A Research on Comparative Steam Education between China and Ghana: A Case Study of Zhejiang Province and Accra Metropolis

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Abstract
The study’s primary objective was to assess teachers’ perceptions of innovative science, technology, engineering, arts, and mathematics (STEAM) teaching in China and Ghana. Three research goals were established to meet this primary research purpose; precisely, the study attempted to; find out how STEAM teaching practice has been implemented in China and Ghana; the perceived values and challenges teachers face during the practice of STEAM education in China and Ghana and the suggestions of development of STEAM education in China and Ghana and implications for the rest of the world. The research approach included document gathering, document sorting by relevance, noting thematic concepts, grouping the concepts into a set of categories, and constructing major themes from these categories. After analyzing the associated ideas and codes, sub-themes, and themes culled from many sources of literature, we interpreted each subject in connection to its conceptual codes and sub-themes in the context of STEAM education. The research included five instructors from five schools in Accra, Ghana, and Zhejiang Province, China. The study found that both Ghana and China alluded the fact that the practice STEAM to a certain degree. Teacher in Zhejiang province indicated their preference for discipline specific STEAM integration while teachers in Ghana supported the content-specific STEAM approach out of the four main approaches used. Both countries revealed that they derived benefits from STEAM. This includes adding to relevance to learning material; helping students develop preparedness for college; empowering students; encouraging students to go beyond the comfort zone; helping students discover their interest and many others. Teachers from two countries further opined some challenges they faced with integrating STEAM in their teaching and learning. This also compose of; difficulty for schools’ leaders to change; difficulty for educators to develop their own level of comfort; difficulty in finding time in the curriculum for project-based learning; difficulty in collaborating with other colleagues; inconsistent access to resource; Colleagues teachers’ perception of STEAM integration, difficulty in balancing district or city initiatives and many more. The study revealed the need for improvement in STEAM integration in both countries by; gaining support from building school leaders; developing community partnerships; speaking with educators who are already integrating STEAM; taking advantage of STEAM professional development opportunities, sharing their success stories.

Keywords: STEAM education Integration; Teaching practice; Challenges; Advantages; Comparative Study

INTRODUCTION

STEAM is an emerging educational concept for structuring conventional academic disciplines (silos) into a framework for constructing integrated curriculum. STEAM is built on STEM education, which may be characterised in a variety of ways. I like to write STEM education as S-T-E-M education, since it depicts the distinct’silo’ sectors of science, technology, engineering, and mathematics education. Each has grown to include components of the other's standards and practises into its own (International Technology Education Association) (ITEA, 2000). In today's culture, technological development and STEAM occupations are expanding at a rapid pace, necessitating the recruitment of people to fill roles that will further advance these discoveries via inventive ideas (Vilorio, 2014; Keane & Keane, 2016). The portion of the study will cover the following topics: the study's background, the issue statement, the research goals, the research questions, the study's importance, the study's limitations, and the study's structure.
With the rapid advancement of technology in Science, Mathematics, Engineering, and the Arts during the industrial revolution, several emerging countries, including China, Ghana, India, Rwanda, and South Africa, have underlined the critical role of creative education in economic growth. Since many emerging nations are confronted with significant economic and educational challenges, such as a scarcity of sophisticated capabilities and skills, the load of economic and monetary change, and the exertion of educational restructuring and modification (Wang, Xu & Guo, 2018). Thus, the research demonstrates that STEAM education is critical for developing nations’ growth, international competitiveness, and job creation. STEAM education is a priority in nations with a high income, a moderate income, or a poor income (Burnett & Jayaram, 2012; Ohize, 2017; Ostler, 2012). However, STEAM education lags behind in other regions of the globe, such as Africa, which has a disproportionate number of low-income nations in comparison to China, the world’s biggest emerging economy. Throughout the contemporary industrial revolution, developing countries such as China, South Africa, Ghana, and Rwanda have an immediate need for elevated real-world talents and pioneering talents who possess advanced knowledge, attitude, and skills necessary for the current needs of organisations, educational institutions, entertainment sectors, and any other country’s developmental sectors. One could wonder if many developing nations’ current talent training conditions in educational institutions ranging from elementary to high school to university allow for the attainment of this aim in their country (Li, 2007). According to Ismail (2018), the research does not describe the perceived advantages that emerging nations such as China, Ghana, and Rwanda have reaped from STEAM education practice.

Numerous scholars, including (Yan, Xie, & Li, 2009; Tian, 2014; Shi, 2015), have shown the need of adopting innovative models of education that promote skills that fit the economic development demands of emerging nations. There have been technical incompatibilities between the unified talent models for elementary through high school students and the industry’s need for ground-breaking talent (Zhao, He & Mang, 2015). This may be accomplished by transforming the nation into a knowledge-based society. A knowledge-based society places a premium on the diversity and imaginative abilities of young individuals capable of developing unique, real-world, and intellectual principles, rather than just increasing experts or intellects. STEAM education is a worldwide educational technique that is prevalent across the Commonwealth of the United Kingdom’s member nations. European and Asian nations, as well as the bulk of African countries, tend to closely follow US advances (Williams, 2011). However, the majority of technologies that developing countries require to alleviate poverty, add value to natural resources, and increase the efficiency of domestic industries have already been invented and are widely used in high-income countries such as the United States of America, the United Kingdom, China, South Korea, Japan, France, and Germany, among others. The difficulty is that many underdeveloped nations lack access to this technology. As a result, the objective for STEAM education is to acquire engineering, technical, and vocational abilities, as well as to perform cutting-edge research and development (Watkins & Ehst, 2008). For instance, postsecondary science and technology education may help poor nations expedite their transition to a knowledge-based economy. Additionally, it is vital for many scholars to work on developing STEAM teaching approaches into school curricula.

Currently, education in many emerging nations is geared toward fusion and the development of creative skills. The moment has come for nations to establish knowledge objectives and content based on the success of several competitions devoted to inventiveness education aimed at boosting creativity and innovations in schools and society (Kim & Park, 2012; Yarkman & Lee, 2012). To ensure that the nation continues to meet its shifting scientific, technology, and innovation demands, it is critical to give STEAM education to primary through high school students. STEM (Science, Technology, Engineering, and Mathematics) education, which subsequently developed into STEAM (Science, Technology, Engineering, Arts, and Mathematics) education, started in the United States and serves as an invaluable reference and source of inspiration for its implementation and success (Song, 2017). Numerous industrialized and emerging nations, including Germany, the United States of America, France, Japan, and China, have implemented STEAM education strategies during the last two decades. This strategy stresses the multidisciplinary aspect of primary and secondary school science, engineering, arts, and mathematics instruction (Fu & Wang, 2014). As a consequence, there is an urgent need for an extra stage in the evolution of creative education.
During this historical period, the introduction of STEM education is a prudent support that gives novel policies and develops a distinctive curriculum by using interdisciplinary teaching structures and methodologies (Honey, Pearson & Schweingruber, 2014). STEAM education was introduced in nations such as China, India, South Africa, Rwanda, and Ghana to increase awareness of the connections between the areas of science, mathematics, technology, engineering, and arts. This has become critical to the instructional system of Chinese education (Kwon et al., 2009; Sanders et al., 2011). Three research objectives were developed to steer the study against this context. A thorough analysis of the linked literature on STEAM education indicated that, despite the tremendous advantages of STEAM education, by stressing the connection and integration of science, technology, engineering, arts, and mathematical disciplines. It has the intrinsic drawback of increasing teacher responsibilities, which contributes to teachers' reluctance to use STEAM teaching techniques (Kwon, Nam, & Lee, 2012; Lee & Park, 2010; Son, Jung, Kwon, Kim, & Kim, 2012; Yoon, Park, & Myeong, 2006). It was again discovered that, despite the abundance of research on STEAM education worldwide, the majority of studies focused on students' STEM attitudes in terms of job choosing, but disregarded the "Arts" component of STEAM education, necessitating the necessity for this study. Again, there are little research on STEAM teaching techniques and how they are influenced by teacher qualities (Owen, 2000; Raines, 2012; Sahin, 2013; Silvera & Rushtonb, 2008).

STEAM education is one of the educational reform ideas that the United States of America has presented in order to address their future academic issues. Due to its success and global application, it may be incorporated into Chinese education and adapted to the country's unique circumstances and features of educational growth (Liu, 2018; Li, Gao, Zou & Wan, 2016). STEAM education has recently emerged as a researchable focal area for arts, mathematics, science, and technology education policy in a number of nations, and can be applied from the elementary through high school level in China.

