AWARENESS, PERCEPTION AND ATTITUDE OF IN-SERVICE TEACHERS TOWARDS INTEGRATED STEM EDUCATION

A dissertation

Submitted in partial fulfilment of requirement of the degree of

Master of education

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CERTIFICATE

This is to certify that Ms. Rachana Agrawal has conducted her dissertation work entitled "AWARENESS, PERCEPTION AND ATTITUDE OF IN-SERVICE TEACHERS TOWARDS INTEGRATED STEM EDUCATION" under my guidance and supervision for the partial fulfilment of the degree of Master of Education (M.Ed.) at Centre of Advanced study in education (CASE) , Faculty Education and Psychology , The Maharaja Sayajirao University of Baroda, Vadodara. To the best of my knowledge, this dissertation is her genuine and original work. I find it satisfactory and fit for submission and evaluation.

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DECLARATION

I Rachana Agrawal, hereby declare that the dissertation entitled "AWARENESS, PERCEPTION AND ATTITUDE OF IN-SERVICE TEACHERS TOWARDS INTEGRATED STEM EDUCATION" conducted and submitted by me for the partial fulfilment of the M.Ed. programme at The Department of Education , Faculty of Education & Psychology ,The Maharaja Sayajirao University of Baroda, Vadodara , is my original work and has not been submitted earlier either to The Maharaja Sayajirao university of Baroda or to any other institution for any course requirement . I also declare that no chapter of this dissertation in whole or in part is taken from any earlier work done either by me or any other person.

Place: Vadodara Investigator

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TABLE OF CONTENT

LIST OF TABLES

LIST OF ANNEXURES	
Annexure 1	Integrated STEM education awareness tool
Annexure 2	Questionnaire for perception of in-service teachers towards integrated STEM education
Annexure 3	Attitude Scale for in-service teachers towards integrated STEM education

Chapter 1

CONCEPTUAL FRAMEWORK

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INTRODUCTION

The country's conventional education system relies on the foundation laid by the British education system for creating factory workers and office clerks. In order to create order-takers and followers and to consciously shun imaginative and creative thought, the British developed and introduced the said educational model. So instead of creating independent thinkers and innovators, the entire aim of education was to create a workforce to function in the factories.

Unfortunately, despite the country being free for the last 70 years, we are still carrying the old model of education and there have been very insignificant changes in the education processes in this country. There is a clear urgency to rethink and reinvent our education system with the advent of globalization, technological growth and automation, scrapping the many conventional work concepts, and introducing it at the earliest if we want our country to play a significant role in rapidly evolving global realities. As, despite having the top-quality talent, the exam-focused education model of the past has limited these students when it comes to innovation, problem-solving and creativity. With the whole world almost becoming a connected global village, there is a need for a paradigm shift in education - to prepare students to be global citizens while providing them with the skills and abilities for them to survive and thrive in the new economic and social order. This is where the well-designed STEM (Science, Technology, Engineering, and Mathematics) curriculum should be adopted and implemented as per the needs of the industry of the future (Saxena, 2020).

A nation's stability is characterized by the degree of quality of its students, scholars, innovators and academic leadership vision. Historically, the Indian subcontinent was a powerful and vibrant centre for abstract intellectual practice such as the discipline of philosophy and mathematical disciplines. Science is well knitted into our customs, resulting in a deep community of physical and applied sciences such as astrophysics, material science, medicine, etc. In areas such as architecture, urban planning, water processing technologies, warfare techniques, pharmacy, surgery, etc., heavy content of intellectual rigour, strong foundations of scientific thought being transformed into innovative engineering and technology is more than evident. This traditional strength has enabled us to have scientists like Srinivasa Ramanujan, C.V. Raman, S. Chandrasekhar, S.N. Bose, Homi Bhabha to name a few in modern times.

A vibrant and creative society, be it the arts, crafts, engineering, science or any other scholastic practice, is characterized by creativity and innovation in every field of life. Societies continue to stagnate without ingenuity and innovation, and gradually begin to decay. They become dependent upon new ideas from other societies. This is true for any human activity, but more so for science and technology. In India, we are heavily dependent on changes occurring elsewhere, often absolutely. Our status in the field of science and technology is that of' takers' and not' givers' with very little to prove as original. It is not as if there is any lack of basic temperament. The answer to this lies in the current state of affairs in STEM education itself.

It's an open secret that science and engineering education in India today has been unable to produce quality employees to resolve the nation's problems. It is difficult to import the solution to those problems. To solve these issues, we need an out of the box solution. STEM education provides the basis for such a high degree of imagination and an innovation culture.

Hence the need of the hour is a thorough re-evaluation of our higher education program.

The number of STEM jobs is growing at the fastest ever rates. According to the National Science Foundation, it is predicted that 80% of the jobs created in the next decade will require some form of math and science skills. These skills are appropriately labelled as 21st-century skills or STEM skills (Aravind, 2018).

The industrial revolution paved the way for formal education, (a system we follow to date), where many people did not require to be educated to high levels, so schools promoted a few who could do managerial and professional work and sent the rest away to assembly lines. Today, however, such repetitive processes are being easily accomplished through automation (Robotics being the latest). The abilities of the 21st century, especially 'creativity and critical thinking,' require a higher degree of awareness, one that is not so compartmentalized and slanted. We can not cope with a system that is trained to leave behind a lot of children.

It is high time we left behind the outdated system and ushered in one that’s integrated and inclusive. Something that will equip children with the skills required for the 21st century and promote creativity, critical thinking, and innovation for a future. A sound foundational knowledge, mathematics and science, critical thinking, creativity, communication and collaboration skills would then be the minimum required education for every student. STEM (Science Technology Engineering Mathematics) offers the perfect solution. STEAM and STREAM are the variants with Art and Reading added to it.

As of today, in order to encourage STEM in colleges, the USA has set aside upwards of $2 billion. In order to encourage STEM education, Japan, the UK, Australia and New Zealand have all allocated a reasonable share of their education budgets. As part of the 'Skill India'

initiative, the government of India has pumped in a total of 488.2 crore to help more than 2000 schools equip themselves and help students gain hands-on experience with Atal Tinkering Labs in futuristic technology (ATL) (Aravind, 2018).

The incorporation of science, technology, engineering and mathematics, known as STEM education, is a growing field in developed and developing countries. STEM education is commonly represented, but there are varying definitions of what it actually means. STEM education seeks to change teaching practices from conventional lecture-based teaching to inquiry-based, project-based and problem-based learning as a means of delivering interdisciplinary, practical learning experiences which may involve two or more of the four main disciplines defined in STEM education. Within such interdisciplinary philosophy, deep conceptual understanding and what is termed as 21st century skills could be developed (H. El-Deghaidy, 2015).

Nonetheless, study results indicate that science and math teachers lack pedagogical expertise and effectiveness in STEM education (Louis S. Nadelson, 2013)

MEANING AND DEFINITION OF STEM EDUCATION

American National Science Foundation first used the acronym SMET for science, mathematics, engineering, and technology in the early 1990s, but determined that this acronym would cause issues of vulgarity, and SMET was changed to STEM (Sanders, 2009). The first use of the acronym STEM was introduced in 2001 when Judith A. Ramaley, a former director of the NSF's Education and Human Resources Division, used STEM to refer to science, technology, engineering, and mathematics curriculum (Breiner JM, 2012).

The 2014 report from the American National Research Council titled, STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research, presents a more holistic definition of integrated STEM:

Rather than a single, well-defined experience, it involves a range of experiences with some degree of connection. The experiences may occur in one or several class periods, or throughout a curriculum; they may be reflected in the organization of a single course or an entire school, or they may be presented in an after or out-of-school activity (p.39).

According to Johnson (2013) – STEM education is an instructional approach, which integrates the teaching of science and mathematics disciplines through the infusion of the practices of scientific inquiry, technological and engineering design, mathematical analysis, and 21st century interdisciplinary themes and skills. This definition also brings to bear a focus on STEM thought processes and skills instead of the traditional emphasis over content.

According to Tsupros et al. (2009) – It is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons in contexts that make connections between school, community, work, and the global enterprise.

According to Merrill (2009) - STEM education is a standard-based, meta-discipline residing at the school level where discipline specific content is not divided, but addressed and treated as one dynamic, fluid study. Here, STEM is addressed as transdisciplinary.

According to Koonce et al. (2011) STEM stands for the four primary discipline families of Science. Technology, Engineering, and Mathematics.

Breiner et al. (2012) discuss it contextually, suggesting "most stake- holders who hold interests in promoting STEM would claim to understand the meaning, yet the finer points of this construct often cause confusion."

Arguably, the most robust and detailed definition of STEM education is provided by **Moore et al. (2015),** whose definition was adopted for this study (as such). They define it as "the teaching and learning of the content and practices of disciplinary knowledge which include science and/or mathematics through the integration of the practices of engineering and engineering design of relevant technologies."

Kelly and Knowles (2016) defined STEM as an approach in which students are taught the content of two or more STEM domains in applications that relate science, technology, mathematics, and engineering in contexts involving real-life problems to enrich their learning.

According to these definitions, STEM education is employed as

(i) it involves an application that relates at least two of the science, technology, mathematics and engineering fields,

(ii) these fields are brought together in a context based on real-life problems, and

(iii) it helps teaching students the subject-matters or enriches their learning.

INTERDISCIPLINARY STEM / INTEGRATED STEM

Education in science, technology, engineering, and math (STEM) is typically known as a meta-discipline. It is the creation of integrated knowledge across disciplines to form a new curriculum to be taught as a whole. In the early 2000s, STEM was first introduced as an educational term by the American National Science Foundation.

Building upon the past two decades of STEM education reform efforts, Sanders (2009) argues that integrated STEM education focuses on integrating the four disciplines in Science, Technology, Engineering and Mathematics and on new integrative approaches that explore teaching and learning between and among any two or more of the STEM subject areas. Engineering design-based learning can be an effective pedagogical approach for effectively teaching crosscutting concepts across these four content areas. Further, STEM education emphasizes that it is critically important to foster opportunities to increase problem-solving skills, especially in light of developing economic competitiveness (TJ Moore, 2015)

STEM education gives opportunities to students to understand the world around them and solve real-world problems. According to the Organization of the Economic Co-operation and Development (OECD) report, productive individuals should have a high level of technical skills and also be independent, cooperative, and flexible in improving their qualifications (Johnson, 2013).

In order to understand STEM, it is significantly important to understand the relationship between its disciplines. Science seeks consistency and understanding of the external world. There is a strong link found between science and technology to the extent that most individuals think that technology is applied science. The processes that are used in learning about science encompass exploring, discovering, or inquiring. The use of scientific method is the most important to apply science. Technology has been defined as what is human made ([NRC], 2011). It is driven by human genius and creativity and offers an efficient and productive life to make the lives of people easier by solving problems. Engineering is the profession that needs study, experience, application, and knowledge of science and math in order to utilize economically the materials that could benefit the humanity. The National Academy of Engineering supports technology and engineering literacy because

of the strong relationship between the two disciplines. Finally, Mathematics investigates the patterns and relationships of sciences, as explained by mathematicians today that mathematics is the study of patterns real or imagined, visual or mental, arising from the natural world or from within the human mind. Mathematics is a common discipline that is used in many disciplines such as science, technology, and engineering not only for numbers, measurements, probability, but also for use of minimum formulas, precision and purity (Esra Bozkurt Alan, 2016)

There are a number of ways that STEM can be taught in schools. The first option is to teach each discipline of STEM as an independent subject with no or little integration. This is known as S-T-E-M.
The second way is to teach each of the STEM disciplines with emphasis on one or more subjects and this is referred to as SteM.
Another strategy is to integrate the three disciplines into one discipline that can be taught. For example, robotics is an engineering project, but requires integration between science, technology, and mathematics. In this case, the engineering teacher will take responsibility in teaching the subject. However, the collaboration between teachers of the other disciplines is very important in teaching the subject. This is known as E→STM (Sayary, 2015).

In STEM education, there are two ways to incorporate Science and Mathematics fields into the Engineering field as Context and Content (Moore, 2014). In context integration, engineering design is seen as a motivating tool for teaching the content of mathematics and science fields, whereas for integration of content, engineering skills form a part of the learning objectives together with science and mathematics content. Based on these integration approaches, the STEM curricula should involve (i) a process and product based evaluation (ii) in a digital format (iii) using inquiry, problem and performance based and constructivist teaching approaches (iv) with an interdisciplinary approach and understanding by design (Knowles, 2016).

In general, pedagogical techniques such as inquiry-based instruction, argumentation, interactive learning, programming, and robotics are used during curriculum implementation. Students are required to identify everyday problems in inquiry-based teaching, shape hypotheses, gather data, test hypotheses, generalize them and test

themselves in this process. Students are expected to engage in a logical debate in the argumentation, make a claim based on the evidence, explain and defend these arguments, and determine the conditions under which the arguments should be correct. Throughout the learning-teaching phase, they are to use electronic devices such as cell phones, tablets and notebooks while they are in digital learning. In coding and robotics, students are asked to program a robot using one of various coding languages (Kanadh, 2019).

PROBLEM BASED LEARNING

Problem-based learning is a student-centred pedagogical approach that combines the inquiry approach and problem solving process. Learning with PBL occurs when students go through three steps: *What do they know? What do they need to know? And how can they find out what they need to know?*

There are other theoretical concepts supporting PBL which are constructivist methods, metacognition, and cultural and social influences. The PBL theory is a constructivist philosophy, because learners need to create their own interpretation of new concepts. The constructivist process is contained in "*What do they know? What do they need to know? How do they know?*" In other words, explicit attention should be paid to students' prior and existing knowledge, and the ability to construct new knowledge based on prior knowledge.

In three stages, Piaget described this cognitive process: assimilation, accommodation, and equilibrium, in which learners integrate new experiences into existing experiences. The cognitive structure of the learner is thus adjusted in reaction to the context, and maintains a balance between what is known and what needs to be learned. The co-constructed mechanism in which individuals communicate and work together to solve problems is internalised by the person and is part of the cognitive growth of the student (Sayary, 2015).

