approach and persuade them to come up with innovative ideas. For innovation, the teachers thought about things that were not familiar to the students. Apart from that, learners received reflective-based investigations, which increased their critical thinking and problem-solving skills. For example, students were given a challenging-based task and explored it from different sources, which made them examine it again and again. Eventually, the above study revealed that students had made more progress compared to their previous year's performance.

I reviewed a range of studies about teaching STEM education in Afghanistan to find that different teaching pedagogies were considered in STEM subjects, but most of them focused on the challenges of the country. Only a few of them, like Safi (2014). Halimi (2013), and Goddard (2018) pointed out some of the pedagogies implemented in schools by STEM teachers. For instance, Halimi (2013) and Goddard (2018) addressed learning activities like pair work, group work, and individual work. The mentioned studies, in some cases, even criticized teachers for not being able to well manage the classes. For instance, Halimi (2013) indicates that there was less alignment between the previous lesson and the new lesson in her observation. In addition, Goddard (2018) specifies that a lack of resources and teachers' preparation causes students to not show much interest in STEM subjects. He further indicates that teachers mainly rely on lectures and pay less attention to learner-centered approaches in

STEM subjects. He continues that students are given less time, and therefore they remain passive learners.

As it was pointed out in the aforementioned studies of Stohlmann et al., (2012) and Lavi et al., (2021), they specified a wide range of teaching pedagogies, which were not all addressed in my finding. In contrast, my participants have only raised a few of the teaching pedagogies in this investigation. The informants contend that after receiving the training and follow-up provided by AKF, it enabled them to develop their lesson plan and the required learning materials. In addition, teachers used some of the activities, including group work, individual work, and some other learner-led activities. Teachers in their interviews and FGD mentioned that they concentrate on how to involve their students and provide them with a better learning environment both psychologically and physically. The teachers specified that they focus on analyzing their classes due to identifying the different learning levels in classes that enable them to provide their lesson on the basis of students' demands. Differentiating learners is what was emphasized by Stohlmann et al., (2012), as they argue that it could enable the teachers to realize their students' strengths and improve points. Moreover, teachers in my study indicated that they attempt to work in different ways with slow learners. Furthermore, the instructors pointed out that they are endeavoring to galvanize their students to contemplate the application of the lesson in their daily lives, which makes the lesson meaningful. Nonetheless, the teachers did not mention project work, reflective-based lessons, or research, which are important for increasing students' 21st century skills. As it was earlier discussed, this is because following the centralized national curriculum constrains the teachers' work.

In addition to the points mentioned, STEM education requires schools to incorporate lots of materials in order to engage students and let them experience real-life practices. So, it is the duty of teachers to speculate first and estimate which materials would be needed for students'

real-life practices. For instance, when there is a car project in engineering, teachers can purchase the needed tools in advance. It could be possible to design a project from low-cost materials in order to give students the opportunity to practice STEM studies via available tools in their locality. Nowadays, schools attempt to allocate enough resources for STEM teachers, including the internet, programs for designing, and software, in order to equip classes with modern tools. In addition, STEM activities and practices require enough space for practicing and storing the different projects Stohlmann et al., (2012).

Lavi et al., (2021) assert that they used four methods, including laboratory, in their study for students' skill development. The above authors indicate that when learners were sent to the laboratory and did the experiments, it helped them get more involved and everything was understandable for them because the pupils obtained new things through practice and the result of each step was obvious to them. Likewise, when students challenged each other's work, that made them redo it and come up with new ideas and approaches. Hence, these all resulted in the development of soft skills among the students.

Another corresponding study conducted by Zhbanova (2019) demonstrated an interesting result where STEM was taught by integrating art. The above study demonstrated that the focus in STEM education was on creativity. For example, when the biology teacher taught students about marine life, he or she was asking the students to create those things by painting and designing. Similarly, students in engineering subjects were motivated to design and paint the things they had studied. Furthermore, students in math subjects were asked to develop things in a creative manner to measure their class environment, and they received individual and project based assignments to investigate more about what they had been taught.