The STEAM methodology's challenges and opportunities for moving beyond the classroom, in the innovative combination of creative thinking with trans disciplinary perspectives, are leveraging a massive collaborative network environment, from the perspective of information and communication technologies (ICTs) and Internet access, when addressing social and educational reality in new structures of learning.

The following aims are planned in this thesis in light of these rational situations, which have been absorbed as strengths.

The study's primary objective was to assess teachers' perceptions of innovative science, technology, engineering, arts, and mathematics (STEAM) teaching in China and Ghana. Three research goals were established to meet this primary research purpose; precisely, the study attempted to:

1. Find out how STEAM teaching practice has been implemented China and Ghana.
2. Ascertain the perceived values and challenges teachers face during the practice of STEAM education in China and Ghana.
3. Determine the suggestions of development of STEAM education in China and Ghana and implications for the rest of the world.

LITERATURE REVIEW

Theoretical Framework of the Study

Two theoretical theories underpin STEAM education: constructivism and culturally relevant pedagogy (CRP). Constructivism is a theory of learning that asserts that individuals acquire knowledge and understanding via the process of generating their own meaning and understanding from their own experiences (Vygotsky, 1978). Students acquire knowledge via experience rather than just listening and taking notes. Banks (1991) defines knowledge
building as the process through which instructors assist students in investigating, comprehending, and determining how disciplinary views and biases impact how knowledge is formed. By evaluating and respecting diverse views, students develop become critical consumers of information (Banks, 1993). STEAM education focuses on engaging students in active learning and on developing their own knowledge via a variety of STEAM-integrated learning activities.

Culturally responsive pedagogy involves developing rigorous education that is appropriate to students' cultural and language backgrounds (Hammond & Jackson, 2015). Ladson-Billings (2009) described culturally relevant pedagogy as a method of educating students that enables them to preserve cultural integrity while achieving academic success. Students learn when their education is relevant and culturally sensitive. STEAM education acknowledges the critical nature of students' learning experiences being connected to their own life experiences. STEAM education starts by immersing students in their areas of expertise and interest in order to develop the skills necessary to address challenges creatively and innovatively (Opperman, 2016; Thurley, 2016). CRP aims to shift training away from a deficit model, which assumes that pupils are unable to accomplish due to their cultural background, and toward a strength model, which assumes that cultural differences enrich learning and create opportunities for deeper knowledge and connections (Hammond & Jackson, 2015). Additionally, CRP incorporates cultural references, concepts, and experiences from students as critical components of the learning process. Additionally, CRP acknowledges institutional injustices and works to reform educational methods to be affirming and inclusive of all students. Integration of STEAM disciplines is utilised to narrow the opportunity gap. The opportunity gap was generated by school culture and teacher cultural views and understandings, which influenced not just how they viewed students, but also which instructional practices would have the greatest effect on student results.

To decrease the opportunity gap via STEAM integration in schools, instructors must be supported in addressing their own implicit biases towards children and STEAM integration. According to CRP, it is vital for teachers to confront their own implicit prejudice in order to close the opportunity gap (Hammond & Jackson, 2015). The theoretical framework emphasises the significance of students learning via experience and the cultural relevance of learning activities. Additionally, the theoretical framework emphasises the critical nature of instructors facing their own cultural viewpoints and unconscious prejudice in order to enhance student results. STEAM education is founded on active learning, relevance for students, and a strength-based perspective on students in order to help reduce the opportunity gap for children. The literature study addresses the many definitions of STEAM, the application of STEAM teaching techniques, the challenges to STEAM implementation, and the supports available to instructors utilising STEAM instructional strategies.

**Conceptual Review**

**Concept of STEAM Education**

Educators have struggled to define and comprehend STEAM education. This may be attributed in part to a dearth of research in this field. However, since 2013, the area of STEAM education has grown quickly (Grant & Patterson, 2016). Additionally, the debates around STEM and STEAM frameworks are elucidating the distinctions between the two. There is widespread agreement that STEAM education incorporates 21st-century skills, perspectives, and performance evaluation and is student-centered (Opperman, 2016; Thurley, 2016). Herro and Quigley (2016) defined STEAM education as an issue that must be handled using the following methods: project-based learning; some use of technology; STEAM topic knowledge as required by the challenge; and collaborative problem-solving.

STEAM education evolved from Science, Technology, Engineering, and Mathematics (STEM) education (Li, 2018), which was originally proposed by American University of Virginia scholar Yakman in the study of comprehensive education with the goal of strengthening K–12 education in science, technology, engineering, art, and mathematics in the United States of America (US) (Li, Gao, Zou & Wan, 2016). STEM education was first suggested; later, art and

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humanities literacy were progressively merged into STEM education, resulting in STEAM education (Wang, Wang & Sun, 2017). STEAM education is gaining more attention as it develops. The introduction of hands-on creative courses has grown through time into a national education policy in the United States. STEAM education is regarded as "excellent education" in the United States, and as such has garnered research and interest from throughout the globe (Chen, 2016).

At the moment, STEAM education has become a study focus for many nations' scientific education policies, and has been steadily integrated into the science and technology education curriculum at the elementary school level (Wang & Wu, 2014). STEAM is a relatively recent paradigm for interdisciplinary education. It has evolved to accommodate a new educational paradigm. STEAM is based on STEM education, which arose out of a pressing need for more students to succeed in comprehending the systems and connections (Baek et al., 2011; Yakman, 2008) that connect the hard sciences, technology, engineering, and mathematics in order to contribute to the solution of global problems (Dakers, 2006). This notion has gained renewed focus in recent years, resulting in the formation of a new educational branch known as STEM, which may be described in two ways:

i. The more conventional approach, which we like to refer to as S-T-E-M education, is to educate students in the distinct 'silo' subjects of science, technology, engineering, and mathematics. Each has grown to incorporate features of the other's standards and procedures into its own.

ii. The notion of integrated STEM education is a more recent development. It encompasses the techniques of teaching and learning when disciplines are actively blended. When taught, one field may be the dominating base field, or all may be unilaterally mixed.

While examining the elements that impact teaching and learning across STEM disciplines, it was difficult to ignore the effect of the arts disciplines. The arts include all of the divisions that interact with the inherent possibilities of integrating the other areas in order to define development's direction. As a result, it is vital to include critical components of the arts such as aesthetics, ergonomics, sociology, psychology, philosophy, and education into the study of S-T-E-M principles. This thought sparked the creation of an educational framework that could explicitly connect the study of the hard sciences to the study of the artistic divisions. This analysis resulted in a more in-depth examination of each of the major subject areas with the aim that the finer educational divisions might be recognised as having value and effect within each of the other silo disciplines, which included all aspects of social, fine, and physical arts. The following are the fundamental definitions that resulted from our investigation:

a. Science is the study of what occurs naturally and how it is influenced (Rutherford & Ahlgren, 1989)

b. What is technology? It is "innovation, change, or alteration of the natural world in order to meet perceived human requirements and desires."

c. ITEA, 2000 ITEA, 2000 ITEA, 2000 ITEA, - "is any alteration of the natural environment carried out in order to meet human requirements or desires" (NRC, 2012, p. 202).

d. Engineering - "is a systematic and often iterative process of creating items, processes, and systems that satisfy human requirements and desires" (NRC, 2012, p. 202).

e. Mathematics is the study of numbers, symbolism, patterns, forms, indeterminacy, and reasoning. (1993, AAAS; 2000, NCTM)


g. Education, History, Philosophy, Politics, Psychology, Sociology, Theology, and Science Technology Society (STS) are all examples of liberal arts (social).
h. Aesthetics: Aesthetics is where the earliest enduring cultural items originate that tell of civilization's earliest records (Mishook & Kornhaber, 2006). Unraveling the disciplines of social, fine, manual, physical, and liberal arts revealed how they stretch outward to impact and be influenced by the S-T-E-M fields' studies and activities.

All of this research resulted in the creation of the STEAM framework, which enables educators to teach courses in a way that more closely resembles how they are connected in reality. The following picture was generated from all of these relationships in order to develop a framework for structuring and analysing the interactive character of both the practise and study of the formal areas of science, technology, engineering, mathematics, and the arts.