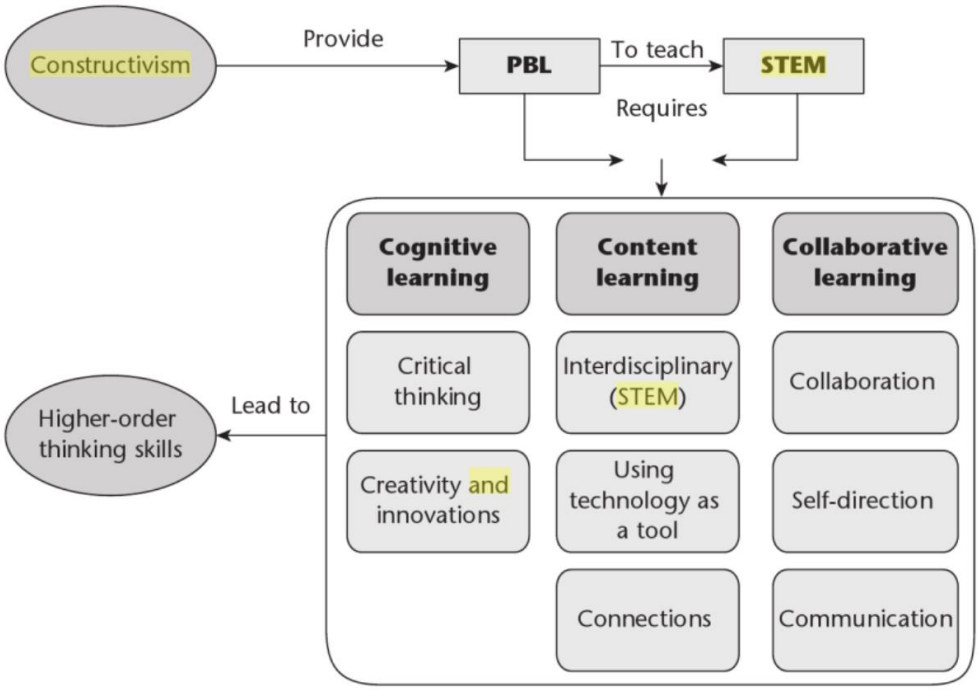


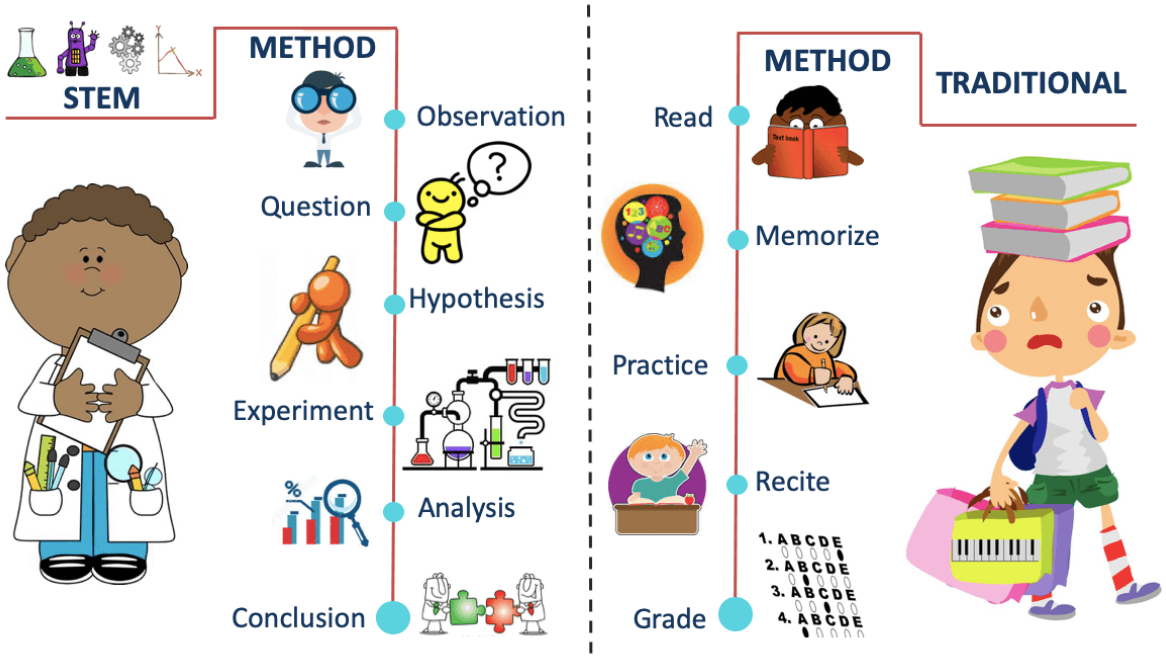
Fig. 1 A Conceptual Framework illustrates the relationship between PBL and STEM **Source:** (Sayary, 2015)

A large and growing body of literature has revealed that there are three types of learning included in PBL models: cognitive learning, content learning, and collaborative learning. The above figure 1 illustrates these three elements' relationships with PBL and STEM. The figure 1 shows that cognitive learning focuses on critical thinking, creativity, and innovation skills while collaborative learning focuses on collaboration, self-direction, and communication skills. Finally, content learning focuses on the integrated knowledge through STEM disciplines, use of technology, and connection to real life which lead to fine outcomes, such as, higher-order thinking skills (Sayary, 2015).

HOW IT IS DIFFERENT FROM TRADITIONAL EDUCATION METHODS?

A STEM program is structured to provide full realistic exposure and hands-on experience in a specific area for its students. It provides a great mix of course modules with a few obligatory laboratory assignments and community projects that assist in learning through the practical application of theoretical knowledge. This kind of vocational training is being introduced at the K-12 level in many schools worldwide. Though science lovers, who do not have any prior experience of such a learning environment, may experience this learning through higher education, that is, the bachelors and masters level education

STEM is not just an acronym for Science, Technology, Engineering and Mathematics but an education method that integrates all these subjects. It addresses the concerns that these subjects or disciplines are often taught in isolation when they are all interconnected in reality. It is an interdisciplinary approach focused on hands-on learning that is coherent.



It is difficult to dissimilate certain fields from one another in today's world. Choose any thing from your home or office and try to fit it into only one of the STEM topics. It would be hard for you to do so because everything is interconnected with one another. Science and math contribute to the advancement of technology, which is then incorporated into engineering to make it usable in our lives. Instead of depending on what the textbook says, STEM allows children to experiment, make mistakes and learn from their own experiences to achieve right results.

Critical thinking, logical analysis, inquiry and project-based learning are the keystones in STEM education. It boosts the curiosity in the kids, making learning process fun, relevant and everlasting. This is a paradigm shift from traditional education, which vitally lacks in hands-on learning, to a learning that is much better and deeper.

A major flaw with isolated learning is that students are often unable to apply the concepts taught to specific problems, limiting their efficiency or comprehension capacity and thus execution. Problem solving is an important skill set that is not covered by the existing educational system. If questions or learning gaps are not resolved in the early years, as the difficulty level of the subjects increases with time, things get worse. This loose end in basic

education, all due to the inherent lag in conventional education, contributes to fear of the topic going forward. By helping students work on the applications, STEM education ensures that there is no disconnection in the interpretation of concepts. Taking a very basic example for initial years, math is introduced to kids with number learning, like 1, 2, 3 and so on. Kids don't understand why they are being taught numbers and why less/more cannot suffice in place of numbers. On the other hands, asking questions like how much more or how less can immediately get them to understand the sense behind numbers and quantification.

What is important to consider is how the concepts taught apply to the real world and how understanding them will help children overcome their everyday problems. Similarly, playing board games, mixing math with surrounding arts & patterns will increase the awareness and interest of children in the subject, leaving no room for anxiety. For any discipline, this is how STEM learning occurs.

CHALLENGES IN IMPLEMENTING STEM BASED LEARNING IN SCHOOLS

In order to build STEM skills on a scale, there are some really difficult pressing obstacles to address before India can really tap on the benefits of these global opportunities. Designing the facilities, curriculum and equipping children with the best instruction and support is one of the main challenges involved in introducing STEM education.

Another biggest hurdle is our unitary reliance on marks – focused and exam-oriented education system. We definitely need some sweeping changes in our teaching-learning and evaluation processes. Many teachers still assume that students will be distracted from their studies by implementing STEM and they will not be able to complete their given curriculum in that specified period of time. The best way to fix this is to make them aware and change their views by showing them the positive effects of exposing their children to the methodology of STEM learning. This approach is being implemented by countries around the world by adopting national curricula that set frameworks and projects that implement the STEM methodology.

Quality infrastructure and the funds needed to build such infrastructure are the third major challenge for STEM education. Here the business world needs to cooperate and contribute through its CSR activities to enhance education. Over the decades, the cost of doing quality education and science has risen, and the facilities need to be cutting edge for cutting edge developments to happen.

CONTEXT OF STEM EDUCATION IN INDIA

The situation has changed in the present world despite the commendable work of ancient Indian scholars such as Charaka, Susruta, Aryabhata, Bhaskaracharya, Chanakya, Patanjali and Vatsayayna, and numerous others in various fields of science and technology. It should be noted that while the school education system in India places growing emphasis on the two end subjects of the philosophy acronym STEM, neither engineering nor technology form part of the regular curriculum of pedagogy (National Policy on Education, 2016).

Science education is facing three practical challenges in India: availability and access of basic infrastructure and scientific equipment to be used while teaching science, shortage of quality teachers who are equipped with in the latest know how in their respective fields and the nation's science curriculum, which needs immediate attention (Malti, 2017). Lack of critical thought, inquiry-based learning, and hands-on learning are the key reasons for the significant number of high school dropouts from science education. Besides strong infrastructure and professional teachers, a remarkable administrative divide, in addition to the academic and casual attitude of the regulators, has all led to the diminished quality parameter of Indian education system The parallel business of paid academic coaching is a clear indicator of the lack of credibility of the Indian school system (National Policy on Education, 2016).

NATIONAL STEM POLICIES

India has made remarkable progress since independence and established the department of education and literacy under the ministry of human resource development on August 29, 1947 with the objective of expanding educational facilities. The National Policy on Education, as formulated in 1968, 1986 and modified in 1992, recognises education as a precondition for development and sets out three critical issues – equity, accessibility and quality. Despite the robustness in conception and orientation, earlier education policies failed to change the state of education in last several years. However, the 'National Policy on Education, 2016' during 12 Five Year Plan (recent policy planning) recognises education as the most important tool for social, economic and cultural transformation and emphasises on innovation, critical thinking and skill development. This identifies four essential components: building values, awareness, knowledge and skills to enable citizens accomplished and competent for contribution in the nation's well-being, strengthens democracy, fosters and social cohesion (National Policy on Education, 2016)

In conjunction to its education policy, India's Scientific Policy Resolution (SPR) of 1958 also resolves to 'foster, promote and sustain' the 'cultivation of science and scientific research in all aspects'. Science, technology and innovation have been identified as the drivers that have the potential to accelerate India's sustainable and inclusive growth (Science, Technology and Innovation Policy, 2013)

'STEM FOR SCHOOL' INITIATIVES: GOVERNMENT OF INDIA

Through numerous interesting initiatives, the Indian government is working hard to promote scientific disposition among school students, and to provide them with research training opportunities to develop a professional workforce.

The major science and technology programmes of the Indian government for school students are as follows:

1. The Ministry of Human Resource Development has launched the Rashtriya Avishkar Abhiyan (RAA) in July 2015, across School Education and Higher Education to encourage children towards learning Science and Mathematics through activities related to Science and Mathematics. Some of the interventions under RAA for promotion of science are strengthening of school Science and Mathematics laboratories, Science Fair/Exhibition and Talent Search at district level; provision of mathematics and science kits to schools, visit of students to higher educational institutions and learning enhancement of students.

2. National Children's Science Congress

National Children's Science Congress (NCSC) is a nationwide flagship programme of the Department of Science and Technology (DST), government of India, initiated in 1993. DST is an apex nodal department of Government of India, established in May, 1971 to organise, promote and coordinate science and technology (S&T) activities in the country (National Children Science Congress, 2017)

NCSC invites open-ended scientific projects from an individual or team of young innovators, based on different themes since its inception and provides platform to approximately 1 million

children aged between 10 and 17 years every year, to exhibit their creativity and innovation to address societal problems through the intervention of S&T.