In the context of Afghanistan, it seems that the MoE (2017) clarifies that the MoE has the mission of utilizing laboratorial materials in STEM education. The above plan desires to

integrate laboratories into STEM subjects in collaboration with NGOs. In contrast, a study conducted by Samady (2007) and Azam, Fauzee, and Daud (2014) demonstrated that the MoE, because of its dependency on foreign aid, could not reach the under-resourced schools in the remote areas of Afghanistan. The mentioned findings contend that even in urban areas where technology and laboratories are available, a lack of professional teachers means that learners cannot benefit from the opportunities.

I have discovered in my studies that AKF's main focus was practical lessons through incorporating laboratorial materials. It is remarkable that the result of utilizing laboratories showed consequences in the studies of Stohlmann et al. (2012) and Lavi et al. (2021). For instance, the participants in my study mentioned that the ultimate goal of providing training, communication with different partners, and mentoring with the teachers was to inspire the instructors to teach the students through real-life exercises. My study figured out that this approach resulted in students' satisfaction with the lessons as they became engaged and executed the experiments. Alongside that, the participants indicated that utilizing the laboratory maximized pupils' motivation, because they interacted with their peers and learned by using laboratory materials. Additionally, the learners got familiar with the usage of some technology, including a microscope, a convex mirror, and a concave mirror. In the meantime, the real life practices motivated the teachers to investigate their expertise and do more research. Nevertheless, the institution could not reach some of the areas as a result of geographical issues and a lack of materials and human resources.

5.2 Conclusion

Overall, this study aimed to investigate Aga Khan Foundation (AKF) initiatives in teaching and learning skills development in STEM subjects in secondary public schools in Shughnan, Afghanistan. The study found that there is an extensive demand for STEM education in a global context. Therefore, countries are attempting to focus on investing in STEM subjects and teachers in schools. So, governments allocate budgets to schools in order to equip them with state-of-the-art technology, laboratories, and resources. Mainly, they attempt to teach the learners in a way that enables them to obtain 21st-century proficiency. On the downturn, STEM education is facing many challenges in Afghanistan, though in the last 20 years, schools have witnessed some improvements. For instance, economic dependency, a lack of professional teachers, and political challenges make it difficult for the government to provide standardized STEM education for students. As the findings suggest, the government cannot afford to incorporate modern technology into schools' curricula. Meanwhile, the schools are encountering challenges in terms of teaching pedagogy and real-life practices. My study with the participants showed that AKF collaborated with private and governmental organizations to implement STEM education initiatives in three provinces, particularly in the district of Shughnan, Afghanistan. The AKF invested its time and energy in planning the program and used its internal resources from other regions, like Tajikistan, to train teachers in utilizing laboratories. The organization conducted the training, where the focus was on utilizing laboratories and upskilling the teachers with teaching-learning pedagogy. Apart from that, the institution helped the teachers equip themselves with content knowledge and emphasized putting it into practice. The institution also provided follow-up support through mentorship, TLC, and Key Teachers enterprises. This in turn enabled the instructors and schools to gain knowledge and skills while they were collaborating. Alongside that, the teachers became able to utilize laboratories, which helped them shift from theory to real-life practice and learner-

centered approaches. The participants declared that the institution assisted them with required and available materials, but in some areas they could not reach the schools. Meanwhile, using technology and standardized STEM education is still one of the negotiable aspects, which also roots in dependency on external contributors.

The findings revealed that AKF initiatives assisted the pupils to learn deeper and comprehend the lessons through experiments and discussions with their companions. Eventually, the research also found that after the implementation of the approaches, a high majority of students in Shughnan got admission to universities in Afghanistan. On the contrary, teachers are limited by particular pedagogies and curricula that make them less creative because most instructors are constrained by the rigid curriculum.

5.3 Recommendations

Based on the investigation that was done about AKF initiatives in STEM education, the following recommendations are being made:

- There should be consistency in providing professional development (PD), and this requires a decentralized curriculum through which the teachers can take action in their locality according to their needs.

- Training in STEM education should be based on internationally recognized standards because there is a rapid change in these subjects, and the training should be designed on the basis of updated and recent research on these subjects. Besides, the curriculum should be flexible enough to address the local needs of the teachers and adapt it to their locality.

- All the schools in Shughnan district can come together and create a shura where parents, teachers, school leadership, and civil society can have membership. This Shura can communicate with governmental authorities and NGOs to address the challenges across the schools and request that NGOs and public organizations resolve the issues.