STEAM-style education may be offered more effectively and meaningfully within the already-established arena of education by being more engaging and deeply embedded. The STEAM philosophy is founded on the premise that STEAM = Science and Technology interpreted via Engineering and the Arts, all of which are mathematically based (Yakman, 2008). A notable common thread is that each primary division emphasises the need of pupils acquiring a level of expertise in the topic that will enable them to remain adaptable to and knowledgeable about the field's fundamental changes. We can refer to extensive studies on how to inculcate scientific literacy, technical literacy, design process literacy, mathematical literacy, and linguistic literacy in pupils when we consider the breadth of the categories (Driver et al., 1994). We would argue that this leads to the conclusion that students need a breadth of primary disciplinary literacy, which includes the capacity to transfer information across disciplines using higher order thinking, in order to achieve functional literacy (DeBoer, 1991; Yakman, 2008). Thinking that is discipline-specific is transferrable to various topic bases. Individuals that are functionally literate are more productive because they are able to think across a range of subjects and comprehend the links across disciplines. Students that participate in STEAM not only acquire literacy in a single (silo) sector, but also develop into lifelong learners who are considerably more capable of adapting to and improving global society. This also enables individuals to have a deeper understanding of people and things from various disciplines, views, and cultures, allowing them to interact and collaborate while maintaining their own identities.

STEM education evolved into STEAM education as a result of the continual evolution of education. STEM education increasingly included humanities, art, society, and other components. STEAM education emphasises project-based learning as the primary mode of instruction. This is a novel educational paradigm built on the principles of STEM education. It is a synthesis of technology and engineering education with aesthetic humanities education, with the goal of fostering technology-enabled instructional innovation (Sun, Wu & Ren, 2015). Numerous counties have used the STEAM idea in recent years to promote and integrate inventive talent, and it has progressively become fashionable. A survey on the development of learners' abilities (Zhao & Lu, 2016). STEAM education focuses on developing students' practical skills while also integrating information from other disciplines. Unlike prior teacher-designed courses, it takes a holistic approach to design and problem solving, stressing scientific inquiry, engineering design, and problem-based open learning, all of which may increase students' excitement for learning.

The term STEAM was coined in 2007 at a National Science Foundation conference on the link between arts, STEM study, and workforce development (CLA, 2014). The NextGen study (Livingstone and Hope, 2011) and the Creative Industries Federation's Creative Education Agenda papers (CIF 2015) suggested that the arts should be central to education in order to foster and grow creativity. This transformation in the economic rationale for STEM to become STEAM was essential in the acronym gaining traction with Universities in the United Kingdom (2012). The government was encouraged to reject the 'narrow idea that science, technology, engineering, and mathematics constitute the only path to economic success.' Rather than that, 'students...must have access to the broadest possible range of creative disciplines in order to equip them to participate in the information economy' (Universities UK, 2012). Additionally, the final report of the Culture, Media, and Sport Select Committee said that '[t]he critical significance of arts subjects in contemporary education should be recognised, and arts courses should be included to STEM disciplines, rebranding STEM as STEAM' (DCMS, 2013, para. 117). Numerous publications present a distinct storey, posing the question not of how STEAM emerged as an amalgamation of STEM and the arts, but of when STEM and
the arts disciplines were separated. They claim that a culture of creativity and inventiveness, which often results in economic advantage, is contingent on the education of polymaths. They mention examples ranging from Steve Jobs to Leonardo DaVinci, Galileo, and Einstein, demonstrating a long history of scientific and artistic collaboration (Hayes, 2015).

**STEAM Integration in Education**

Integrated STEM education prepares students for careers in industry and markets. Today's resource-based global economy and market has resulted in extinction of species and degradation of humans (Taylor & Taylor, 2019). The present state of STEAM integration must be reviewed in light of the current educational trend in various nations. Several research on STEAM education have been published, including Vanscoder (2014), Dolberry (2015), Park et al. (2016), Herro and Quigley (2016), and Kant et al. (2018).

Several STEAM research studies focused on curriculum, content, and integrated teaching-learning of several disciplines. 3D printing is one of the STEAM learning environments. This technology enables instructors to create a physical replica of an abstract scientific or math idea. Math and science professors may utilise 3D printing to construct manipulable models of abstract topics (Vanscoder, 2014). Students' exposure to arts and design in STEM boosted their performance using visual models (Rabalais, 2014; Vanscoder, 2014). Dolberry (2015) studied hip-hop art and culture in STEAM education. Dolberry (2015) examined hip-hop culture via epistemological lenses. He utilised critical race theory to analyse the hegemonic system that privileges one race while excluding or marginalising others. An urban cultural setting was studied in the US.

Globally, STEAM education has grown in popularity over the previous decade. Park et al. (2016) investigated South Korean teachers' views on STEAM education. The authors evaluated instructors' teaching approaches, perceptions of STEAM education, its influence on students' learning, and the problems teachers experienced while implementing STEAM classes in classrooms. They found that most instructors were worried about time and workload while teaching STEAM (Park et al., 2016). Despite these limitations, the South Korean Ministry of Instruction has made serious attempts to improve STEAM education in schools (Kang, 2019; Park et al., 2016).

Scholars in STEM fields were ‘struggling to comprehend what STEM is and how to educate via an integrated STEM approach’ as STEAM education gained traction. Herro and Quigley (2016) studied 21 middle school math and science instructors in the Southern United States over a three-year period. The instructors were invited to a PD session on STEAM literacy. The research found that participants improved their grasp of STEAM topics. STEAM activities with professional development also helped transform teaching methods (Herro & Quigley, 2016). Kim and Bolger (2016) reported on improvements in Korean school policies including STEAM teaching and learning. Ensuring that all schools have STEAM classes, the South Korean government has implemented important educational changes. The participants influenced their opinions towards STEAM education. The participants' perceived skill, value, and commitment to STEAM teaching and learning increased significantly (Kim & Bolger, 2016). Similarly, Kang (2019) observed a decline in STEM career enthusiasm among South Korean youth, prompting the government to finance STEAM transformation at the national level.

Several schools and institutions in the USA have embraced STEAM pedagogy to include vulnerable and underrepresented groups. Native Americans are underrepresented in STEM disciplines (Kant et al., 2018). One goal of STEAM education is to improve underrepresented and underprivileged populations' involvement and interest. Improving educational diversity, particularly in STEM professions, may help attain this goal (Kant et al., 2018). Underrepresented Native American Girls in STEM disciplines was investigated by the South Dakota Space Grant Consortium and the National Science Foundation's Pre-Engineering Education Collaborative (PEEC), which linked Flandreau Indian School with SDSU's Civil and Environmental Engineering Department. STEAM Girls was the programme name (Kant et al., 2018). Through the arts, a majority of respondents altered their minds about science,
engineering, technology, and mathematics. The STEAM Girls end programme post-focus group findings revealed that participants loved the activities that featured pride in Native American culture. They appreciated the field involvement activities at SDSU (Kant et al., 2018).

Various programmes in Europe, Africa, and Latin America promote STEAM education in schools. Examples include the EuroSTEAM initiative, which developed a framework for STEAM education to be implemented in partner nations' schools (Haesen & Van de Put, 2018). It relates STEAM subjects to real-world challenges. This spider web approach combines five fundamental abilities with five subjects: creativity, communication, ecology, critical thinking, and mathematics (Haesen & Van de Put, 2018). This concept depicts STEAM education as a transdisciplinary network, with students and instructors working together to solve problems (Haesen & Van de Put, 2018). With a multi-fund strategy to improving physical infrastructure, curriculum, training, and implementation in schools, the European Union announced a policy of “Strengthening STE(A)M education in the EU” on June 26, 2019. (European Committee of the Regions, 2019).

Many European countries are promoting STEM/STEAM education (European Schoolnet, 2018). For example, Denmark has implemented a strategy to enhance student interest in STEM subjects. In Italy, a national strategy has been created to encourage academic careers in STEM fields. In the UK, the National Endowment for Science, Technology, and the Arts (NESTA), Creative Learning Industries Federation, and Cultural Learning Alliance (CLA) joined forces to promote STEAM education (Siepel et al., 2016). According to Siepel et al. (2016), focusing on STEM education creates a positive learning environment where young kids may thrive.

In Africa, STEAM education projects have been established to empower women and girls (Women Entrepreneurs for Africa, 2020). Women Entrepreneurs for Africa (WEforAFRICA) has created an initiative to empower girls and women via community libraries and micro-enterprises. Similarly, the STEAM Foundation NPC promotes STEAM education in South Africa by training educators, developing and distributing instructional resources, and investigating STEAM challenges (STEAM Foundation NPC, 2020).