3. Innovation in science pursuit for inspired research programme

Innovation in Science Pursuit for Inspired Research (INSPIRE) is an innovative programme developed by DST in 2008 during the 11th Plan with long term foresight for attracting young talent to the excitements of a creative quest for science as a career option and building the required critical human resource pool for strengthening and expanding the research and development base in the country. The INSPIRE scheme includes three components to facilitate all categories from school students to young researchers to do research (See figure2)

Recently the INSPIRE Award – MANAK (Million Minds Augmenting National Aspiration and Knowledge) has been revamped to align with the action plan for the 'Start-up India' initiative launched by the Honourable Prime Minister of India (INSPIRE Awards - MANAK., 2017)

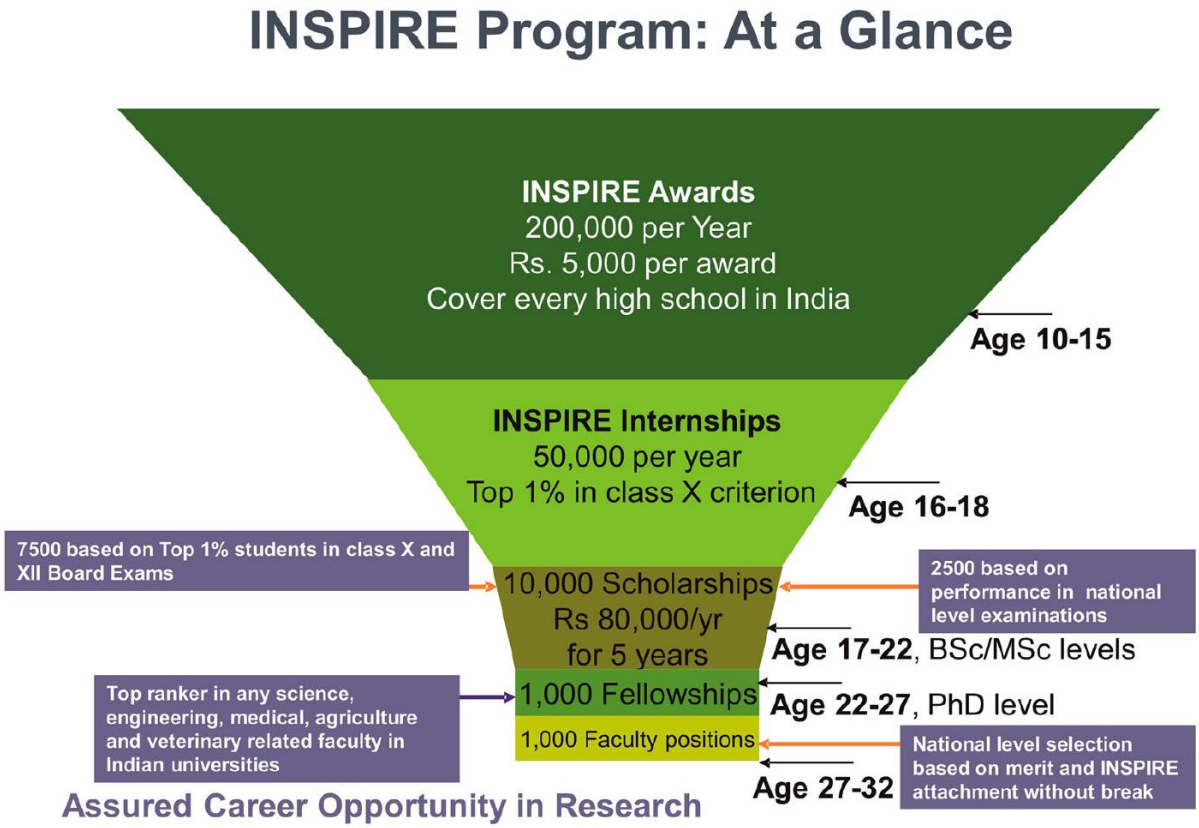


Fig. 2 INSPIRE (Source : http://mhrd.gov.in/sites/upload_files/mhrd/files/raa/Presentation_by_INSPIRE_PROGRAMME.pdf).

4. Atal Tinkering Laboratories

Atal Innovation Mission is setting up Atal Tinkering Laboratories (ATLs) in schools across India with a goal to' Cultivate one million children in India as Neoteric Innovators.' The purpose of this scheme is to promote curiosity, innovation, and imagination in young minds; and to inculcate skills such as mind set design, analytical thinking, adaptive learning, physical computing, etc.

ATL is a work space in which young minds can form their ideas through hands on do - it-yourself mode; and learn skills in innovation. Young kids will have the ability to work with tools and equipment to grasp STEM concepts (Science, Technology, Engineering and Math). ATL will include' do it yourself ' kits and equipment on educational and learning–science, electronics, robotics, open source microcontroller boards, sensors, and 3D printers and computers. Certain desirable services include meeting rooms and facility for video-conferences.

To promote inventiveness among students, ATL can conduct various activities at regular intervals, ranging from regional and national competitions, exhibits, workshops on problem solving, product design and manufacturing, lecture series, etc.

AIM provide grant-in-aid of Rs. 20 Lakh to each school that includes a one-time establishment cost of Rs. 10 lakh and operational expenses of Rs. 10 lakh for a maximum period of 5 years to each ATL. (ATAL Tinkering Labs, 2017)

To date , 5441 Schools have already been selected for ATL grants and in Gujarat we have 250 schools that have ATLs (ATAL Tinkering Labs, 2017).

With the National Education Policy 2020 recognising the need for flexibility in choosing the subjects that a student wants to study, implementation of this policy will boost science, technology, engineering and mathematics (STEM) education in India (National Education Policy (NEP)-2020).

The National Curriculum Framework (NCF) 2005, suggested a paradigm shift in science education in India. As per NCF 2005, inquiry skills should be supported and strengthened by language, design and quantitative skills. Schools should place much greater emphasis on activities aimed at stimulating investigative ability, inventiveness, creativity and transfer of learning in varied situations. The perspective of NCF-2005, on science has been translated into

syllabi, textbooks and teacher support material developed by the National Council of Educational Research And Training (NCERT). The NCERT has continuously been building capacity of science teachers and teacher educators at the secondary stage for content and pedagogies which promote inquiry, thinking and problem-solving skills in students. NCERT also conducts National Science Exhibition every year to further promote scientific temper among students.

We are now at a stage where the number of STEM jobs is increasing at a fast pace and the number of STEM graduates actually exceeds that. It is estimated, according to the National Science Foundation, that 80 percent of the jobs generated in the next decade would require some sort of math and science skills (Malti, 2017) While possessing the highest quality talent, these students have been constrained by the exam-focused education paradigm of the past when it comes to innovation, problem-solving and creativity. It's here where the STEM players come in to fill this void.

It is important to provide the schools with the resources and funding to incorporate STEM into their curriculum and bring it to life in the classroom, inspiring the next generation of coders. STEM engineers have been implementing creative strategies for the last couple of years to ensure children are more inclined and involved in the' do it yourself ' approach (The Hindu, 2018).

In India, though nascent, there is a lot of innovation which is taking place with regard to STEM:

- The education sector is looking beyond smart classrooms towards hands-on learning and STEM enhancement on their current information and communications technology and smart class platforms.
- Many STEM companies are working with schools to help them set up STEM centres, tinkering labs with upcoming technologies like Virtual Reality and Augmented Reality.
- The government is looking to help educational institutions to upgrade their library infrastructures with more engaging learning assets and management tools, and implementing Learning Management Systems, assessment systems, language labs, library management system, gamification, etc.
- New ‘entry level’ coding devices are coming to market that provide schools with the ability to teach simple coding and bring STEM to life in the classroom (The Hindu, 2018).

RATIONALE OF THE STUDY

The acronym STEM (science, technology, engineering and mathematics), proposed by the American National Science Foundation (NSF), is now widely accepted and used to express a specific knowledge and application area today.

In educational space the word "STEM Education" is frequently heard nowadays. STEM is an acronym for Science, Technology, Math and Engineering. Day by day it is gaining popularity due to rapid developments in these fields. Several reports have shown that not only do a majority of our potential jobs fall into this category but that many new jobs will be created in these regions. It should be noted that the STEM fields have the same impact on all other areas, be they arts, humanities or some other field. STEM skills will be of great economic importance in a world which is rapidly developing and inclined towards technology. At a crucial time when the Indian government is supporting initiatives like Make in India, Skill India, digital India to promote manufacturing, technology use and skills development in the country, STEM turns out to be an important and integral part of our education (Malti, 2017)

However, even from a very wide perspective, when we look at the existing Indian education system, we clearly find that we are far behind in adjusting to the changes in the global educational arena. Even today, learning by textbook is a big focus on our school education system and, in most cases, secured marks are the only criterion for evaluating skills. Critical thinking, inquiry based learning and hands-on learning is something which is far from implementation especially in a majority of K-12 educational institutions (Sharma, 2018)Curiosity, innovation and a passion for knowledge for Science, Technology, Engineering and Math (STEM) in children can be promoted by early exposure to hands on learning and practical skills in a more engaging and enjoyable environment to learn. When a kid discovers a passion for STEM fields, it smoothes the decision-making process to pick the right field for career pursuance. It will help to create great thinkers, innovators, engineers and scientists that our society and industry needs (Kavya, 2019). As said earlier, it is needed for our future prosperity and to our nation in order to develop competitiveness and play a vital role in global economy.

In India though many schools have started STEM education but still very less work is done at the concrete level. Even the Indian Government have started many programmes like Atal Tinkering labs, Atal Incubation centre, All India Council of Robotics and Automation (AICRA) India STEM Summit, INSPIRE-MANAK Awards etc. and currently promoting

many initiatives such as Make in India, Skill India and Digital India to promote STEM education but still many teachers don't know how to teach using STEM integration approaches in their classroom. Very little research exists on how schools interpret and implement STEM education. This may be due to the overall lack of a coherent definition of STEM education by major education organizations. Therefore, there is a need to understand how schools interpret and implement STEM.

Keeping all this in mind, the investigator, in the proposed study try to study the awareness, perception and attitude of in-service teachers about integrated STEM education. The investigator would like to conduct the study in Vadodara schools where Atal Tinkering Labs (ATLs) are established and STEM education is promoted.

RESEARCH QUESTIONS

The following research questions are in the mind of the investigator:-

1. How far the in-service school teachers have gained insight about STEM education?
2. How have the in-service teachers conceptualised about STEM education?
3. What kind of an educational setting will facilitate STEM education?

STATEMENT OF THE PROBLEM

Awareness, Perception and Attitude of in-service teachers about integrated STEM education

OBJECTIVES OF THE STUDY

The study is taken up with the following objectives in view:

1. To study the awareness of in-service teachers towards integrated STEM education.
2. To study the perception of in-service teachers towards integrated STEM education.
3. To study the attitude of in-service teachers towards integrated STEM education.

OPERATIONAL DEFINITION OF KEYWORDS

Awareness - According to Cambridge online dictionary "Awareness is the knowledge that something exists, or understanding of a situation or subject at the present time based on information or experience."

According to Dictionary of Education “Awareness is the act of having or showing realization, perception or knowledge.”

In present study, ‘awareness’ is related to integrated STEM approach, which means scores obtained from questionnaires filled up by in-service teachers on integrated STEM education.

Perception- Perception is the mental process of ascribing meaning to sensory experiences. The term perception refers to the interpretation and judgment about something based on the observation and experiences. In the present study perception of in-service teachers towards integrated STEM education was measured with the help of content analysis.

Attitude- A predisposition or a tendency to respond positively or negatively towards a certain idea, object, person, or situation. Attitude influences an individual's choice of action, and responses to challenges, incentives, and rewards.

In the present study, the scores on the tool (Likert Scale) used to measure attitude were taken as the attitude of teachers towards integrated STEM education.

EXPLANATION OF THE TERMS

Integrated STEM education- It is an effort to combine some or all the four disciplines of science, technology, engineering and mathematics into one class, unit or lesson that is based on connections between the subjects and real world problems.

Atal Tinkering Labs- It is a program by the Central government of India and established by NITI Aayog under the Atal Innovation Mission with the objective to endorse STEM system of education, by cultivating curiosity, creativity and imagination in the young India.

DELIMITATION

This study will be delimited to the ATL schools of Vadodara city.

SCHEME OF CHAPTERISATION

The present study follows the listed scheme of chapterization.

Chapter I details the introduction of the present study along with all the taken variables. The chapter helps to build the rational for the present study. The appropriateness of the study and the reason to conduct the study is presented in this chapter. The chapter also presents the details

of the research questions, the objectives of the study, operational definition of terms and delimitations of the present study.

Chapter II gives a detail of the reviewed literatures in the field of STEM education, awareness, perception and attitude of teachers towards STEM education. This helped the researcher to prepare the implications of the review of related literature for the present study. It also helped the researcher to consider different methodological aspects for the present study.

Chapter III details with the methodology adopted in the present study. This chapter details about the design of the study, the population and sample, the procedure followed to develop and select the tools used for data collection and the procedure of data analysis adopted.

Chapter IV provides details of the analysis and interpretation of collected data. The chapter also provides the findings of the present study and implications of the same.

Chapter V presents the whole study in a nutshell along with the major findings of the present study, the discussion on the results arrived at after the analysis, implications drawn from the present study and suggestions. This chapter is followed by the Bibliography and Appendices.

Chapter 2

REVIEW OF RELATED LITERATURE

CHAPTER 2

REVIEW OF RELATED LITERATURE

Review of related literature gives a clear idea to the researcher about the researchers that have been conducted in his/ her field of research. Although the area of STEM education is relatively new in Indian context, a considerable amount of literature exists in abroad. Filtering out the most relevant studies, an attempt has been made to develop a holistic perspective of the nature and findings of these studies and to draw implications for the present study. In this regard therefore, the most relevant work (25 studies) have been reviewed here.

According to Breiner et.al (2012) STEM is a variety of activities which will replace traditional lecture- based teaching strategies with more inquiry and project based approaches. Lamberg & Trzynadlowski (2015) suggested that STEM education is a carefully designed instructional sequences which are connected to real world applications whereas El-Deghaidy & Mansour (2015) interpreted that teacher's deep content knowledge, innovative teaching strategies, interdisciplinary learning and the development of strong teams are important for teachers to introduce STEM education into their schools. Sumen & Calisici (2016) conducted study on the associating abilities of pre-service teachers science education program acquisitions with engineering using STEM education and suggested that teaching pre-service teachers in the use of STEM allows them to apply it easily to their lessons during their vocational life. Nuangchalerm (2018) who studied the perception of in-service primary teachers on STEM education in Thailand interpreted that STEM education not only needs to focus on content knowledge but also needs to include thinking skills and 21st century learning skills whereas Wang et.al (2011) viewed STEM integration as multidisciplinary and interdisciplinary. In the multidisciplinary approach a learner could easily identify each subject. In contrast an interdisciplinary approach is like a melting point in that the boundaries among subjects are blurry.

The in-service teachers' perception towards integrated STEM education and how they conceptualise it has been studied by Breiner et.al (2012), Lamberg & Trzynadlowski (2015) El-Deghaidy & Mansour (2015), Altan & Ercan (2016), Sumen & Calisici (2016) , Madden et.al (2016), Nuangchalerm (2018) and Kanadlı (2019)

In addition to these studies, Wang et.al (2011), Sayary et.al (2015), Akran & Aşiroğlu (2018) and Admawati & Jumadi (2018) focused on the relationship between STEM education and

Constructivist education approach and how it is affecting the teaching-learning process. Whereas Altin & Pedaste (2013), Khanlari (2013) and Holmquist (2014) have examined the impact of educational robots on learning STEM and students' attitude towards educational robot.