- Teachers should use different methods such as project-based learning, peer observation, and portfolios to engage their students and maximize their critical thinking, problem solving, and other skills.

- There should be a committee where school leadership, the Department of Science, and civil society can have membership and supervise the recruitment process to employ professional teachers for STEM education.

5.3.1 Recommendations for Further Study

- Based on the importance of STEM education, it is required that there be an individual study on each individual subject of STEM education in order to address the challenges and provide solutions.

- Another in-depth study is needed on this research site to investigate how STEM education can boost the local economy in order to improve schools' leadership and encourage parents to put more attention on STEM education.

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Appendices: Appendix A. Consent Letter

Dear Sir/ Madame

This is Hassan Ali Shah Hussaini, a postgraduate student at BRAC University in Dhaka, Bangladesh. I am doing my Master's degree in education leadership and school improvement. Let me let you know that I have selected my thesis topic under the title "Investigating Aga Khan Foundation (AKF) initiatives in teaching-learning skills development on STEM subjects in secondary public schools in Shughnan, Afghanistan." The aim of this research is to understand your opinion and perceptions about the teaching and learning of STEM education at secondary public schools. Therefore, it requires me to conduct an interview or FGD along with your sound recording. It is mentionable that you will be asked some questions related to your job areas as well as your experience, which will be completely familiar to you. Your data will be used only for this research purpose, and if I need it in the future, I will undoubtedly ask your permission. In the meantime, you have the right to answer the queries independently without any hesitation. Moreover, you have the right to reject or agree with the points I will be asking you. Similarly, your ideas and thoughts would be kept anonymous, and any time I quote your points, I will use your pseudonym. I would like to let you know that the interview or FGD will take a maximum of 90 minutes. To confirm, please sign off at the end of this paper along with your full name, position, and date. For more queries, please reach out to me through email: hassanali.hussaini94@gmail.com or WhatsApp: +93796949797.Participants full name……. ……. Position …….

date and signature ……. Kind regards Hassan Ali Shah Hussaini

Appendix B. Interview Guide for Trainers

Full name……. contact/email …….

Organization …… position …….

Site ……. date ……...

1. Tell me about your experience of conducting professional training on STEM subjects.
2. What are your goals for conducting this training for secondary school teachers?
3. Why did you give the priority to STEM subjects rather than art subjects? What is the importance these subjects?
4. What curriculums and models have you used in your training and why?
5. If you have used your own curriculum, how did you articulate that with the school curriculum?
6. What is your observation, were there points which contradict in the two curriculums and how did you balance the contradicted points?
7. What approaches and methods have you used in your training?
8. In how many phases have you conducted the training each year?
9. How did you make sure about the implementation of the approaches and methods after your training by teachers?
10. How did you ensure about lack of resources for implementing the methods in STEM education at secondary public schools?
11. Have you seen any significant changes after the training, if yes please name some of them?

12. What were the challenges you confronted before the training, during the training, and after the training? And how did you overcome that?

Appendix C. Interview Guide for Manager

Full name……. contact/email …….

Organization …… position …….

Site ……. date ……...

1. Tell me about your experience of conducting professional training on STEM subjects.
2. What is your main goal in conducting this training for secondary school teachers?
3. Why did you give the priority to STEM subjects rather than art subjects? What is the importance of these subjects?
4. Did your curriculum meet the requirement and expectations of the community and beneficieris? If yes, how did it respond to the demands of the beneficieris?
5. How did you address the experimental and practical aspects like chemistry during the seminar?
6. How did your approaches and methods address 21st-century skills?
7. How did you make sure about the implementation of the approaches and methods after your training by secondary public school teachers?
8. How did you address the problems like lack of resources in secondary public schools in teaching STEM subjects?
9. Have you seen any significant changes after the training, if yes please name some of them?
10. To what extent are you satisfied from achieving your goals and objective on providing training in STEM education? If yes. please explain.

Appendix D: FGD Guide

Full name……. contact/email …….

Organization …… position …….

Site ……. date ……...