Egypt (Aziz, 2015) and the UAE (Shaer et al., 2019) have prioritised integrated STEM/STEAM education as part of continual curriculum reform to promote 21st-century capabilities. Egypt's schools are urged to promote STEM/STEAM education via certification (Aziz, 2015). Advanced Science Agenda, Think Science, and National Agenda have all focused on promoting STEM/STEAM education. The UAE Vision is to be one of the top twenty high performing nations in PISA and the top 15 high performing nations in TIMSS (Shaer et al., 2019).

Developed and undeveloped countries alike are embracing STEAM education. As an example, in Nepal, certain schools (like Samriddhi School in Kathmandu) and universities (like Kathmandu University: https://soe.kusoed.edu.np/steam-education/) are embracing STEAM pedagogy. Samriddhi School and Kathmandu University School of Education (KUSOED) are two of Nepal's few STEAM schools. KUSOED now offers a master degree in STEAM education (Belbase, 2019). Africa (Badmus & Omosewo, 2020) and Latin America (Badmus & Omosewo, 2020) have (Cevallos et al., 2019). The research and activities stated above show some benefits of STEAM education despite implementation obstacles. At the same time, new publications in STEAM education reveal an increasing interest in STEAM education globally.

**Advantages associated with STEAM Education**

Concerns surrounding secondary and tertiary education, as well as gender inequities in STEAM education, are addressed in the literature on STEAM education in developing nations. It therefore presents solutions to these issues. Studies on STEAM education mainly concentrate on a region like Africa or Asia, combining data from middle- and low-income nations. Science and technology (as a sector) have been linked to economic development and the fight against illnesses like HIV and malaria. Most studies conclude that STEM education promotes economic development.
and competitiveness. Because the literature does not explicitly answer the question, the following method is used: The reasons for STEAM education and major trends are discussed using literature from developed and emerging nations.

High, medium, and low-income nations prioritize STEAM education (Burnett & Jayaram, 2012; Ohize, 2017; Ostler, 2012). But STEAM education lags in other places, including Africa, which has numerous low-income countries (LICs). Budget cutbacks in the 1980s reduced TVET in Africa, which has yet to recover. TVET enrolled just 6% of secondary students in 2012. (African American Institute, 2015). TIMS and UNESCO Global Monitoring Reports show that African pupils' math and science performance consistently lags below worldwide levels (Hooker, 2017). Thus, STEAM education in Africa is lacking. STEAM education is globalized: Commonwealth nations follow UK tendencies, while European and Asian countries follow US ones (Williams, 2011). However, most of the technologies required to alleviate poverty, increase the value of natural resources, and enhance domestic industry efficiency have already been produced and extensively employed in high-income nations. The difficulty is that many underdeveloped nations lack this technology. Developing engineering, technical, and vocational skills is thus more important than cutting-edge research and development (Watkins & Ehst, 2008). For example, postsecondary science and technology education may help developing nations build a knowledge-based economy. Also, research must concentrate on making STEAM relevant to local needs and growth.

The research agrees that STEM education is vital for economic growth, international competitiveness, and job creation. However, the research does not specifically address the advantages of STEAM education in underdeveloped nations, where STEM education is often deficient. Moreover, the STEAM gender gap exists in many industrialised and developing nations (UNESCO, 2017:20). However, STEAM has helped improve teacher training in underdeveloped nations, spark secondary school innovation, and link skills need and supply (Burnett & Jayaram, 2012; Hooker, 2017).

STEAM aids students' professional growth. Most STEAM literature includes teacher training to improve teaching using ICT or to teach STEM courses (Hooker, 2017). There are potential approaches for teaching and learning, including professional teacher learning, according on case study findings. The DEEP pilots in Egypt and South Africa indicate the restricted spectrum of new technologies employed in professional development. Participatory research improved universal basic education in terms of attendance, motivation, quality of learning, literacy, numeracy, and science (Hooker, 2017). “There is a rising focus on using technology to assist deeper learning ways for engaging students in the 21st century of critical thinking, problem solving, teamwork, and self-directed learning” (Hooker, 2017:11).

**Challenges associated with implementing STEAM practices**

Due to the recent change from STEM to STEAM, little study has been done on implementation difficulties. However, studying STEM research may help identify possible STEAM implementation roadblocks. There are four types of teacher comprehension of STEM education. There are a number of reasons why instructors may be reluctant to use STEM in their classrooms. Second, instructors may be aware of STEM and want to learn more. In addition, professional development may help enhance teachers' STEM understanding and experience implementing new STEM knowledge. Finally, a practical approach to STEM education may help instructors comprehend STEM (Bell, 2015).

The amount of instructor comfort and understanding of STEM teaching and implementation effects student learning (Bell, 2015). Henriksen (2017) advised against limiting STEAM education to arts integration since scientific instructors lack creative background and may be unsure how to incorporate arts into STEM. Also, arts instructors may lack STEM understanding. STEM expertise influences STEAM implementation for K-12 and higher education instructors. To teach STEAM concepts, elementary teachers need to have confidence in their conceptual grasp of science, creative approaches, and technological application (Teo & Ke, 2014). Most elementary preservice teachers only take one science teaching techniques course and no arts or technology courses (Zimmerman, 2016). The lack of confidence stems from a lack of STEAM learning experience.
Secondary instructors require help comprehending project-based learning, student-centered learning, and evaluation (Stubbs & Meyers, 2015). There is a shortage of evidence on what schools need to incorporate STEAM. STEM research may give some indications of where schools might start supporting teachers in a move to STEAM education. Leadership transformation, teacher efficacy, effective STEM professional development, supportive teacher-student interactions, STEM instructional methods, and application of STEM conceptual understanding are interrelated factors identified by Saxton et al. (2014). English (2016) identified four challenges with STEM education integration. First, teacher perspectives on STEM education and maintaining discipline integrity while integrating all STEM subjects. Second, teachers approach STEM integration by giving engineering and math a lesser standing than the other subjects.

Third, instructors of underrepresented kids do not have the same access to resources and professional development as teachers of pupils of greater socioeconomic level. Finally, the urge to incorporate arts into STEM may overburden instructors. Bruce-Davis et al. (2014) investigated student and instructor views of instructional tactics and practises, as well as the learning environment. Teachers stressed the significance of respecting teachers so they may adjust curricula to boost rigour and engagement. Students and instructors both shared the responsibility for meeting academic goals and working hard to succeed in class. Teachers also set high expectations for pupils and provided demanding work with clear supports to help them fulfil them. Project-based learning, questioning, inquiry-based learning, supervised independent research projects, developing academic discourse, and application of real-world issues were all taught. Secondary STEAM instructors require the same assistance as STEM teachers, plus support for arts integration. Higher education professors need help collaborating across disciplines.

Madden et al. (2013) discovered no integrated STEAM undergraduate programmes in the US. A few fields provide STEAM education. However, there is tremendous scepticism about transitioning from lecture-based education to student-centered, inquiry-based, and project-based learning (Connor, Karmokar, Whittington, & Walker, 2014). Ghanbari (2014) researched two outstanding university STEM-arts programmes. Students noted stronger links between material and job options and experiences at the institution, which focused on mechanisms of cooperation for professors and students.

Requirements put on classrooms outside of school also hinder STEAM implementation. Douglas et al. (2015) evaluated two schools in the same district that used the identical STEM professional development curriculum. Neither school could combine engineering into other disciplines. For example, instructors at one school claimed that School leaders prioritised testing above engineering lectures, and that there were few chances for teachers to cooperate on integrated engineering lesson design. The School leader's awareness of high quality science and math education influences STEAM instruction implementation. School leaders' input to science and math teachers was found to be more focused on general pedagogy and classroom management than topic specific feedback, which instructors need to enhance student results and their own practise.

Lack of time for planning and training, as well as resources to incorporate classroom activities are other difficulties that might be impediments to implementing STEAM education (Connor et al., 2015). Also, there is no agreement on what should be included in STEAM curriculum. Should the emphasis be on integrating curriculum, teaching and learning methods, or cross-disciplinary faculty cooperation for teaching-learning and projects? Confusion arises owing to a lack of substantive definition and meaning of STEAM integrated curriculum and pedagogy, not just acronyms (Falls, 2019). This perspective leads to STEAM content integration confusion. Process integration is difficult to execute without content integration.