Chia & Maat (2018) identified the level of attitudes towards the integration of STEM among secondary school teachers in Malaysia. Whereas Timur et.al (2019) investigated the effect of STEM based activities on in-service teachers' views about STEM teaching.

Tekerek & Karakaya (2018) aimed to determine pre-service science teachers' STEM awareness in terms of different variables. The purpose of the study conducted by Buyruk & Korkmaz (2016) is describing teacher candidates' awareness levels related to STEM. Madden, Beyers and O'Brien(2016) studied how pre-service and novice teachers view the importance of STEM education in the elementary grades. A sample of prospective and early career elementary teachers was surveyed using an anonymous online questionnaire. The purpose of the study conducted by Han & Yalvac(2015) was to explore teachers' understanding and implementation of STEM Project Based Learning activities using a qualitative case study approach. Thus the research question explored through this study was, "After sustained Professional Development on STEM PBL, what were the participating mathematics and science teachers‟ understanding of and attitude towards STEM PBL and how did they implement STEM PBL in their classrooms (enactment)?"

Sharma & Yarlagaddab (2018) and Kavya & Rishinath (2019) studied the Indian government's initiatives towards STEM education, the potential future challenges that India could face in STEM education at the school level and the awareness of academicians towards government's initiative like Atal Tinkering Labs etc.

In terms of research techniques Wang et.al (2011) , Breiner et.al (2012), El-Deghaidy & Mansour (2015), Lamberg & Trzynadlowski (2015) ,Altan & Ercan (2016), Han & Yalvac(2015) and Sumen & Calisici (2016) adopted qualitative case study. Admawati & Jumadi (2018) conducted quantitative research with one group pre-test and post-test of quasi-experiment. Akran & Aşiroğlu (2018) adopted phenomenography as a qualitative research method . Kavya & Rishinath (2019) conducted quantitative research and used Chi-square test for testing the hypothesis. Dönmez and Taşar (2020) adopted self-study design as one of the qualitative research method. But in studies like Altin and Pedaste (2013), Sharma and Yarlagaddab (2018) and Kanadlı (2019) systematic literature review was conducted. Holmquist (2014) adopted multi-case study approach whereas Khanlari (2013)

adopted qualitative approach in which data are collected through a focus group and to enhance the credibility of the findings, all the statements were recorded, precise description and member checks were utilized. Whereas Chia & Maat (2018) conducted small-scale survey and collected data were analysed using SPSS software, descriptive analysis included percentage and correlation analysis has been utilized to evaluate the collected data. Timur et.al (2019) used pre-test and post-test research design to investigate teachers' reactions to STEM based activities. "Pre-service Teachers' Integrative STEM Teaching Intention Questionnaire" was used to measure teachers' views on STEM teaching. The results showed that STEM based activities had a positive effect on teachers' views about STEM education. Tekerek & Karakaya(2018) used "STEM Awareness Scale (SAS)" as data collection tool, and the data were analyzed using IBM SPSS-21 statistical program. For data analysis, Independent t test, variance analysis (ANOVA) and Tukey significance test were used. Even Buyruk & Korkmaz (2016) also used "STEM Awareness Scale (SAS)" as data collection tool.

In terms of sampling techniques most of the researchers have adopted either purposive sampling or convenience sampling techniques in their studies. In terms of selection of the sample, the investigator observed wide variation. Wang et.al (2011) conducted study with 3 middle school in-service teachers purposefully selected from a pool of teachers involved in a yearlong professional development module on STEM integration. Breiner et.al (2012) carried out study among full-time faculty members of University of Cincinnati. Khanlari (2013) conducted study on 6 robotics teachers who have atleast two years' experiences of teaching robotics in schools. Lamberg & Trzynadlowski (2015) conveniently selected 7 teachers from 3 STEM academies for their study. El-Deghaidy & Mansour (2015) and Altan & Ercan (2016) conducted their study on in-service science teachers. Sumen & Calisici (2016) selected pre-service teachers of Ondokuz Mayis University for their study. Nuangchalerm (2018) carried out his study by purposively selecting 120 STEM teachers from 40 STEM schools in Thailand. Akran & Aşiroğlu (2018) conducted study on 40 primary school teachers, 30 mathematics teachers, 20 science teachers and 15 information technologies teachers, who serve in the city center of Siirt and Batman (Turkey). Kavya & Rishinath (2019) carried out study with 100 in-service teachers selected through convenience sampling method from the schools having Atal Tinkering Labs. Chia & Maat (2018) purposively selected 55 secondary school teachers as the sample for their study. The participants in Timur et.al (2019) study were 39 in-service teachers from different majors

who were working as teachers in public schools in Turkey. Tekerek & Karakaya(2018) collected data from 148 pre-service science teachers studying at a state university in Turkey who were chosen through the convenience sampling method.

Through the review investigator noticed that majority of the researchers carried out qualitative case- study method. The other interesting thing which investigator noticed that majority of the studies were carried out among in-service teachers.

For the purpose of data collection, open-ended questionnaire and interview schedule has been invariably used by many researchers. However, Wang et.al (2011**)** used document analysis and classroom observation and Dönmez & Taşar (2020) used in-class video recording and post-lesson diaries as data collection tool. Tekerek & Karakaya(2018) used "STEM Awareness Scale (SAS)" developed by Buyruk and Korkmaz (2016) as data collection tool. It was a 5-point Likert type scale and consisted of 17 questions with 2 factors. Data sources in the study conducted by Han & Yalvac (2015) were (a) each participant‟s lesson plans, (b) an in-class participant observation, and (c) one-on-one semi-structured interview

In addition to this, very few studies have referred to secondary sources of data to strengthen their data analysis.

A brief discussion of finding of these studies is presented below:

The study of Lamberg & Trzynadlowski (2015) on the perception of in- service teachers towards STEM education revealed that teachers at each STEM academy school conceptualised and implemented STEM differently, it is actually based on the way they interpreted STEM and the resources they had access to. Similarly, Breiner et.al (2012) also found in their study that teachers do not share a common conceptualisation of STEM. Their conception is most likely based on their academic discipline or how STEM impacts their daily lives. While in many studies like El-Deghaidy and Mansour (2015), Altan and Ercan (2016), Madden et.al (2016) , Nuangchalerm (2018) and Kanadlı (2019) it was found that in- service teachers have only a fragmented understanding of the significance of STEM education especially at elementary levels and the studies also suggested that in-service training programs should be developed for teachers to raise their awareness of the necessity of STEM education and to enhance their competencies in planning, implementation and evaluation of an instructional process suitable for this approach. And also this approach

would help students to increase their interest in engineering, changing technological advancements and the learning processes would be more effective. Sumen and Calisici (2016) found that pre-service teachers could easily associate elementary education science lessons acquisitions with the field of engineering. Thus, the pre-service teachers should be trained on STEM because they have the ability to implement STEM activities. The study of Chia & Maat (2018) on the teacher's attitude towards integration of STEM in Malaysia revealed that overall attitude of teachers are positive and the positive attitude towards STEM among the teachers can expedite the forming of integrated STEM education in Malaysia and it is expected that the results could provide useful information to the relevant stakeholders in formulating the implementation strategy for the integrated STEM education in Malaysia. Timur et.al(2019) concluded that STEM training course promoted teachers' views about STEM integration. Also teacher professional development program plays cruical role in training teachers, because it can not be expected of pre-service teacher training programs to prepare teachers throughout their careers due to the role of schools are changing over time. Also their study supported the view that teachers' positive view development regarding STEM education is important for future science education. Because teachers' views regarding a subject were positively associated with the good teaching. Also STEM should not be seen as an educational approach that just used by science or math teachers. In this study, their analyses demonstrated that teachers' increase of test scores regarding STEM teaching are independent of their branches. This shows that teachers in all branches (computer teacher, chemistry teacher, math teacher, geography teacher, english teacher, guidance teacher, pre-school teacher etc.) are positively influenced by STEM training course.

With regard to STEM Awareness Tekerek & Karakaya(2018) concluded that there is no statistically significant difference in pre-service science teachers' STEM awareness in terms of gender, academic achievement score, technology usage frequency, and family income level. While they significantly differ in their STEM awareness with regard to grade level. Whereas Buyruk & Korkmaz (2016) concluded that general STEM awareness levels of teacher candidates are quite high and gender has no effect on teacher candidates' STEM awareness. The findings of the study conducted by Han & Yalvac (2015) indicated that the Professional Development sessions were effective in communicating several important concepts about STEM Project Based Learning. The teachers in this study were able to understand and explain what STEM PBL was in comparison with the knowledge-centered

or teacher-centered instruction. Most teachers observed in this study acknowledged that STEM PBL was critical and effective in stimulating students ‟interests and improving students‟ understanding of content.

With regard to the relationship between STEM education and constructivist education approach, Akran and Aşiroğlu (2018) revealed that both STEM education and constructivist education approach are student centred and both approaches handle children with a comprehensive concept of education (cognitive, affective and psychomotor domains), aim for children's learning by doing and experiencing, emphasize on scientific process skills, and expect that theoretical knowledge are converted into practice. Based on social constructivism theory Admawati and Jumadi (2018) revealed that STEM project based learning developed open-mindedness and cooperation with others because every student did their project with their peers in the group. Based on Vygotsky, this condition can help a learner work effectively with support, dialogue with peers to share ideas, and move across the zone of proximal development. Besides that, STEM PjBL gave significant effect on student's curiosity which indicates social constructivist teacher's success on helping students find their passions, helping student discover what they care about, providing self-expression through a variety of media, and helping student understand that they are co-constructors of knowledge that they can make sense of things themselves. Similarly, the study of Wang et.al (2011**)** recommended that STEM integration approach is grounded in the tenets of constructivism. Also the problem solving plays an important role in integrating engineering into science and mathematics. However, they also think prior knowledge, such as science and mathematics content knowledge, is important for students to understand in order to be successful in STEM integration.

Several studies show that teachers are well versed in their subject matter knowledge but they lack of skills in STEM education (H. El-Deghaidy, 2015).According to Wang et. al. (2011), this problem primarily depends on the lack of instructions for teachers to the use of STEM education effectively in classrooms. Srikoom, Hanuscin and Faikhamta (2017) claimed that teachers should be given guidelines on how to integrate STEM education into their classrooms. Another limiting factor is that teachers' inadequate content knowledge in other disciplines because STEM education means interaction with four disciplines. Sanders (2009) indicated that STEM education requires teachers to be expert not only in their subject but also requires them to be informed at least one other STEM subject. All of these

inadequacies affect teachers' STEM implementation (National Academy of Engineering and National Research Council, 2014).

With regard to role of educational robots in STEM education Holmquist (2014) revealed in his study that there is a potential impact regarding the use of educational robots in the elementary setting. Similarly, Khanlari (2013) revealed that robotics help students to learn STEM subjects and it has the potential to change students' understanding and to facilitate students' learning of STEM subjects. Altin and Pedaste (2013) also supported the findings through systematic literature review and concluded that robotics can be seen as a "tool" to create many approaches to STEM education such as inquiry learning and problem solving. They found that the approaches like discovery learning, collaborative learning, problem solving, project based learning and competition based learning have been used in educational robots. Regarding the study of students' attitude towards educational robots they found that it promotes students' interest toward STEM subjects, which results in mitigating the lack of interest toward STEM subjects in schools. Holmquist (2014) in his study suggested that there is a potential impact regarding the use of educational robots in the elementary setting and no age is too early for learning robots.

Thus it can be concluded from these studies that as more schools embrace the STEM movement, a unified understanding and resources are needed to support teachers.

IMPLICATIONS OF THE RELATED LITERATURE FOR THE PRESENT STUDY

From the above review, it was found that majority of studies were undertaken abroad as STEM integration approach in our country seems to be in an embryonic stage.

In terms of research techniques, it was observed that majority have adopted qualitative case-study method. Qualitative studies may be more complex and difficult but they help researchers to learn more information in detail about a situation so for the present study also investigator decided to go for qualitative approach.

Overall there is a dearth of studies attempting to rigorously examine why STEM education are required and how teachers will impart STEM education in classrooms. The review of studies also reveals that majority of the studies are limited in their scope. The themes chosen

by the scholars for research are broad and general rather than pointed and specific. Very few studies Lamberg & Trzynadlowski (2015), El-Deghaidy and Mansour (2015), Altan and Ercan (2016)) are micro level studies regarding problem faced by in-service teachers while integrating STEM education in teaching- learning process.

During review investigator noticed that most of the studies concentrated only on perception of in-service teachers about STEM integration approach. It seems hardly there is any attempt to develop the holistic view (among in-service teachers) to properly contextualise STEM education in Indian scenario. This can be achieved by studying in-service school teachers level of awareness, their perception and attitude towards STEM education. Such an attempt will provide a lot of insight to actualise the objective of STEM education. Thus, this study is an attempt in that regard.

Through the reviewed studies, investigator understood the various topics so far covered in STEM education by researchers and this provided the investigator a framework for the present study.

Chapter 3

RESEARCH METHODOLOGY

CHAPTER 3

RESEARCH METHODOLOGY

INTRODUCTION

In any given investigation, it is desirable to identify and use the most appropriate research method based on the objectives of the study. The decision about the method to be employed however depends upon the nature of the problem selected and the kind of data necessary for its solution. Any research program should really add not on to the fund of knowledge but also to provide the possible solutions to some of the vital issues in the society.

This chapter provides an idea about how the entire research study was conducted. It speaks about the sampling procedure adopted by the investigator, design and development of tools for the study with respect to various objectives, method used for the collection of data and data analysis done for the interpretation of the results.