1. Tell me about your experience from the professional training you have received on STEM subjects.
2. How that training helped you to improve your teaching-learning skills in facilitating STEM subjects?
3. What strategies and methods do you use to address the needs of diverse learners?
4. What similarities and differences did you find between your school curriculum and the trainings you have received from AKF?
5. How did you manage to correlate the pedagogies and approaches of AKF while teaching the school curriculum in the real practice?
6. Was the pedagogy in respond to needs of your students, If yes, how?
7. What approaches and methods were used in the training and how they addressed your challenges in teaching-learning of STEM subjects?
8. What features of the training were new for you, that you have not been familiar with before and how it facilitated your teaching in class?
9. How many phases you have received the training each year and were you satisfied with that in terms of your professional development?
10. Did you find the tips and techniques of the training applicable in other subjects of school and how?

11. Have you received any professional support and supplementary resources, materials, and equipment were considered by AKF after the training? If yes, please explain.

12. What do you suggest for furthering the quality of STEM teaching-learning, based on your experience and real practice?

Appendix E: Sample Transcript of Interview #4

Interviewer:

Q1. Tell me about your experience of conducting professional training on STEM subjects.

Interviewee:

I have been taught math subject nearly 7 years and then employed as mentor at AKF.

Interviewer:

Q2. What are your goals for conducting this training for secondary school teachers?

Interviewee:

Since 2013 the ministry of education completely updated its curriculum. If I tell you about math, there are many topics such as, derivative, limits, integral, statistics and other topics were recently incorporated. These thing newly included in the curriculum and therefore, baccalaureate graduate teachers were not familiar with it. Due to this challenge AKF recruited trainers to train the teachers. We also had training with ministry of education in these topics and then as trainers we provided them training to get well comprehend the [new] topics. Beside the training we mentored the tutors at schools and through that program we did follow up what we provided them in the training. We solved their challenges and the teachers got familiar with the new topics became very pleased of it. We also conducted the training at department of education in presence of AKF authorities, and head of department of education for college lecturers and as well as education supervisors. Because the supervisors are observing the work of teachers and we trained the supervisors to enable them to make sure how much the method is being implemented the teachers.

Interviewer:

Q3. Why did you give the priority to STEM subjects rather than art subjects? What is the importance these subjects?

Interviewee:

In point of fact, the ministry of education through department of science, addressed the challenges in STEM education. For example, the problems in other subjects like English can be solved through attending course or self-studies, but in math it is not that much easy If the students do not see it practically. As a result, we give the priority to the Science subjects.

Interviewer:

Q4. What curriculums and models have you used in your training and why?

Interviewee:

Thank you. I was responsible to develop the materials in statistics. It was one of the difficult topics. However, the topics I have already mentioned like complex numbers were already in the books, but the teachers had problem with it. The rest of the topics were implemented based on the school curriculum.

Interviewer:

It means that you did not have any curriculum for your seminar.

Interviewee:

Well. I am just talking about math. In Physics and biology, the trainers better know, but as far as I know, they have conducted the training based on the manuals which was provided by ministry of education. In math I can say, we did not have any specific manual.

Interviewer:

Q5. If you have used your own curriculum, how did you articulate that with the school curriculum?

Interviewee:

Well, good question. As I have already mentioned that trainers from Bamyan, Baghlan and Badakhshan were asked to go to Kabul. Then the trainers reviewed the curriculum [in science subjects] and found the challenges and then we shared with the head of math department. We sat with him, discussed problems and what was new in the curriculum and then had training

on it. I can say, there was no point in contradiction with the curriculum, because all steps were taken in cooperation with ministry of education and all its agencies provincial level and district level. We developed something which was based on their curriculum that facilitated their work.

If I mention the problems in the curriculum, what we found out in our revision, there were some ambiguous activities. For example, their objective was not cleat in teacher guide book, so we went and talked on those points and then came to a conclusion on it [with our colleagues]. These challenges were in statistics and integral. Even the department of science had problems on some points and writer had also problems on it. But they had access to internet and could solved the issues.

Interviewer:

Q6. What is your observation, were there points which contradict in the two curriculums and how did you balance the contradicted points?

Interviewee:

Well, there was not serious contradiction, but some tiny issues in typing issues like the symbol of plus and minus and multiplication were mixed up for example. These were the things we discussed and we raised these issues. Now I don't remember any exact example, if you need them, I can tell you the next time. For example, the integral $1/x^3 +2$ was challenging for teachers. [though our discussion] we simplified this with the help the member department of science.