School and university departments have been developed on disciplinary curricula, teaching-learning, research and projects, and assessments. Traditional institutional arrangements may hinder faculty cooperation (Costantino, 2017). Another issue may be the disparity in knowledge, philosophy, and perspectives across fields. Faculty members from different departments may fight against each other's principles and opinions, making cooperation difficult or impossible (Costantino, 2017). The relationship at the lower grade levels might be more beneficial than the higher
grade ones. It is possible that the disciplinary paradigms have differing ontological, epistemological, and axiological systems of knowledge and knowing, leading to a tug-of-war between supporters of STEM education and supporters of STEAM education (Jolly, 2014).

There are also disconnects between STEAM instructors' beliefs and classroom practices. So, although most South Korean teachers (65%) felt that STEAM education was necessary, just 18% actually implemented STEAM curriculum in their classrooms (Park et al., 2016). While creative elements in STEAM may not promote social justice concerns in general or STEAM education in particular. Students of colour are underrepresented in STEAM fields (Bennett, 2016). It's hard to imagine STEAM can alleviate the social and economic isolation of disadvantaged groups (Bennett, 2016). To put it simply, integrating disciplines in STEAM is a forced endeavour to cram everything together in a bag where there is no space for re-arranging things or fixing flaws.

While many studies suggest that teachers respect STEM (without an A) integration and are enthusiastic about its practicality and efficiency (Berlin & White, 2012; Fong, 2019), others show that teachers may be obstacles to successful STEM implementation. To examine teachers' opinions of STEM implementation, Owens (2014) looked at their competences and professional development. Owens found that most instructors lacked confidence in their ability to properly incorporate STEM. Teachers want hands-on instruction and professional growth. They also thought they lacked time, leadership, and support to properly incorporate STEM. Owens (2014) emphasised the importance of STEM leadership in curriculum development and teacher training. Kubat (2018), on the other hand, focused on implementation issues such as class size, curriculum, and instructors' lack of STEM understanding.

Various STEAM Models implemented Across Countries

Pyramid STEAM Model

Yakman's pyramid model is one of the theoretical theories that regulate STEAM education (2008). This strategy was created to apply the STEAM national curriculum based on historical research and educational philosophies. STEAM stands for Science, Technology, Engineering, Arts, and Mathematics (Yakman, 2008, p.8). The goal of this concept was to fix the educational system's fundamental flaws. Disciplines were viewed as superior or inferior (DeRosa, 2017; Yakman, 2008, p. 11). The pyramid was divided into four levels: content-specific, discipline-specific, interdisciplinary, and integrative (p. 17). Interdisciplinarity is important, according to Yakman, since all areas are necessary. Science, Technology, Engineering, Arts, and Mathematics education are interdependent (Yakman, 2008, p. 17). The results of Yakman's research led to the establishment of a STEAM framework that emphasises functional literacy, where students are taught to interpret and apply knowledge across disciplines. (12) Yakman This research found that STEAM functional literacy helps students understand people, history, society, and individual viewpoints and ideologies better so they can converse with individuals from various disciplines. The research also advised that “teachers may collaborate with other instructors from various fields to boost pupils' learning” (Yakman, 2012). Moreover, Yakman found a link between educational psychologists' ideas and STEAM education, including Bloom's taxonomy, constructivism, proximal development, and multiple intelligences (Yakman, 2012). Figure 2 explains the STEAM framework.
The STEAM framework is explained below. The framework critically examines the four phases through which STEAM evolved by explaining, the content integration phase; discipline specific integration; multidisciplinary integration and interdisciplinary integration.

The goal of content integration is to bring together disparate topic sectors into an unified curriculum in order to emphasize key concepts from numerous content areas. For example, a teacher may develop a curriculum on the efficiency of solar-powered lighting. While knowledge of electricity is necessary, truly comprehending how efficient solar energy is also demands knowledge of arithmetic in terms of price per unit and efficiency rate comparisons. A unit that incorporates information from many disciplines enables a teacher to teach content from each discipline while emphasising how these disciplines all work together to address a problem in this area. We illustrated the distinction between context and content integration with these instances; nonetheless, we consider transdisciplinary inquiry as including both context and content integration. While the objective of instructors developing STEAM methods is to teach transdisciplinarity, we recognise that this goal may not always be possible. Having said that, integrating disciplines at any level enables the use of diverse materials and approaches to address issues.

In this concept, the second component of instructional material is discipline integration. Discipline integration refers to the numerous ways in which the material and methodologies of multiple disciplines are blended in order to teach curricular topics and solve difficult issues. As we work to design an assessment instrument for STEAM activities, we recognise that disciplinary integration encompasses interdisciplinary, multidisciplinary, and transdisciplinary integration, all of which may be planned and implemented successfully to differing degrees. While integration of disciplines is a characteristic of STEAM education, some components of effective STEAM education may be done via single discipline instruction. For instance, if a teacher constructs a unit that focuses only on scientific content and processes (e.g., recognising blossoming plants in a park), this is not disciplinary integration; rather, it is "single content." However, the unit may meet the other components of STEAM practises. Thus, in this part, we will discuss how discipline integration happens, the many degrees of integration, and the components of this form of teaching.
Integration of multidisciplinary disciplines entails the use of information, techniques, and abilities from several disciplines, such as science and mathematics. Multidisciplinary research is regarded in the literature as the least integrative kind of integrated research—yet it is also likely the most feasible, since no effort is made to combine the fields (Janseen & Goldsworth, 1996). As an example of this field, students may be asked to calculate the densities of a variety of sodas, which requires merely recognising densities from a list of densities. Students in multidisciplinary courses would be asked to determine densities. The benefit of this technique is that, despite the disciplinary nature of the approaches, the many viewpoints on the topic may be collected and synthesised for the purpose of presenting the results (Max-Neef, 2005), although it is often not well-integrated (Jakobsen, Hels, & McLaughlin, 2004).

A significant drawback of interdisciplinary education is the degree to which the approach is problem-oriented. While interdisciplinary education is often seen as thematically structured rather than problem-oriented (Wickson, Carew, & Russell, 2006), others argue that curricula may be built around a primary issue (Petts, Owens, & Bulkeley, 2008), which we concur. However, since a multidisciplinary approach lacks an iterative process for the generation of new issues inside and for another field, it is not as problem-focused as interdisciplinary or transdisciplinary methods. Due to the fact that STEAM activities emphasize the development of problem-solving abilities (see the skills section below), the interdisciplinary approach is incompatible with the STEAM method.

Interdisciplinary discipline integration is the application of one discipline's knowledge, procedures, and abilities to another. Students analysing the pros and drawbacks of a carbon tax while attempting to reduce CO2 emissions by 50% is one example of this technique. To properly appreciate the subject, students must understand the physics underlying CO2 emissions, the economic models used to determine whether a carbon tax would help or hurt businesses, and the role of political power in the decision-making process for legislation affecting nations beyond the United States. While interdisciplinary inquiry makes use of a range of disciplines, the inquiry into each field is conducted inside that discipline (i.e., using economic modelling to understand the financial impacts of a carbon tax).

Interdisciplinary methods place a premium on tackling specific 'real world' system challenges and hence encourage student participants to produce new knowledge across disciplines (Stock & Burton, 2011). Students collaborate across disciplines to define a topic, agree on a methodological approach, and evaluate data using an interdisciplinary approach (Hammer, & Söderqvist, 2011). Thus, interdisciplinary study needs instructors to deliberately develop a topic that encourages the use of a range of methodologies to tackle it in a manner that a diverse approach does not require (Robinson, 2008).

While this strategy is useful in that it integrates more problem solving and promotes the use of a range of ways to tackle the issue, it also strives to synthesise the various disciplines yet often generates conclusions for those integrated disciplines. Thus, information developed inside domains continues to benefit mainly individuals within those areas (Stock & Burton, 2011), but transdisciplinary research strives to have an influence both within and beyond those fields.