METHODOLOGY

The investigator adopted the Survey method. **Survey research** is a less structured **research methodology** used to gain in-depth information about people's underlying reasoning and motivations. The end goal is to develop a deep understanding of a topic, issue, or problem from an individual perspective.

POPULATION OF THE STUDY

The population of the proposed study consisted of all the ATL schools in Gujarat state i.e. 250 schools consisting of private, government and grant-in aid schools.

SAMPLE

1. Sampling of Schools- In the whole Vadodara region 14 schools have Atal Tinkering Labs so it was taken as sample**.** The list of Schools are as follows

    a. Navrachana Vidyani Vidyalaya
    b. New Era Senior Secondary School
    c. MES Boys High School
    d. Kendriya Vidyalaya, ONGC, Vadodara
    e. MES Girls high school

f. Zen school, padra

g. Delhi Public School, Harni

h. Fertilizer nagar school

i. MES high school nagarwada

j. Bright Day School , Bhaili

k. Bright day School CBSE unit Vadodara

l. Rosary High School, Vadodara

m. Urmi School

n. Dabhasa English School

2. Sampling of respondents- All the 14 teacher in charges who are involved in managing Atal Tinkering Labs

TOOLS AND TECHNIQUES FOR DATA COLLECTION

1. **Questionnaire: -** For measuring awareness of in-service teachers for STEM education investigator used Questionnaire. The Questionnaire comprised of 15 questions which were close ended and covered various aspects like concept of STEM education, concept of STEM integration approach, interdisciplinary and multidisciplinary approach, about Atal Tinkering Lab and technology used etc. One mark was given to each correct answer and there were no negative marking. The classification of scores of Awareness Test shows that the scores ranging from 0-5 are put in the low awareness level category and interpreted as poor. The scores ranging from 6-11 are put in the average awareness level category and interpreted as satisfactory and the scores ranging from 12-15 are put in the high awareness level category and interpreted as good. Teachers who earn a score of 0-5, 6-11 and 12-15 are under the low, average and high awareness level category respectively. The questionnaire was given to STEM experts for validation. The questionnaire for measuring awareness is given in Appendix-1
2. **Open ended questions: -** The perception of in-service teachers towards STEM integration approach was measured with the help of Open ended questions. With the help of Google form following questions were asked (It is given in Appendix 2):-
   a. **What is integrated STEM education?**
   b. **How does STEM influence and impact your life?**
   c. **Why do you think that the STEM integrated education is needed and its importance for our country?**

d. **What are the barriers you face while implementing STEM in your school?**

3. **Likert Scale: -** The attitude of in-service teachers towards implementation of STEM integration approach in their classrooms was measured with the help of Likert scale. Likert scale consists of a series of statements all of which are related to a person's attitude towards a single object. The scale consists of 30 items with five alternative responses. Each statement is set against a five-point scale of Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree. Weightage of 5,4,3,2 and 1 were given in that order for the positive statements. The scoring is reversed for the negative statements. There were 19 positive statements and 11 negative statements. It was then validated by STEM experts. The Likert scale is given in Appendix 3.

SOURCES OF DATA:- Official documents, Principals and teachers responsible for managing ATLs

PROCEDURE FOR DATA COLLECTION

Due to Corona Pandemic it was not possible for the investigator to physically visit the ATL schools for data collection. So, the investigator contacted ATL in charges and mailed the Google form for measuring awareness, perception and attitude regarding STEM education. The data collection procedure took at least one month.

DATA ANALYSIS

The present study is a survey type wherein the main objective is to find awareness, perception and attitude of in-service teachers towards integrated STEM education.

The awareness of in-service teachers about integrated STEM education are collected using questionnaire consisting of close ended questions and are analysed using frequency and percentage.

The perception of in-service teachers about integrated STEM education are collected using open ended questions and are analysed using content analysis.

The attitude of in-service teachers towards integrated STEM education are collected using Likert scale and are analysed using Intensity Index.

Chapter 4

ANALYSIS AND INTERPRETATION

CHAPTER 4

ANALYSIS AND INTERPRETATION

INTRODUCTION

Analysis of data means studying the tabulated material in order to determine inherent facts or meanings. It involves breaking down existing complex factors into simpler parts and putting the parts together in new arrangements for purposes of interpretation.[1]

"The analysis and interpretation of data involve the objective material in the possession of the researcher and his subjective reactions and desires to derive from the data the inherent meanings in their relation to the problem. To avoid making conclusions or interpretations from insufficient or invalid data, the final analysis must be anticipated in detail when plans are being made for collecting information. The problem should be analysed in detail to see what data are necessary in its solution and to be assured that the methods used will provide for definite answers. The researcher must determine whether or not the factors chosen for study will satisfy all the conditions of the problem and if the sources to be used will provide the requisite data."[2]

In the analysis of data, the data are studied from as many angles as possible to explore the new facts. Analysis requires an alert, flexible and open mind.[3] It requires a number of closely related operations such as establishment of categories, the application of these categories to raw data through coding, tabulation and then drawing statistical inferences.

The data were analysed based on the objectives of the study. These objectives are:

1. To study the awareness of in-service teachers towards integrated STEM education.
2. To study the perception of in-service teachers towards integrated STEM education.
3. To study the attitude of in-service teachers towards integrated STEM education.

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1 S.P Sukhia, P.V. Mehrotra &R.N. Mehrotra, Elements of Educational Research, 3rd revised edition, New Delhi, 1974, p.181

2 J.Francis Rummel, An Introduction to Research Procedures in Education, New York, 1958,p. 122 , as cited in S.P. Sukhia et al, p.180

3Lokesh Koul, Methodology of Educational Research, fourth edition, New Delhi, 2009, p.296

DESCRIPTIVE ANALYSIS OF DATA

Descriptive analysis, also known as descriptive analytics or descriptive statistics, is the process of using statistical techniques to describe or summarize a set of data. As one of the major types of data analysis, descriptive analysis is popular for its ability to generate accessible insights from otherwise uninterpreted data.

Unlike other types of data analysis, the descriptive analysis does not attempt to make predictions about the future. Instead, it draws insights solely from past data, by manipulating in ways that make it more meaningful.

LEVEL OF AWARENESS OF IN-SERVICE TEACHERS TOWARDS INTEGRATED STEM EDUCATION

To achieve objective 1 of the present study i.e. "To study the awareness of in-service teachers towards integrated STEM education" data were collected from the ATL in-charges of 14 Schools via Google Form. Data were collected through a questionnaire and collected data were analyzed using frequency and percentage which is given and analyzed in table 4.1 and table 4.2.

As shown in Table 4.1, the classification of scores of Awareness Test shows that the scores ranging from 0-5 are put in the low awareness level category and interpreted as poor. The scores ranging from 6-11 are put in the average awareness level category and interpreted as satisfactory and the scores ranging from 12-15 are put in the high awareness level category and interpreted as good. Students who earn a score of 0-5, 6-11 and 12-15 are under the low, average and high awareness level category respectively.

Table 4.1 Level of integrated STEM Awareness of the total sample

Awareness level	Range of scores	Frequency	%
High	12-15	11	78.6
Average	6-11	3	21.4
Low	0-5	0	0
Total		14	100

The score of the total sample in Table 4.1 on the level STEM awareness shows that 78.6 % of the in-service teachers are under the high score, 21.4 % are under the average score, and none of the in-service teachers are in the low score. It can be seen that majority of the in-service teachers have high level of STEM awareness and very few of the students are in the average awareness level category. This shows that STEM awareness level of in-service teachers of ATL schools in Vadodara district is good.

Table 4.2 Awareness of in-service teachers upon STEM education

Questions	No. of correct responses	No. of incorrect responses	% of correct responses
1. What does STEM stand for?	14	0	100
2. What word(s) describe STEM education?	13	1	92.9
3. Which initiative is taken by Government of India to promote a culture of innovation and entrepreneurship in the country?	14	0	100
4. ATL contains educational and learning 'do it yourself' kits and equipment on – science, electronics, robotics, open source microcontroller boards, sensors and 3D printers and computers.	14	0	100
5. 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file	13	1	92.9
6. What is the full form of PLA in 3D printing technology?	7	7	50
7. Which technology is used in 3D printers in Atal Tinkering labs?	8	6	57.1
8. Who first used the acronym STEM?	10	4	71.4

9. Which system is used for submitting Utilization Certificate in order to get subsequent tranches of grant- in –aid ?	7	7	50
10. When ATL Community Day is celebrated and to whom the tribute is given?	13	1	92.9
11. A robust STEM education creates critical thinkers, problem-solvers, and next generation innovators.	14	0	100
12. The aim of STEM education is to develop by a holistic approach by establishing a relationship between disciplines.	14	0	100
13. STEM contributes to the development of creativity in the field of engineering by using the basic knowledge and skills of individuals.	14	0	100
14. The STEM education handle children with a comprehensive concept of education (cognitive, affective and psychomotor domains), aim for children's learning by doing and experiencing, emphasize on scientific process skills, and expect that theoretical knowledge are converted into practice.	14	0	100
15. Constructivist education approach, which is a contemporary approach, enables children to have high level thinking skills and analyze, synthesize and evaluate things at the same time.	14	0	100

The above table reveals the awareness of in-service teachers towards STEM education, Atal Tinkering Labs, technology used in STEM education etc. Almost 100 % respondents are aware of full form of STEM, concept of STEM education and the initiative taken by Government of India to promote a culture of innovation and entrepreneurship in the country through Atal Innovation Mission. Almost all the respondents (100%) are aware of Atal Tinkering Lab and all the educational and 'Do it yourself' kits like microcontrollers, 3D printers, sensors etc.

Only 57.1 % are aware of the technology used in 3D printers and 50 % about the most popular filament used in 3D printing. Also only half of the total respondents (50 %) are aware of the PFMS system which are used for submitting Utilization Certificate in order to get subsequent tranches of grant- in –aid.

Almost all the respondents are aware of STEM education, its aim, its contribution towards development of creativity and innovation among students and how it handles children with comprehensive concept of education i.e. all the three domains cognitive, psychomotor and affective. All the 100% respondents are aware that constructive education approach is preparatory to STEM education and it enables children to have high level thinking skills and analyze, synthesize and evaluate things at the same time.

LEVEL OF PERCEPTION OF IN-SERVICE TEACHERS TOWARDS INTEGRATED STEM EDUCATION

To achieve objective 2 of the present study i.e. “To study the perception of in-service teachers towards integrated STEM education” data were collected from the ATL in-charges of 14 Schools via Google Form. Data were collected through a questionnaire containing 4 open ended questions and collected data were qualitatively analysed using content analysis. To begin the analysis researcher read the responses and coded them according to her own schematic. The final list of codes was constructed on the basis of words, whole sentences or paragraphs and after making comparisons between the codings, categories were formed on the basis of the predominant themes and thus the coding list was simplified and its final form was determined.

The responses for question # 1 i.e. What is integrated STEM education? were straight forward and easy to code. Respondents either defined their notion of integrated STEM education, or this question was left blank. In response to research question 1, 71.4 % (10 out of 14) responded to this question and the remaining 28.6 % left that question blank. (In table 4.3)

Table 4.3 Teachers' perception about the integrated STEM education

Category	Percent of respondents (n = 14)
Knew what integrated STEM education is	71.4 % (n= 10)
Combination of science, technology, engineering, and mathematics into one class, unit, or lesson	60% of 71.4% (n = 6)
It's a connection between subjects and real world concepts	40% of 71.4% (n = 4)
Left the question blank	28.6% (n = 4)

In response to question #2, How does STEM influence and/or impact your life? themes emerged from the survey responses that were coded into three broadly defined categories: (1) null relationship to STEM, (2) personal reasons, and (3) societal issues. Some responses fit into more than one category. Table 4.4 describes the breakdown of data into these three broad categories.

Table 4.4 Teachers' perception about the influence of STEM education and its impact in their life

Category	% of Respondents (n = 14)
Null relationship to STEM	21.4 % (n = 3)
Personal reasons	50% (n = 7)
Social reasons	28.6 (n = 4)

CATEGORY 1- As noted in Table 4.4, 21.4 % (n = 3) felt that STEM did not impact their life, yet they were able to articulate a relevant conceptualization of it. Some typical responses in this category included the following:

Unknown.

Not at all.

Right now I have no direct contact with STEM, but would like to learn more about it.

CATEGORY 2- Of the respondents who described personal reasons as the way STEM impacted their lives, many described their own careers or discussed their children. Some typical responses in this category included the following:

It helps us to learn new and modern techniques.

It influenced me to know more about my subjects.

Since I teach Computer Science and Math, two of the four disciplines are areas I teach.

My position is partly in a technology program, and I suppose the emphasis is such that one's personal life could be improved through discoveries made through these STEM programs.

CATEGORY 3- Some responses touched on ideas that could fit into social reason categories. Exemplars from these themes include statements like:

It taught critical thinking skills and instils a passion for innovation. Beyond the benefit of learning science, technology, engineering, and math, STEM assists in the problem-solving and exploratory learning that fuel success across a variety of tasks and disciplines.

It helps to understand the concept to the children and they will be more knowledgeable. They will apply their knowledge into real life.

The initiative insures educating Indian youth in an attempt to offset the need for persons in this field to run Indian science enterprises.

In response to question # 3 it was attempted to determine their perceptions about the reasons for the necessity of STEM Education. The findings obtained as a result of the analysis of the responses given to these questions are presented in Table 4.5.

Table 4.5 Teachers' perception about the reasons for the necessity of STEM education

Category	Frequency (f)
Improvement of STEM knowledge and academic achievement	7
Skill Development	14
Affective behaviour development in STEM areas	6
Societal contribution of STEM	14
Career development in STEM areas	10

As can be seen in Table 4.5, the teachers viewed developing positive attitudes towards STEM areas, enhancing creativity and interdisciplinary inquiry skills, improvement of academic achievement and societal contribution as important reasons for the necessity of STEM education. In Skill Development category respondents mentioned different skills such as Interdisciplinary inquiry skill, interdisciplinary problem solving skill, creativity in STEM areas, technology- utilisation skill, scientific process skills and decision making skills. Teachers also responded that STEM education is necessary for people desiring a career as an Engineer or Scientist. Teachers mentioned developing positive attitudes towards STEM areas and lack of motivation as reasons for STEM education. The teachers two more reasons for the necessity of STEM education that are having a say in scientific developments and increasing the level of development of a country and they indicate that the teachers developed some ideas about the societal contribution of STEM.