Interviewer:

In physics and chemistry and biology, the worked more practical and used the manuals which was prepared by the ministry of education. But, I am talking about [my stance] in math.

Interviewee:

Q7. What approaches and methods have you used in your training?

Interviewee:

You have studied in these school and you know that teachers were using classic methods, such us lecturing and as a result, the teacher was more responsible [rather than the students]. The challenges we revealed through our observation, was that teacher the instructors always target the active students and mostly first grade and second grade in a class. So, we said the teachers, when you say grade 7 or 12 twelve, you do not go only for one student, then try to employ different methods to involve the students we said. we suggested them to run individual work, pair work and group work. We also conducted activity based approach in our training. For example, there is an activity called “think per share” and this activity make the students to presume individually, then share it with their pairs and after with their group. We said [the lesson] should be learner-centered and we voted more the activity was is focusing more on student involvement. Though it is true the challenging topics should be explained by the teacher first, the attention should be more in students [engagement].

Interviewer:

Q8. In how many phases have you conducted the training each year?

Interviewee:

As I mentioned, there were many things were updated and it was not feasible to get things done within a short time and transfer to the teachers. We had the fortune in education, the way the training was designed, it was like for 12 days or I do not remember the precise length of each phase, you can inquire from others, but we had mentorship program. Through our mentorship we observed and checked wither the teachers struggle with content knowledge or method and designing activities, to implement learner-led lessons. We noted the issues, asked the feedbacks of them and then shared their strengths points and improved points and suggested them our alternatives. Fortunately, the teachers were satisfied [with the mentorship] and became optimistic. There is a problem that we cannot measure education,

just we can see the consequence like students' success rate in Kanore exam. For instance, in years a go from our [my] village only I passed the Kancor exam and succeeded in education faculty, but now we have many engineer and other fields graduate.

Interviewer:

Q9. How did you make sure about the implementation of the approaches and methods after your training by teachers?

Interviewee:

I have already mentioned, we had observation form, although we have now. In our mentorship, based the schedule of the teachers, we asked the authority of education in district level and the principals permission and once or twice a week we had mentorship with the teachers. We [I] considered one hour of math subject and then observed the lesson to realize wither the teachers have challenges in content knowledge, method, class management or [communication]. After the class we discussed the strength points and challenges with the teachers in a friendly way in their free time. We began from positive points and then shared our [my] alternatives and convinced them. For the next time, we practically overserved that do teachers are following it or not.

Interviewer:

Q10. How did you ensure about lack of resources for implementing the methods in STEM education at secondary public schools?

Interviewee:

Thank you. As I mentioned we emphasized on the using methods in classes. We provided the teachers stationery and other materials like parabola chart in order to make the lessons more practical for the students. Overall, in math we lack adequate materials compared to the other subjects. For example, it hard for the teachers how to create from paper.

Interviewer:

As we are living in 21st century like critical thinking, collaboration, communication and other skill, so how did you address these skills.

Interviewee:

Compared to other countries, we are living in 10th century. We told the teachers to group the students to strengthen their communication, collaboration and other skills. In 21st century also we persuade pluralism and diversity amongst students and teachers as well. We have [nearly] 25 types of learning skills which requires more works. Despite having challenges, we have plus points which is prominent. In terms of critical thinking, teachers perceive it negatively. We said the teachers that the main goal of critical thinking is not challenging others which, rather it is positive and can reform the students, school and the community. This was what I talked about my training, but I do not know about other trainers and not intend to generalize it.

Interviewer:

Q11. Have you seen any significant changes after the training, if yes please name some of them?

Interviewee:

We had three steps of mentorship considered in our plan. We undergone through those steps and then reported that. First we observed the teachers, then worked with them and after that we reported that. We saw that the teachers were very pleased with the training and warmly welcomed us. Teachers implemented the points they were said, but some of them were not able execute that right after the training.

Interviewer:

Q12. What were the challenges you confronted before the training, during the training, and after the training? And how did you overcome that?

Interviewee:

Before the training teachers had difficulties with the updated materials and when we went to the school, the teacher hesitated and did not share their problems and then we encouraged them to share their obstacles with us. We assured them that we would not share their secrets with anyone including the custodians. The caused that we could build the trust and enhanced our communication.