STEAM Model Movement Across Various Countries

Both government and non-government institutions and groups are constantly working to improve STEM/STEAM education in many regions of the globe. For the past couple of decades, the STEM movement has been a popular phrase in the education sector. Recently, the US government has taken it more seriously. In a study titled 'Charting a route for success: America's strategy for STEM education,' the Executive Office of the President of the United States unveiled a strategic plan. The study was authored by the National Science and Technology Council's Committee on STEM Education (CoSTEM, 2018). According to the study, 'the nature of STEM education has evolved away from a collection of overlapping disciplines toward a more integrated and intradisciplinary approach to learning and skill development' (CoSTEM, 2018, p. v). STEM is highlighted in the strategic plan as a source of inspiration for discoveries, revolutionary technologies, a competitive economy, and a sustainable future via strategic collaborations, enhanced diversity and fairness, and increased openness and accountability. The study includes government objectives
for the next five years aimed at strengthening the STEM foundation, promoting social justice, and preparing young people with strong STEM capabilities for the future (CoSTEM, 2018). Additionally, the CoSTEM prioritised expanding public and youth participation in STEM education and careers, enhancing students' STEM experiences, and developing better educational programmes to meet future needs (Hom, 2014).

Other institutions have also contributed to the development of STEAM education. For instance, John Maeda, President of the Rhode Island School of Design (RISD), revitalised STEM by reconciling scientific truth and rigour with artistic beauty and ideals. Since its inception, RISD has developed a number of programmes and initiatives that integrate science, mathematics, engineering, technology, and the arts, including projects and designs for oceanic case studies, conducting experiments in the Nature Labs, and engaging students through internships in medical, scientific, engineering, and artistic fields (Rabalais, 2014). Similarly, there are several other current STEAM initiatives and academic programmes in the United States, such as North Carolina's The New School Project and Concordia University's M.Ed. in STEAM instruction. The teacher education programme at Concordia University focuses on STEAM education and includes courses such as Foundations of STEAM Education, STEAM Integration in K-12, From Theory to Practice: Developing STEAM-Enhanced Curriculum, and STEAM Program Leadership (Concordia University, 2019).

Several other STEAM programmes for kids and instructors are being planned by various consultancies, universities, and organisations. For instance, from 26 April to 4 May 2019, The Franklin Institute hosted the Philadelphia Science Festival. The STEAM component was a major component of this event, which had the vision 'Science is an art, and art is science' (The Franklin Institute, 2019, n.p.). Brown STEAM at Brown University, MIT STEAM at Massachusetts Institute of Technology, RISD STEAM at Rhode Island School of Design, Yale STEAM at Yale University, Boston University STEAM at Boston University, Rutgers STEAM at Rutgers University, and Harvard STEAM at Harvard University are the other active STEAM programmes (https://steamwith.us/index.html). These are university-based STEAM enrichment programmes that are mostly organised by student organisations with institutional backing.

Certain STEAM programmes are geared at K-12 education. For instance, Discovery Education, a branch of Discovery Communications, recently announced the commencement of a three-year STEAM initiative with the Mt. Vernon City School District in New York. This initiative sought to provide 'high-quality STEAM learning experiences in K-12 schools, as well as a strategy for building an integrated curriculum for the future Mt. Vernon STEAM Academy' (Discovery Education, August 2, 2018, n.p.). These events and projects reflect STEAM education's popularity. Additionally, it is obvious in the National Art Education Association's (NAEA) new STEAM policy statement, which states unequivocally that 'the integration of art and design ideas, concepts, and methods into STEM education and learning' (NAEA, 2014, para. 1; as cited in Liao, 2016, p. 45). NAEA (2014) expounded on its underlying ideas about STEAM education in its position statement. These beliefs articulate the fundamental values of transdisciplinary STEAM education in terms of implementation strategy, emphasis on creativity and innovation, and the rigour of such pedagogy or programme designed to enhance students' learning experiences through visualisation of abstract concepts using dynamic visualisation (Castro-Alonso et al., 2015).

China, South Korea, and Singapore are among nations that have implemented STEAM education in schools, either as an integrated part of normal curriculum or as an enrichment programme. South Korea has adopted STEAM education in elementary and middle schools in this framework. The initiative is meant to address curriculum and pedagogical issues in South Korean mathematics, science, engineering, and arts education (Ministry of Education and Science Technology, 2010; as cited in Kim & Lee, 2015). South Korea's new STEAM education system intends to foster students' problem-solving abilities, convergent thinking, and collaborative culture in order to promote students' interest in math, science, engineering, the arts, and technology (Kim & Lee, 2015). Similarly, numerous Singapore schools have included STEAM instruction into their curricula via the Applied Science Centre. Singapore's Ministry of Education intends to implement this curriculum in all primary level courses by 2023. (MoE Singapore, 2019). Numerous schools have already implemented Applied Learning Programs in the fields of applied science, engineering,
and robotics, environmental science and sustainable living, food science and technology, health science and technology, information technology and programming, material science, simulation and modelling, transportation and communication, language, humanities, business and entrepreneurship, aesthetics, and interdisciplinary education (MoE Singapore, 2019).

Certain mathematics and science instructors seem to embrace STEAM education in their classroom instruction by integrating mathematics and scientific studies with engineering and other fields, including the arts (Bush & Cook, 2019b; Smith et al., 2015). Smith et al. (2015) addressed a maths lesson that included STEAM ideas via the use of a motion-controlled game. The game used the concept of angles and measures, the science of colours and motion, and the game's design. They used Common Core and Next Generation Science Standards, as well as the art of gaming, in order to get a variety of colours and angles from the sensors and light beams. The STEM/STEAM projects described above represent a global push toward a new path via integrated or amalgamated pedagogy for meaningful teaching and learning across disciplines. These efforts have reimagined the purpose of education both inside and outside the STEAM area.

**Critique of Previous Research**

The difficulty with STEAM research is that several definitions of STEAM exist. Guyotte et al. (2015) defined STEAM as an interdisciplinary field of study focusing on community social activities, whereas Zimmerman (2016) characterised STEAM education as "transdisciplinary," implying the integration of all STEAM fields. There is no consensus over the definition of STEAM education, which makes it difficult to grasp what instructors need to execute STEAM education and how to assess student learning opportunities and knowledge.

Due in part to a lack of consensus over what constitutes STEAM education, STEAM pedagogy and instructional methodologies are founded on principles from STEM, the arts, technology, successful community partnerships, and project-based learning. This, however, has varied according on the organisation or individual providing teacher training. Herro and Quigley (2016) exposed teachers to a variety of STEAM classes and then watched instructors as they developed and taught STEAM lessons using characteristics from their own STEAM learning experience. Instead than having a collection of characteristics based on best practises from each of the disciplines to assist instructors in learning about the components of STEAM education, the research utilised the teachers' resources and instructional tactics as examples of what STEAM teaching looks like. Overland (2013) and Fulton and Simpson-Steele (2016) concentrated only on the integration of a component of the arts into one of the other STEAM fields. Watson and Watson (2013), as well as Catterall (2013), emphasised the need of incorporating the arts into engineering education. Hunter-Doniger et al. (2018) examined whether teachers who participated in a multi-day professional development session that merged arts and scientific requirements were able to construct arts integrated curricular units. No rubric analysis was performed on the units. Additionally, prior to the professional development, instructors were not asked to complete a survey assessing their present capacity to combine arts and science. Zimmerman (2016) and Kuhn (2015) conducted studies on primary teachers' incorporation of arts into science education, while Geimer (2014) researched arts integration into elementary math instruction. Richard and Treichel (2013) conducted an examination of secondary science teachers' practises on the integration of arts into their curriculum.

When more than two STEAM disciplines were examined to determine what constitutes high-quality STEAM education, the research focused on describing a project undertaken by the researcher to draw attention to the way all disciplines were integrated rather than on the strategies used to design these 33types of learning opportunities (Acosta, 2015; Connor et al., 2014; Crayton & Svihla, 2015; Madden et al., 2013; Mote et al., 2014; Radziwill et al., 2015). Oner et al. (2016) investigated students' perspectives of the creative process at a STEM summer camp. According to the researchers, using creativity to address challenges promotes a STEAM learning environment at the STEM camp. There was, however, no improvement in the pupils' understanding of what creativity was. Students self-reported how much their own creativity was employed in each of the learning situations. To assess the influence on creative thinking...
abilities. Seifter et al. (2016) presented the arts-based STEM innovation programme to high school students and young adult STEM workers. The creative thinking abilities of the young adult STEM workers were unchanged. Furthermore, no elementary or middle school pupils were included in the investigation. To execute lessons, schools are forming STEAM teams (Watson, 2016). An instructional expert is often a member of a STEAM team. While research on STEM instructional specialists has been conducted to better understand their role, needs, and challenges, no research has been conducted on the role of a STEAM instructional specialist in implementing high-quality STEAM instructional practises, assessments, units, lessons, and projects.