In response to question # 4 it was attempted to determine teachers' perceptions about the barriers to implementation of STEM Education. The findings obtained as a result of the analysis of the responses given to these questions are presented in Table 4.6

Table 4.6 Teachers' perception about barriers to implementation of STEM education

Category	Code	Frequency
Teachers	The profile of teacher not open to new ideas	10
Students	Student readiness	8
Teaching Program	The content of teaching program is not suitable	11
Teacher education	Improper teacher qualifications	13
Others	Technical facilities	12
	Cost	6
	Time	10
	Difficulty in integrating the knowledge and skills of different disciplines	8
	Prejudiced Parents	2

As mentioned in above table, the biggest barrier to implementation of STEM education is improper teacher qualifications, technical facilities, time, the content or structure of teaching program and teachers not opening or accepting new ideas. Teachers also felt difficulty in integrating the knowledge and skills of different disciplines and also student's readiness is also considered as barriers to implementation of STEM education

EFFECTIVENESS OF INTEGRATED STEM EDUCATION IN TERMS OF THE ATTITUDE OF THE IN-SERVICE TEACHERS

To achieve objective 3 of the present study i.e. "To study the attitude of in-service teachers towards integrated STEM education" data were collected from the ATL in-charges of 14 Schools via Google Form. Data were collected through a Likert type five point reaction scale. Collected data were analyzed using percentage and intensity index (II) which is given and analyzed in table 4.7.

Table 4.7 Summary of the attitude of in-service teachers towards integrated STEM education in terms of Percentage and Intensity Index (II)

S. No.	STATEMENT	SA	A	U	D	SD	II
1.	Integrated STEM education gives the scope to assess different aspects of the learner's development.	42.9	57.1	0	0	0	4.4
2.	Integrated STEM education encourages rote memorisation among the pupils	0	0	0	78.6	21.4	4.2
3.	Atal Tinkering Labs are helpful in implementing STEM education in the school.	71.4	28.6	0	0	0	4.7
4.	The stakeholders hardly play any role in the effective implementation of STEM education in the school.	0	0	7.1	78.6	14.3	4.1
5.	STEM provides opportunity to the students for greater participation in different activities of the school.	28.6	71.4	0	0	0	4.3
6.	The orientation and in-service training of teachers is essential for the proper implementation of STEM education in the school.	78.6	21.4	0	0	0	4.8
7.	STEM education does not provide a platform for the development of creative potentialities of the learners.	0	0	0	42.9	57.1	4.6
8.	Teachers feel overburdened due to introduction of integrated STEM education.	14.3	28.6	14.3	28.6	14.3	3.2

9.	Teachers owe less responsibility and accountability in the proper/effective implementation of STEM education in the school.	0	0	14.3	50	35.7	4.5
10.	STEM education provides the scope to the learner for self-evaluation.	21.4	78.6	0	0	0	4.2
11.	Implementation of STEM education could be possible without raising community awareness and appreciation.	0	0	0	78.6	21.4	4.2
12.	STEM education is helpful in assessing only cognitive domains.	0	0	14.3	71.4	14.3	4.4
13.	The child friendly climate is not an important element in STEM education.	0	0	0	71.4	28.6	4.3
14.	Government is helping in implementing STEM education by establishing Atal Tinkering Labs in both urban and rural schools.	78.6	21.4	0	0	0	4.8
15.	For effective implementation of STEM education, the resource materials need to be provided to all the schools for ready reference by the teachers.	64.3	28.6	0	0	0	4.5
16.	Development of the thought process of the learners is given more emphasis in STEM education.	50	50	0	0	0	4.5
17.	Teachers need to be trained in STEM education before its introduction in the school.	85.7	14.3	0	0	0	4.8
18.	For the effective implementation of STEM, the teacher's manual shall be provided for practical guidance.	64.3	35.7	0	0	0	4.6
19.	STEM education never gives opportunity to the learners for self-evaluation.	0	0	0	85.7	14.3	4.1
20.	Successful implementation of STEM education in the school requires a strong and supportive monitoring mechanism.	64.3	35.7	0	0	0	4.6
21.	A robust STEM education creates critical thinkers, problem-solvers, and next generation innovators.	57.1	42.9	0	0	0	4.6

22.	Robotics impacts the students' interests and achievements in STEM related subjects in negative way.	0	0	0	57.1	42.9	4.4
23.	Robotics, with its multi-disciplinary nature, provides constructive learning environments that are suitable for a better understanding of more scientific and non-scientific subjects and it has a significant role on learning Mathematics, Science, Technology, and Engineering subjects.	57.1	42.9	0	0	0	4.6
24.	The plug-and-play characteristic of educational robots, like LEGO Mindstorm RCX, makes it easier to learn complex engineering subjects without having prerequisite knowledge.	14.3	78.6	7.1	0	0	4.1
25.	Robotics in STEM education increases students' self-confidence and this self-confidence leads students to try more and be better in other courses.	50	50	0	0	0	4.5
26.	The Schools in Vadodara understand the importance of STEM education.	0	57.1	42.9	0	0	3.6
27.	There are colleges and/or universities and/or community colleges that offer scholarships for students to pursue STEM degrees in Vadodara.	0	0	42.9	50	7.1	2.6
28.	My school organises STEM related training programmes for teachers.	0	71.4	14.3	7.1	7.1	3.5
29.	My School allows teachers to participate in STEM workshops and training programs.	7.1	78.6	14.3	0	0	4.1
30.	The Constructivist Education Approach is preparatory to the STEM education	57.1	42.9	0	0	0	4.6
OVERALL REACTION							**4.54**

In terms of the attitude of in-service teachers towards statement 1 i.e. “Integrated STEM education gives the scope to assess different aspects of the learner’s development.”, 42.9 percentage and 52.1 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.4 showed favourable attitude of in-service teachers towards integrated STEM education stating that it gives the scope to assess different aspects of learner’s development.

In terms of the attitude of in-service teachers towards statement 2 i.e. “Integrated STEM education encourages rote memorisation among the pupils.”, 78.6 percentage and 21.4 percentage of them reacted as disagree and strongly disagree respectively. The intensity index of 4.2 showed favourable attitude of in-service teachers towards integrated STEM education stating that it actually discourages rote memorisation among the students.

In terms of the attitude of in-service teachers towards statement 3 i.e. “Atal Tinkering Labs are helpful in implementing STEM education in the school.”, 71.4 percentage and 28.6 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.7 showed strongly favourable attitude of in-service teachers towards integrated STEM education stating that Atal Tinkering Labs in schools are helpful in implementing STEM education.

In terms of the attitude of in-service teachers towards statement 4 i.e. “The stakeholders hardly play any role in the effective implementation of STEM education in the school.”, 7.1 percentage, 78.6 percentage and 14.3 percentage of them reacted as undecided, disagree and strongly disagree respectively. The intensity index of 4.1 showed favourable attitude of in-service teachers towards integrated STEM education stating that the stakeholders play very important role in the effective implementation of STEM education in the school.

In terms of the attitude of in-service teachers towards statement 5 i.e. “STEM provides opportunity to the students for greater participation in different activities of the school.”, 28.6 percentage and 71.4 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.3 showed favourable attitude of in-service teachers towards integrated STEM education stating that STEM provides opportunity to students to participate in different activities of the school.

In terms of the attitude of in-service teachers towards statement 6 i.e. “The orientation and in-service training of teachers is essential for the proper implementation of STEM education in the school.”, 78.6 percentage and 21.4 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.8 showed strongly favourable attitude of in-service teachers towards integrated STEM education stating that for successful implementation of STEM education in school the orientation and in-service training of teachers are very important.

In terms of the attitude of in-service teachers towards statement 7 i.e. “STEM education does not provide a platform for the development of creative potentialities of the learners”, 42.9 percentage and 57.1 percentage of them reacted as disagree and strongly disagree respectively. The intensity index of 4.6 showed strongly favourable attitude of in-service teachers towards integrated STEM education stating that STEM education provides a strong platform for the development of creative potentialities of the learners.

In terms of the attitude of in-service teachers towards statement 8 i.e. “Teachers feel overburdened due to introduction of integrated STEM education”, 14.3 percentage, 28.6 percentage, 14.3 percentage, 28.6 percentage and 14.3 percentage of them reacted as strongly agree, agree, undecided, disagree and strongly disagree respectively. The intensity index of 3.2 showed moderate attitude of in-service teachers towards overburdening of teachers due to introduction of integrated STEM education. Some felt overburdened whereas few of them felt it as the part of their job and it actually helps them to make students understand the difficult concepts.

In terms of the attitude of in-service teachers towards statement 9 i.e. “Teachers owe less responsibility and accountability in the proper/effective implementation of STEM education in the school”, 14.3 percentage, 50 percentage and 35.7 percentage of them reacted as undecided, disagree and strongly disagree respectively. The intensity index of 4.5 showed strongly favourable attitude of in-service teachers towards integrated STEM education stating that Teachers have lot of responsibility and accountability in the proper/ effective implementation of STEM education in the school.

In terms of the attitude of in-service teachers towards statement 10 i.e. “STEM education provides the scope to the learner for self-evaluation.”, 21.4 percentage and 78.6 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.2 showed

favourable attitude of in-service teachers towards integrated STEM education stating that it provides the scope to the learner for self- evaluation.

In terms of the attitude of in-service teachers towards statement 11 i.e. “Implementation of STEM education could be possible without raising community awareness and appreciation”, 78.6 percentage and 21.4 percentage of them reacted as disagree and strongly disagree respectively. The intensity index of 4.2 showed favourable attitude of in-service teachers towards integrated STEM education stating that implementation of STEM education in schools requires community awareness and appreciation.

In terms of the attitude of in-service teachers towards statement 12 i.e. “STEM education is helpful in assessing only cognitive domains.”, 14.3 percentage, 71.4 percentage and 14.3 percentage of them reacted as undecided, disagree and strongly disagree respectively. The intensity index of 4.4 showed favourable attitude of in-service teachers towards integrated STEM education stating that STEM education is helpful in assessing not only the cognitive domain but also the affective and psychomotor domains.

In terms of the attitude of in-service teachers towards statement 13 i.e. “The child friendly climate is not an important element in STEM education.”, 71.4 percentage and 28.6 percentage of them reacted as disagree and strongly disagree respectively. The intensity index of 4.3 showed favourable attitude of in-service teachers towards integrated STEM education stating that it is a student- centred approach.

In terms of the attitude of in-service teachers towards statement 14 i.e. “Government is helping in implementing STEM education by establishing Atal Tinkering Labs in both urban and rural schools.”, 78.6 percentage and 21.4 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.8 showed strongly favourable attitude of in-service teachers towards the help provided by Government in implementing STEM education by establishing Atal Tinkering Labs in both urban and rural schools.

In terms of the attitude of in-service teachers towards statement 15 i.e. “For effective implementation of STEM education, the resource materials need to be provided to all the schools for ready reference by the teachers.”, 64.3 percentage and 28.6 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.5 showed strongly favourable attitude of in-service teachers towards the necessity of resource materials for effective implementation of STEM education.

In terms of the attitude of in-service teachers towards statement 16 i.e. “Development of the thought process of the learners is given more emphasis in STEM education.”, 50 percentage and 50 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.5 showed strongly favourable attitude of in-service teachers towards integrated STEM education stating that it emphasizes on development of the thought process of the learners as it is student- centered approach.

In terms of the attitude of in-service teachers towards statement 17 i.e. “Teachers need to be trained in STEM education before its introduction in the school.”, 85.7 percentage and 14.3 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.8 showed strongly favourable attitude of in-service teachers towards the necessity of training of teachers in STEM education before its introduction in the school.

In terms of the attitude of in-service teachers towards statement 18 i.e. “For the effective implementation of STEM, the teacher’s manual shall be provided for practical guidance.”, 64.3 percentage and 35.7 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.6 showed strongly favourable attitude of in-service teachers towards the importance of teacher’s manual for practical guidance for effective implementation of STEM education.

In terms of the attitude of in-service teachers towards statement 19 i.e. “STEM education never gives opportunity to the learners for self-evaluation.”, 85.7 percentage and 14.3 percentage of them reacted as disagree and strongly disagree respectively. The intensity index of 4.1 showed favourable attitude of in-service teachers towards the integrated STEM education as it gives opportunity to the learners for self- evaluation.

In terms of the attitude of in-service teachers towards statement 20 i.e. “Successful implementation of STEM education in the school requires a strong and supportive monitoring mechanism.”, 64.3 percentage and 35.7 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.6 showed strongly favourable attitude of in-service teachers towards the necessity strong and supportive monitoring mechanism for effective implementation of STEM education.

In terms of the attitude of in-service teachers towards statement 21 i.e. “A robust STEM education creates critical thinkers, problem-solvers, and next generation innovators.”, 57.1 percentage and 42.9 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.6 showed strongly favourable attitude of in-service teachers towards the

integrated STEM education as it encourages critical thinking, problem- solving attitude in students and create next generation innovators.

In terms of the attitude of in-service teachers towards statement 22 i.e. “Robotics impacts the students’ interests and achievements in STEM related subjects in negative way.”, 57.1 percentage and 42.9 percentage of them reacted as disagree and strongly disagree respectively. The intensity index of 4.4 showed favourable attitude of in-service teachers towards the Robotics in STEM education as it impacts the students’ interests and achievements in positive way.