**RESEARCH METHODOLOGY**

**Research Design**

The research will be conducted via a descriptive survey approach. According to Creswell (2009), descriptive survey research design helps researchers to evaluate relationships between variables under examination; hence, the researchers chose this research design because it enables them to gather data and develop meaningful interpretations of the study's results. This is consistent with the statement made by (Fraenkel & Wallen, 1990) that descriptive survey design gives a clear account of events and people's behaviour based on survey data in order to make meaningful judgments. A qualitative research approach is more appropriate for this thesis since the intention is to investigate and define how external influences might effect e-commerce enterprises. Qualitative research is often used to investigate, describe, or explain social phenomena, which is what this thesis attempts to do. Qualitative research enables the writers to perform an in-depth examination and comprehension of the respondents' diverse viewpoints (Leavy, 2014). In a qualitative research, primary data are mostly gathered via interviews with a variety of relevant respondents (Kvale and Brinkmann, 2008). However, there is always a chance that the approach used may complicate generalising the results. Because primary data collection is insufficient to relate the findings to all businesses operating in the specified area (Bryman and Bell, 2016), the qualitative technique is the most appropriate for this thesis.

**Sampling Technique**

Purposive sampling is accomplished via the collection of substantial specific information, in which researchers choose respondents based on factors that directly relate to the research questions for the discovery (Creswell and Poth, 2006). Collecting data is critical during a research project since it contributes to a better grasp of the theoretical framework (Bernard, 2002). The term "purposive sampling" is often used to refer to judgement sampling (Lewis and Shepard, 2006). The researchers identify the data that will be necessary and the persons who will offer it based on their expertise and competency (Bernard, 2002). This approach is often represented by the key informant technique, in which one or more individuals are recruited to act as cultural guides (Garcia, 2006). Among the individuals recruited are Only instructors of Science, Technology, Engineering, Arts, and Mathematics who are culturally sensitive and eager to offer their knowledge or expertise will be considered for the research (Campbell, 1955). Purposive sampling instructs researchers on how to recruit talented persons willing to offer their expertise or experience via the use of a purposive sample strategy (Seidler, 1974). Numerous studies have used this methodology of purposive sampling for purposes such as population sampling, analysis, and important outcomes and data collection (Dolores and Tongco, 2005). The research topic dictates the sampling method's aims and methods. Purposive sampling is separated into three areas in order to identify competent and dependable informants. These categories include investigations of specialised skill, knowledge, and practise. It is critical for writers to be prepared and to establish criteria or qualities for good informants. Purposive sampling with a set of particular criteria is thus critical. The credentials include professionals who offer their expertise and knowledge in order to speak about a certain topic or area using theoretical notions or as close to them as feasible (Lewis and Shepard, 2006). Purposive sampling with a list of requirements is more efficient for researchers and assists them in locating the most suited informant. However, this strategy is used in data gathering since it requires respondents to complete questionnaires in order to determine the quality of acculturated persons (Dolores and Tongco, 2005).
Data Collection Instrument

The research approach included document gathering, document sorting by relevance, noting thematic concepts, grouping the concepts into a set of categories, and constructing major themes from these categories. The spring of 2019 marked the start of the document collecting for the research of STEAM education. A few essential themes were culled from the contents of the websites of over 21 different government, non-government, and educational organisations. Additional STEAM education concepts were culled from over 30 books or chapters, over 20 journal articles, seven conference proceedings, and two PhD dissertations. These materials were gathered from a variety of internet sources as well as the university library's resources.

There were four distinct sorts of papers used to collect data for STEAM Education. The first source of knowledge was the content of websites devoted to STEAM Education. Using various terms, such as STEAM education, STEAM initiatives, STEAM pedagogy, STEAM learning, STEAM teaching, STEAM assessment, and STEAM approach, etc., a google search uncovered multiple websites devoted to STEAM education. The second source of information was the peer-reviewed journal papers and conference proceedings. The majority of these papers dealt with engineering pedagogy, educational reform, professional development, STEAM methods, and sustainability. There were only two periodicals entirely dedicated to STEAM education: Claremont University's STEAM Journal and Turkey's Journal of STEAM Education. However, studies relating to STEAM have been published in other journals and conference proceedings, such as Kang (2019). This constraint demonstrates the scarcity of journals devoted to STEAM education. The third source of knowledge included books and chapters, such as Khine and Areepattamannil's (2019) STEAM Education: Theory and Practice; and Sousa and Pilecki's (2019) STEAM Education: Theory and Practice (2013) From STEM to STEAM: Integrating the Arts Through Brain-Compatible Strategies, to mention a few. The fourth category of resources included reports, news websites, and brochures, as well as university course materials and government papers. The study's research tool will be a semi-structured interview. A questionnaire consists of a series of questions pertaining to the study's objectives and the verification question, to which the responder is obliged to reply in writing. Primary data is the form of data that researchers gather themselves, and it may be costly, time-consuming, and difficult to obtain. Primary data may be obtained in a variety of ways, including observation, experiments, surveys, and interviews. While observation is regarded a data collecting technique in and of itself, regardless of whether data collection method is used, observations should always be a critical component (Adams et al., 2014). For a qualitative research, such as this thesis, the major data gathering method is via interviews, which enables the study to obtain a thorough grasp of the topic. Face-to-face or telephone interviews are the most often utilised methods in business and management research because they enable the collection of large amounts of data. Qualitative studies using interviews often have much smaller sample sizes than quantitative research using surveys (Adams et al., 2014). Due to the present state of Covid-19, interviews through Zoom and phone conversations were done for this qualitative research.

The research conducted document analysis by conducting a comprehensive evaluation of pertinent documents, including journal articles, book chapters, reports, and website material (Bowen, 2009). For this research, we gathered data from a variety of sources and tabulated it in a matrix style in order to filter and categorise it into distinct themes. Then, we extracted vital and crucial concepts from them and coded them with related concepts. We tallied all ideas and codes in a matrix and classified those that were closely connected into distinct sub-constructs. We halted the coding procedure when the matrix was completely saturated and no meaningful new information emerged from the extra ideas (Bowen, 2009). After completing the sub-constructs, I organised them into four themes based on their relationships with one another. After that, we created a matrix that connected the codes, sub-constructs, and themes. I customised the categorical thinking approach for the purpose of associating the codes with other STEAM education themes pertinent to the study's subject (Freeman, 2017). I used a grounded theory approach to coding, connecting codes to form sub-constructs and arranging the sub-constructs into STEAM
instruction (Bryant, 2017). The study of the material (data) from the different literature sources revealed four themes and fourteen sub-themes.

**Interpretation of Themes**

After analysing the associated ideas and codes, sub-themes, and themes culled from many sources of literature, we interpreted each subject in connection to its conceptual codes and sub-themes in the context of STEAM education. While writing the interpretation, we recreated textual descriptions of themes and sub-themes using codes and notions that connected them to the corresponding literature. In this sense, this study was an iterative process of organising information about STEAM education from various documents and related website contents in order to highlight STEAM education's status in terms of two distinct themes – Perceptions of STEAM Education Practice and Challenges Teachers Face During STEAM Education Implementation. The first version focused on the relationship between conceptual codes within a sub-theme. The second version builds on these codes to provide a comprehensive description of STEAM education-related challenges. The description was aligned with the sub-themes and themes in the third iteration. The fourth iteration was used to revise the descriptions and interpretations of sub-themes and themes, including any necessary citations and references. Through ongoing comparison and theoretical sampling of important ideas, these iterative procedures enabled us to match the analyses, descriptions, and interpretations of the themes with the conceptual codes and sub-themes.

**Data Processing and Analysis**

The qualitative technique is critical for researchers who want to delve into a certain subject or experience. Because there are several viewpoints on the qualitative approaches used in various investigations. For data processing, both content and theme analysis were used to examine all data acquired from the internet. After conducting a review of the literature, aggregate points were calculated depending on the study's goals.