In terms of the attitude of in-service teachers towards statement 23 i.e. “Robotics, with its multi-disciplinary nature, provides constructive learning environments that are suitable for a better understanding of more scientific and non-scientific subjects and it has a significant role on learning Mathematics, Science, Technology, and Engineering subjects.”, 57.1 percentage and 42.9 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.6 showed strongly favourable attitude of in-service teachers towards the Robotics in STEM education and its multi-disciplinary nature.

In terms of the attitude of in-service teachers towards statement 24 i.e. “The plug-and-play characteristic of educational robots, like LEGO Mindstorm RCX, makes it easier to learn complex engineering subjects without having prerequisite knowledge.”, 14.3 percentage, 78.6 percentage and 7.1 percentage of them reacted as strongly agree, agree and undecided respectively. The intensity index of 4.1 showed favourable attitude of in-service teachers towards the plug and play characteristic of educational robots which makes easier to learn complex topics or subjects like engineering.

In terms of the attitude of in-service teachers towards statement 25 i.e. “Robotics in STEM education increases students’ self-confidence and this self-confidence leads students to try more and be better in other courses.”, 50 percentage and 50 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.5 showed strongly favourable attitude of in-service teachers towards the necessity of Robotics in STEM education which increases students’ self-confidence which leads to perform better in other courses.

In terms of the attitude of in-service teachers towards statement 26 i.e. “The Schools in Vadodara understand the importance of STEM education.”, 57.1 percentage and 42.9 percentage of them reacted as agree and undecided respectively. The intensity index of 3.6 showed favourable attitude of in-service teachers towards understanding the importance of STEM education by the schools in Vadodara.

In terms of the attitude of in-service teachers towards statement 27 i.e. “There are colleges and/or universities and/or community colleges that offer scholarships for students to pursue STEM degrees in Vadodara.”, 42.9 percentage, 50 percentage and 7.1 percentage of them reacted as undecided, disagree and strongly disagree respectively. The intensity index of 2.6 showed not favourable attitude of in-service teachers towards the scholarships provided by colleges or universities in order to pursue STEM degrees in Vadodara.

In terms of the attitude of in-service teachers towards statement 28 i.e. “My school organises STEM related training programmes for teachers.”, 71.4 percentage, 14.3 percentage, 7.1 percentage and 7.1 percentage of them reacted as agree, undecided, disagree and strongly disagree respectively. The intensity index of 3.5 showed moderately favourable attitude of in-service teachers towards the organisation of STEM related training programmes for teachers by the school.

In terms of the attitude of in-service teachers towards statement 29 i.e. “My School allows teachers to participate in STEM workshops and training programs.”, 7.1 percentage, 78.6 percentage and 14.3 percentage of them reacted as strongly agree, agree and undecided respectively. The intensity index of 4.1 showed favourable attitude of in-service teachers towards the permission given by schools to the teachers to participate in STEM related workshops and training programs.

In terms of the attitude of in-service teachers towards statement 30 i.e. “The Constructivist Education Approach is preparatory to the STEM education”, 57.1 percentage and 42.9 percentage of them reacted as strongly agree and agree respectively. The intensity index of 4.6 showed strongly favourable attitude of in-service teachers towards the Constructivist approach being the foundation or preparatory to the STEM education.

CONCLUSION

The present chapter described in details the descriptive and relational analysis of data related to Awareness, Perception and Attitude of in- service teachers towards integrated STEM education. The major findings and discussion thus obtained from the analysis have been summarized and presented along with a brief report of the research study in the next chapter.

Chapter 5

SUMMARY, DISCUSSION AND CONCLUSION

CHAPTER 5

SUMMARY, DISCUSSION AND CONCLUSION

INTRODUCTION

This chapter presents the summary of the entire study, major findings of the present study, discussions of the major findings and suggestions for the future endeavors. The findings are drawn out from the analysis of the data and the interpretations of the data arrived from the data analyzed.

OVERVIEW OF STUDY

Rapid changes such as emergence of k-economy, scientific and technological innovation, and advances in information and communication technology (ICT) are visibly experienced in the 21st century. These changes are interconnected and our world is becoming more complex as these changes continues to increase. The complexities of today's environment need that everyone acquire a new set of essential knowledge and abilities in order to address complicated situations. Indeed, the abilities required for success in the workplace have evolved as a result of global shifts. As has been well explored in the literature, the 21st century workplace places a premium on human capital that is informed and capable of applying that knowledge to create innovations that benefit society and increase national prosperity. In addition to knowledge, innovation in the 21st century requires a new range of skills known as 21st century skills. For instance, effective communication and collaboration problem solving skills are part of the 21st century skills. As challenges get more complicated, experts must be able to communicate effectively and collaborate with individuals from all over the world to solve problems or develop new products. The ability to navigate successfully in the more complicated and competitive life and work environment of the twenty-first century requires twenty-first-century abilities.

These changes imply that science, technology and innovation are now key for greater social well-being and economic growth. Furthermore, the complexities of today’s world require all people to be equipped with science, technology, engineering and mathematics (STEM) knowledge and 21st century skills to solve most problems that are interdisciplinary in nature. Because education is the foundation of human capital development, schools must generate kids who are STEM-literate and proficient in 21st-century abilities in order for them to become science and technology entrepreneurs and remain competitive in the labour market.

To contribute towards enhancing the quality of the 21st century human capital, STEM education and 21st century learning have been introduced by the Ministry of Education. Since that, acronym STEM and 21st century classroom have been widely discussed among teachers. However, an understanding of STEM education and 21st century learning vary especially among science and mathematics teachers. When hearing the term “STEM” and “21st century learning”, many conjure images of classrooms equipped with ICTs or using technologies to teach STEM subjects. Others think of teaching students about technology. As a results, some schools started equipping classrooms with computers/smart boards, and began organising apps/robot/software designing courses for students. Moreover, some of teachers do not realize the interconnection of the STEM education and 21st century learning. Both are viewed as two distinct approaches with distinct goals. In summary, teachers continue to raise key concerns about how to advance STEM and 21st-century education. They struggle to provide meaningful STEM activities for pupils that encourage 21st-century learning. The term "21st century learning" is commonly used to characterise the kind of skills required to succeed in today's complex and linked global environment.

Changes in science, technology, and engineering have been known to accelerate in recent years. We can understand these developments by looking at scientific investigations and innovations, as well as new technology instruments and equipment, and new engineering processes. From this point of view, it is able to be claimed that education systems are changed to be adopted new changes which have been seen in industry, as well. STEM education can be identified as one of new approaches to be used in education system, which also aims students to be able solve problems in their daily lives. Meanwhile it is thought STEM education must be introduced. There are some different STEM concept defines in the literature. STEM is an educational and teaching approach which integrates the content and skills of science, technology, engineering and math. Breiner JM (2012) states that STEM is being created by using capital letters of science, technology, engineering and math.

STEM education focuses on bridging the gap between science, technology, engineering, and mathematics fields by developing links between real-world problems; in other words, the challenges are multi-disciplinary. Borders between disciplines should be erased based on the application of these disciplines to real-world challenges. Each STEM discipline brings a different competency and viewpoint but as in real life, for a successful team, teamwork is the key term (Wang, 2012). This approach points out integrated education programs capitalizing on the knowledge and skills of every discipline. However, given the current elements of

education programs, it is clear that adoption of such an approach requires the restructuring of many elements ranging from the training of STEM teachers, changing the structure of education programs from the revision of measurement-evaluation methods and the cost and time of making such big changes stand as an barrier in front of this reform (Moore, 2014)

STATEMENT OF THE PROBLEM

Awareness, Perception and Attitude of in-service teachers about integrated STEM education

OBJECTIVES OF THE STUDY

The study is taken up with the following objectives in view:

1. To study the awareness of in-service teachers towards integrated STEM education.
2. To study the perception of in-service teachers towards integrated STEM education.
3. To study the attitude of in-service teachers towards integrated STEM education.

OPERATIONAL DEFINITION OF KEYWORDS

Awareness - According to Cambridge online dictionary "Awareness is the knowledge that something exists, or understanding of a situation or subject at the present time based on information or experience."

According to Dictionary of Education "Awareness is the act of having or showing realization, perception or knowledge."

In present study, 'awareness' is related to integrated STEM approach, which means scores, obtained from questionnaires filled up by in-service teachers on integrated STEM education.

Perception- Perception is the mental process of ascribing meaning to sensory experiences. The term perception refers to the interpretation and judgment about something based on the observation and experiences. In the present study perception of in-service teachers towards integrated STEM education was measured with the help of content analysis.

Attitude- A predisposition or a tendency to respond positively or negatively towards a certain idea, object, person, or situation. Attitude influences an individual's choice of action, and responses to challenges, incentives, and rewards.

In the present study, the scores on the tool (Likert Scale) used to measure attitude were taken as the attitude of teachers towards integrated STEM education.

EXPLANATION OF THE TERMS

Integrated STEM education- It is an effort to combine some or all the four disciplines of science, technology, engineering and mathematics into one class, unit or lesson that is based on connections between the subjects and real world problems.

Atal Tinkering Labs- It is a program by the Central government of India and established by NITI Aayog under the Atal Innovation Mission with the objective to endorse STEM system of education, by cultivating curiosity, creativity and imagination in the young India.

DELIMITATIONS OF THE STUDY

This study will be delimited to the ATL schools of Vadodara city.

METHODOLOGY

The investigator adopted the Survey method. **Survey research** is a less structured **research methodology** used to gain in-depth information about people's underlying reasoning and motivations. The end goal is to develop a deep understanding of a topic, issue, or problem from an individual perspective.

POPULATION OF THE STUDY

The population of the proposed study consisted of all the ATL schools in Gujarat state i.e. 250 schools consisting of private, government and grant-in aid schools.

SAMPLE

1. Sampling of Schools- In the whole Vadodara region 14 schools have Atal Tinkering Labs so it was taken as sample**.** The list of Schools are as follows

a. Navrachana Vidyani Vidyalaya
b. New Era Senior Secondary School
c. MES Boys High School
d. Kendriya Vidyalaya, ONGC, Vadodara
e. MES Girls high school
f. Zen school, padra
g. Delhi Public School, Harni
h. Fertilizer nagar school
i. MES high school nagarwada

j. Bright Day School , Bhaili
k. Bright day School CBSE unit Vadodara
l. Rosary High School, Vadodara
m. Urmi School
n. Dabhasa English School

2. Sampling of respondents- All the 14 teacher in charges who are involved in managing Atal Tinkering Labs

TOOLS AND TECHNIQUES FOR DATA COLLECTION

1. **Questionnaire: -** For measuring awareness of in-service teachers for STEM education investigator used Questionnaire. The Questionnaire comprised of 15 questions which were close ended and covered various aspects like concept of STEM education, concept of STEM integration approach, interdisciplinary and multidisciplinary approach, about Atal Tinkering Lab and technology used etc. One mark was given to each correct answer and there were no negative marking. The classification of scores of Awareness Test shows that the scores ranging from 0-5 are put in the low awareness level category and interpreted as poor. The scores ranging from 6-11 are put in the average awareness level category and interpreted as satisfactory and the scores ranging from 12-15 are put in the high awareness level category and interpreted as good. Teachers who earn a score of 0-5, 6-11 and 12-15 are under the low, average and high awareness level category respectively. The questionnaire was given to STEM experts for validation. The questionnaire for measuring awareness is given in Appendix-1
2. **Open ended questions: -** The perception of in-service teachers towards STEM integration approach was measured with the help of Open ended questions. With the help of Google form following questions were asked (It is given in Appendix 2):-

a. What is integrated STEM education?
b. How does STEM influence and impact your life?
c. Why do you think that the STEM integrated education is needed and its importance for our country?
d. What are the barriers you face while implementing STEM in your school?

3. **Likert Scale: -** The attitude of in-service teachers towards implementation of STEM integration approach in their classrooms was measured with the help of Likert scale. Likert scale consists of a series of statements all of which are related to a person's

attitude towards a single object. The scale consists of 30 items with five alternative responses. Each statement is set against a five-point scale of Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree. Weightage of 5,4,3,2 and 1 were given in that order for the positive statements. The scoring is reversed for the negative statements. There were 19 positive statements and 11 negative statements. It was then validated by STEM experts. The Likert scale is given in Appendix 3.

SOURCES OF DATA:- Official documents, Principals and teachers responsible for managing ATLs

PROCEDURE FOR DATA COLLECTION

Due to Corona Pandemic it was not possible for the investigator to physically visit the ATL schools for data collection. So, the investigator contacted ATL in charges and mailed the Google form for measuring awareness, perception and attitude regarding STEM education. The data collection procedure took at least one month.

DATA ANALYSIS

The present study is a survey type wherein the main objective is to find awareness, perception and attitude of in-service teachers towards integrated STEM education.

The awareness of in-service teachers about integrated STEM education are collected using questionnaire consisting of close ended questions and are analysed using frequency and percentage.

The perception of in-service teachers about integrated STEM education are collected using open ended questions and are analysed using content analysis.

The attitude of in-service teachers towards integrated STEM education are collected using Likert scale and are analysed using Intensity Index.

MAJOR FINDINGS OF THE STUDY

Objective 1- To study the awareness of in-service teachers towards integrated STEM education

- Majority of in-service teachers in the sample are ATL- incharges of their schools.

- Majority of in- service teachers are aware of the full form of STEM and concept of STEM education.
- Majority of in-service teachers are aware of Atal Tinkering Lab and all the educational and DIY kits like microcontrollers, sensors, 3D printers etc.
- Only half of the in-service teachers are aware of technology used in 3D printer and the most popular filament used in 3D printer i.e. Polylactic Acid.
- Only half of the in-service teachers are aware of Public financial management System (PFMS) which they use for submitting Utilization Certificate in order to get subsequent tranches of grant-in-aid.
- Majority of in-service teachers are aware of STEM education, its aim, its contribution towards development of creativity and innovation among students and how it handles children with comprehensive concept of education i.e. all the three domains cognitive, psychomotor and affective.
- All the respondents are aware of constructive education being the preparatory of STEM education.

Objective 2- To study the perception of in-service teachers towards integrated STEM education

- 71.4% in-service teachers knew what integrated STEM education is. Their perception is positive towards the integrated STEM education
- In response to perception towards how STEM education impacted their life, half of the in-service teachers (50%) gave personal reasons like how STEM education modified their way of teaching and how it helps in enhancing their subject knowledge. Few of them gave social reasons and rest of them mentioned null relationship with STEM.
- In response to perception about the reasons for the necessity of STEM education the teachers viewed developing positive attitudes towards STEM areas, enhancing creativity and interdisciplinary inquiry skills, improvement of academic achievement and societal contribution as important reasons for the necessity of STEM.
- In response to perception about barriers to implementation of STEM education the in-service teachers mentioned the biggest barrier to implementation of STEM education is improper teacher qualifications, technical facilities, time, the content or structure of teaching program and teachers not opening or accepting new ideas.

Objective 3- To study the attitude of in-service teachers towards integrated STEM education

- Majority of in-service teachers showed favourable attitude towards integrated STEM education stating that it gives the scope to assess different aspects of learner's development.
- Majority of in-service teachers showed favourable attitude towards integrated STEM education stating that it actually discourages rote memorisation among the students.
- Majority of in-service teachers showed strongly favourable attitude towards that Atal Tinkering Labs in schools which are helpful in implementing STEM education
- Majority of in-service teachers showed favourable attitude towards integrated STEM education stating that the stakeholders play very important role in the effective implementation of STEM education in the school.
- Majority of in-service teachers showed favourable attitude towards STEM education which provides opportunity to students to participate in different activities of the school.
- Majority of in-service teachers showed strongly favourable attitude towards integrated STEM education stating that for successful implementation of STEM education in school the orientation and in-service training of teachers are very important.
- Majority of in-service teachers showed strongly favourable attitude towards STEM education which provides a strong platform for the development of creative potentialities of the learners.
- Majority of in-service teachers showed moderate attitude towards overburdening of teachers due to introduction of integrated STEM education. Some felt overburdened whereas few of them felt it as the part of their job and it actually helps them to make students understand the difficult concepts.
- Majority of in-service teachers showed strongly favourable attitude towards integrated STEM education stating that Teachers have lot of responsibility and accountability in the proper/ effective implementation of STEM education in the school.
- Majority of in-service teachers showed favourable attitude towards integrated STEM education stating that STEM education is helpful in assessing not only the cognitive domain but also the affective and psychomotor domains.

- Majority of in-service teachers showed favourable attitude towards integrated STEM education stating that it is a student- centred approach.
- Majority of in-service teachers showed favourable attitude towards STEM education which provides opportunity to students to participate in different activities of the school.
- Majority of in-service teachers showed strongly favourable attitude towards the help provided by Government in implementing STEM education by establishing Atal Tinkering Labs in both urban and rural schools.
- Majority of in-service teachers showed strongly favourable attitude towards the necessity of resource materials for effective implementation of STEM education.
- Majority of in-service teachers showed strongly favourable attitude towards the necessity of training of teachers in STEM education before its introduction in the school.
- Majority of in-service teachers showed strongly favourable attitude towards the importance of teacher's manual for practical guidance for effective implementation of STEM education.
- Majority of in-service teachers showed strongly favourable attitude towards the necessity strong and supportive monitoring mechanism for effective implementation of STEM education.
- Majority of in-service teachers showed strongly favourable attitude towards the integrated STEM education as it encourages critical thinking, problem- solving attitude in students and create next generation innovators.
- Majority of in-service teachers showed favourable attitude towards the Robotics in STEM education as it impacts the students' interests and achievements in positive way.
- Majority of in-service teachers showed strongly favourable attitude towards the Robotics in STEM education and its multi-disciplinary nature.
- Majority of in-service teachers showed favourable attitude towards the plug and play characteristic of educational robots which makes easier to learn complex topics or subjects like engineering.
- Majority of in-service teachers showed moderately favourable attitude towards the organisation of STEM related training programmes for teachers by the school.
- Majority of in-service teachers showed favourable attitude towards the permission given by schools to the teachers to participate in STEM related workshops and training programs.

- Majority of in-service teachers showed strongly favourable attitude towards the Constructivist approach being the foundation or preparatory to the STEM education.

DISCUSSION

It was observed that in-service teachers which are also ATL-incharges of their school had positive perceptions on STEM education. According to the teachers, STEM education brings an individual in problem solving skill, arouses an individual's interest in the course and enhances his motivation, enables him to be technological literate and to have creative and critical thinking skills by putting forth different projects. As Breiner (2012) argued, children take part in different projects by STEM education, use many technologies in this project training process and this enhances their motivations. Children whose motivations enhance become open to new information and skills. What is important is to continue these skills for the whole life. Because the world we live in changes swiftly. It seems difficult especially for young children and teachers to follow these changes and adapt. Here STEM is an education that helps children and teacher in both children's planning their developmental characteristics and teacher's planning the learning-teaching process in the classroom and how they should use technology.

Children make inventions like a researcher in STEM education and converts their knowledge on different disciplines such as Science, Technology, Engineering and Mathematics to practice (Esra Bozkurt Alan, 2016). Therefore, there is not a single expected outcome of the system in STEM education. Children entering the system gain knowledge and skills with a comprehensive education approach throughout the process. Thus, also in this research, in-service teachers opined similarly to these explanations made on STEM education. It was observed that teachers expressed positive attitude towards STEM education that it provides life skills to children, children handle real life problems and find solutions by STEM and it provides children self-respect, empathy and many other skills.

It can be recommended that in-service training programs should be developed for teachers to raise their awareness of the necessity of STEM education and to enhance their competencies in planning, implementation and evaluation of an instructional process suitable for this approach.

IMPLICATIONS OF THE PRESENT STUDY

The following are the implications drawn out from the findings of the present study:

The findings can give suggestions to government and non- government organizations to frame and conduct professional development programmes for in- service teachers with the aim to enhance technological knowledge and 21st century skills used in implementing STEM education in their classes

The curriculum of pre- service teacher education programmes should be designed with the objective to develop passion towards STEM education so that teachers are motivated to implement innovative teaching methods in the classrooms.

SUGGESTION FOR FURTHER STUDIES

- STEM education and constructivist education approach can be compared for further studies.
- Comparison of STEM education with different approaches/models and theories can be made.
- Contributions of teaching programs prepared according to STEM education on individuals' high level thinking skills can be investigated.
- Qualitative and quantitative studies can be conducted on student profiles in schools in which STEM education is applied.

CONCLUSION

The present study was conducted with the objective to study awareness, perception and attitude of in-service teachers towards integrated STEM education. The findings of this study revealed that majority of teachers are aware of the concept of STEM education, government initiative towards the STEM education in the form of Atal Tinkering Labs, the educational kits used in these labs. But few teachers also need to brush up their knowledge about the technologies used in these labs for implementing STEM education. The study also revealed the perception of in-service teachers towards necessity of STEM education, how it affects their life and the barriers they faced while implementing STEM education in their schools. Majority of in-service teachers showed favourable attitude towards STEM education and how it can be integrated in the school curriculum.

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APPENDIX

APPENDIX-I

INTEGRATED STEM EDUCATION AWARENESS TOOL

Instruction: Read the following questions carefully and choose the correct answer from the options given below. Please enter your response a/b/c/d in the given box against each statements.

1. What does STEM stand for?
a. Science, Teaching, Electrical, Management
b. Science, Technology, Engineering and Management
c. Science, Technology, Engineering and Mathematics
d. Society, Technology, Engineering and Marketing

2. What word(s) describe STEM education?
a. Problem- based
b. Real- world
c. Integrated
d. All of the above

3. Which initiative is taken by Government of India to promote a culture of innovation and entrepreneurship in the country?
a. Rajiv Gandhi innovation mission
b. Atal Innovation Mission
c. Sardar Patel Innovation Mission
d. APJ Abdul Kalam Innovation and Entrepreneurship Mission

4. ATL contains educational and learning 'do it yourself' kits and equipment on – science, electronics, robotics, open source microcontroller boards, sensors and 3D printers and computers.
a. True b. False

5. 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file
a. True b. False

6. What is the full form of PLA in 3D printing technology?
   a. Programmable logic array
   b. Polylactic acid
   c. Programmed language application
   d. Polymer amino acid

7. Which technology is used in 3D printers in Atal Tinkering labs?
   a. Fused Deposition Modelling Technology
   b. Laser Powder Forming
   c. Electron Beam Melting
   d. Ultrasonic Additive Manufacturing

8. Who first used the acronym STEM?
   a. American National Science Foundation
   b. NITI Aayog
   c. American Psychology Association
   d. Atal Tinkering Labs

9. Which system is used for submitting Utilisation Certificate in order to get subsequent tranches of grant- in –aid ?
   a. ATL Dashboard
   b. Aim.gov.in
   c. PFMS
   d. NITI Aayog

10. When ATL Community Day is celebrated and to whom the tribute is given?
    a. 5 September, Dr. Sarvapalli Radhakrishnan
    b. 14 November, Jawaharlal Nehru
    c. 2nd October, Mahatma Gandhi
    d. 14 April, Dr. B.R. Ambedkar
11. A robust STEM education creates critical thinkers, problem-solvers, and next generation innovators.
    a. True b. False

12. The aim of STEM education is to develop by a holistic approach by establishing a relationship between disciplines.
    a. True b. False

13. STEM contributes to the development of creativity in the field of engineering by using the basic knowledge and skills of individuals.
    a. True b. False

14. The STEM education handle children with a comprehensive concept of education (cognitive, affective and psychomotor domains), aim for children's learning by doing and experiencing, emphasize on scientific process skills, and expect that theoretical knowledge are converted into practice.
    a. True b. False

15. Constructivist education approach, which is a contemporary approach, enables children to have high level thinking skills and analyse, synthesize and evaluate things at the same time.
    a. True b. False

APPENDIX-2

PERCEPTION OF IN-SERVICE TEACHERS TOWARDS INTEGRATED STEM EDUCATION

Instructions: Following are few questions regarding your perception towards integrated STEM education. Please try to give detailed information which will help me in my dissertation work. Your answers will be kept confidential and it is only used for my dissertation work.

1. Name-
2. Name of your School-
3. E-mail ID-
4. What is integrated STEM education?
5. How does STEM influence and impact your life?
6. Why do you think that STEM integrated education is needed and its importance for our country?
7. What are the barriers in the implementation of STEM education in your School?

APPENDIX-3

TEACHER'S ATTITUDE SCALE TOWARDS INTEGRATED STEM EDUCATION

PLEASE FILL UP THE FOLLOWING INFORMATION

Name:_____
Name of the School_____

Locality: URBAN/ RURAL
School Type: Govt. / Private

Educational Qualification:_____Age:_____Sex: Male/ Female

Teaching Experience:_____Years

Instructions:

This scale consists of statements, which shows your beliefs and inclinations towards integrated STEM education. You need to rate each statement on any one of the five given responses i.e. Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (DA) and Strongly Disagree (SDA). Kindly read each statement carefully and select the option which appropriately shows your behaviour. There is no right or wrong answer of any statement. Give your free and frank response without any hesitation. The data generated will be used for research work only. Your statement will be kept strictly confidential and will be used only for research purpose.

Thank You

Developed By

Rachana Agrawal

(Investigator)

S. No.	STATEMENT	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
1.	Integrated STEM education gives the scope to assess different aspects of the learner's development.					
2.	Integrated STEM education encourages rote memorisation among the pupils					
3.	Atal Tinkering Labs are helpful in implementing STEM education in the school.					
4.	The stakeholders hardly play any role in the effective implementation of STEM education in the school.					
5.	STEM provides opportunity to the students for greater participation in different activities of the school.					

6.	The orientation and in-service training of teachers is essential for the proper implementation of STEM education in the school.					
7.	STEM education does not provide a platform for the development of creative potentialities of the learners.					
8.	Teachers feel overburdened due to introduction of integrated STEM education.					
9.	Teachers owe less responsibility and accountability in the proper/effective implementation of STEM education in the school.					
10.	STEM education provides the scope to the learner for self-evaluation.					

11.	Implementation of STEM education could be possible without raising community awareness and appreciation.					
12.	STEM education is helpful in assessing only cognitive domains.					
13.	The child friendly climate is not an important element in STEM education.					
14.	Government is helping in implementing STEM education by establishing Atal Tinkering Labs in both urban and rural schools.					
15.	For effective implementation of STEM education, the resource materials need to be provided to all the schools for ready reference by the teachers.					

16.	Development of the thought process of the learners is given more emphasis in STEM education.					
17.	Teachers need to be trained in STEM education before its introduction in the school.					
18.	For the effective implementation of STEM, the teacher's manual shall be provided for practical guidance.					
19.	STEM education never gives opportunity to the learners for self-evaluation.					
20.	Successful implementation of STEM education in the school requires a strong and supportive monitoring mechanism.					
21.	A robust STEM education creates critical thinkers, problem-solvers, and					

	next generation innovators.					
22.	Robotics impacts the students' interests and achievements in STEM related subjects in negative way.					
23.	Robotics, with its multi-disciplinary nature, provides constructive learning environments that are suitable for a better understanding of more scientific and non-scientific subjects and it has a significant role on learning Mathematics, Science, Technology, and Engineering subjects.					
24.	The plug-and-play characteristic of educational robots, like LEGO Mindstorm RCX, makes it easier to learn complex engineering subjects without having prerequisite knowledge.					
25.	Robotics in STEM education increases students' self-confidence and this self-confidence leads students to try more and be better in other courses.					
26.	The Schools in Vadodara understand					

	the importance of STEM education.					
27.	There are colleges and/or universities and/or community colleges that offer scholarships for students to pursue STEM degrees in Vadodara.					
28.	My school organises STEM related training programmes for teachers.					
29.	My School allows teachers to participate in STEM workshops and training programs.					
30.	The Constructivist Education Approach is preparatory to the STEM education					