Table 1: Data Analysis

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**RESULTS AND DISCUSSIONS**

**Background Information of Respondents**

The research included five instructors from five schools in Accra, Ghana, and Zhejiang Province, China. Three of the teachers in Accra, Ghana, were male, while the other two were female. In a similar vein, the research included two male professors from Zhejiang province. While three respondents in Zhejiang province were females, representing 60% of all respondents, demonstrating female domination in the application of STEAM in teaching and learning. This has clearly been illustrated in Figure 3 below.
In Ghana, the majority of instructors (3) 60% had more than ten years of teaching experience, while their counterparts (2) 40% had fewer than ten years of teaching experience in the application of STEAM education in teaching and learning. Three instructors, or 60% of the total, have earned a master's degree in STEAM education. The remaining two, or 40%, had bachelor's degrees and were qualified to teach STEAM to kids to assist them in developing creative and innovative learning environments. In China, most instructors (60%) had more than ten years of teaching experience, while their counterparts (2) had fewer than ten years of teaching experience in the application of STEAM education in teaching and learning. Three instructors, or 60% of the total, have earned a master's degree or equivalent advanced certification in STEAM education. The remaining two, or 40%, had a bachelor's degree and were qualified to teach STEAM to students to help in their teaching and learning. The next part goes into depth about the major findings and debates.

Main Results and Discussions

This section presented the findings of the qualitative study from phase one of the mixed-methods study. This included semi-structured interviews of 10 teacher participants. The sample was assembled through purposive sampling with 10 teachers from the two countries with five each. The study adopted document analysis and interview for collecting data. Ten teachers were interviewed until data saturation was reached. This occurred while interviewing the ninth participant because the responses to the interview protocol were becoming repetitive. Research themes were identified through the coding of each interview transcript, and broad themes and sub-themes were based on general and specific categories of the codes. By using the open coding method, the initial themes were analyzed by constant re-reading, and three main themes emerged from the data based upon the three main research objectives that guided the study. Figure 4 summarizes the process involved in analyzing and reports for the thematic analysis.
Content Analysis of the Practice of STEAM in China and Ghana.

The study analyzed several documents, including journal articles, book chapters, reports, and website material (Bowen, 2009). For this research, we gathered data from a variety of sources and tabulated it in a matrix style in order to filter and categorise it into distinct themes. Then, we extracted vital and crucial concepts from them and coded them with related concepts. The study tallied all ideas and codes in a matrix and classified those that were closely connected into distinct sub-constructs, papers, and books on the countries’ implementation of STEAM education focusing on the Zhejiang Province and Accra Metropolis as illustrated in Figure 5.
This research found that STEAM functional literacy helps students understand people, history, society, and individual viewpoints and ideologies better so they can converse with individuals from various disciplines. The research also advised that “teachers may collaborate with other instructors from various fields to boost pupils' learning” (Yakman, 2012). Moreover, Yakman found a link between educational psychologists' ideas and STEAM education, including Bloom's taxonomy, constructivism, proximal development, and multiple intelligences (Yakman, 2012). Figure 6 provides examples of the kinds of STEAM practiced in China and Ghana respectively.

Figure 6: STEAM Teaching Practice in China and Ghana

The review and analysis of the document revealed that majority of the Chinese schools within the Zhejiang province preferred to use STEAM approaches such as the integrative, multidisciplinary, discipline and content specific STEAM teaching practices.
The study revealed that a significant number of schools preferred discipline specific STEAM teaching practice in the Zhejiang Province. Figure 8 asserts that majority of the teachers and school preferred Discipline specific STEAM educational practice to its counterparts such as content specific or integrative approach.

By implication discipline integration within the Zhejiang province of China refers to the numerous ways in which the material and methodologies of multiple disciplines are blended in order to teach curricular topics and solve difficult issues. School work to design an assessment instrument for STEAM activities, that recognize that disciplinary integration encompasses interdisciplinary, multidisciplinary, and transdisciplinary integration, all of which may be planned and implemented successfully to differing degrees. While integration of disciplines is a characteristic of STEAM education, some components of effective STEAM education may be done via single discipline instruction. For instance, if a teacher constructs a unit that focuses only on scientific content and processes (e.g., recognizing blossoming plants in a park), this is not disciplinary integration; rather, it is "single content."
Within the Accra metropolis of Ghana, schools prefer content-specific STEAM educational practices as described in Figure 9. The goal of content integration is to bring together disparate topic sectors into a unified curriculum in order to emphasize key concepts from numerous content areas. For example, a teacher may develop a curriculum on the efficiency of solar-powered lighting. While knowledge of electricity is necessary, truly comprehending how efficient solar energy is also demands knowledge of arithmetic in terms of price per unit and efficiency rate comparisons. A unit that incorporates information from many disciplines enables a teacher to teach content from each discipline while emphasizing how these disciplines all work together to address a problem in this area.
There appear to be some level of difference in the approaches implemented and adopted by both countries in teaching and learning in this 21st century where majority of countries are heading towards educating their students to be able to solve world problems and the global needs of their economies.

Figure 11: Difference in STEAM teaching practices.

Details of the STEAM implementations has been clearly illustrated below. Figure 12 summarizes the themes that erupted from content analysis of STEAM teaching practice in China and Ghana.

Figure 12: Summary of theme of Research Question One
4.3.2. Integration of STEAM Education in China and Ghana

First exposure to STEAM integration varies widely between China and Ghana. In comparison to China or Zhejiang Province, educators in Ghana receive little to no exposure to STEAM integration during preservice educator training, receive little professional development for School leaders, and their first exposure occurs through self-selection into a professional development opportunity related to STEAM integration. Both nations' participants discussed their initial exposure to STEAM integration.

According to Vygotsky's constructivism theory of learning (Vygotsky, 1978), individuals learn by generating their own meaning and understanding of their own experiences. The educator's first introduction to STEAM integration demonstrated how participants developed their own knowledge of STEAM integration. School leaders get limited professional development on STEAM integration or strategies for assisting teachers who integrate STEAM. When asked about STEAM integration professional development for School leaders, a participant from Ghana's Accra metropolitan (TA#1) stated, "Not in our district." "That would be close to zero," participant TA#2 said. Approximately zero experience." Later, the same participant added, "Because, uh, as an School leader team, the instructors that I supervise are elective teachers and um, spEd, special ed." Without formal or informal chances for School leaders to learn about STEAM integration, it is difficult for School leaders to give input to teachers on how to incorporate STEAM into their education.

A participant from Zhejiang province (TB#) had a similar sentiment. Preservice teachers have practically minimal exposure to STEAM integration. Three instructors said that their preservice training did not include STEAM integration. Participant TB#1, a general education teacher, commented, "I've been teaching for ten years, and there was no discussion or courses on STEAM in my preservice programme." Participant TB#1, a STEAM elective instructor, echoed a similar sentiment: "I was never instructed to incorporate it into my STEM/STEAM or, more precisely, my science curriculum." Finally, Participant TA#5, a teacher of general education, said, "I mean not a lot. And not in any particular way; simply in the wider courses, which we didn't have a lot of. We remained steadfastly loyal to our cohort, our language arts cohort."

The paucity of exposure in preservice teacher education may be because STEAM integration as a component of learning experiences has just been popular since 2012. Each participant has been teaching for at least five years. This may be why the instructors were not exposed to STEAM integration. Student teaching placement is determined by geography, the cooperating teacher's desire to volunteer, and who has the requisite number of years of experience and endorsement to comply with the state's teacher licence rules.

Two of the instructors mentioned that their first introduction to STEAM integration occurred when they were completing their student teaching experience. Participant TA#1 discussed his cooperating teacher: "During my practicum, I was fortunate enough to work at a high school with a teacher who offered an engineering elective, which was roughly ten years ago." Student teachers have difficulties since they are often forced to adhere to the cooperating teacher's regulations, classroom management plan, annual scope and sequence, and instructional practise.

As a result, few student teachers are paired with STEAM-integrated cooperating teachers. Participant TB#1 discussed how his cooperating teacher had two heart attacks and how the school's tragedy prompted the participant to experiment with STEAM integration to engage his pupils. There were fatalities. Explosions occurred. Stabbings occurred. There were those who set others on fire. Throughout the day, windows were blasted out. My mentor teacher had two heart attacks throughout the school year. It was precise. It was akin to extreme trauma for me, uh, entering education for the first time and teaching and learning in buildings and urban schools, and just this whole thing. And as a result of that, what might be deemed a disaster was born, such that I am now required to connect with students and communities in a new manner, since the historical method in which children and families interact with the school experience is plainly problematic. Educators self-select into opportunities for professional development.
There are several possibilities for teachers to attend professional development from organisations that promise to educate how to incorporate STEAM. However, there is no systematic way for educators to become aware of these possibilities. Additionally, some possibilities require instructors to pay for and attend professional development on their own. Two instructors shared how they became acquainted with STEAM integration as a result of taking advantage of accessible professional development opportunities, sometimes on their own dime. "And then, on my own time and expense, I've opted to attend conferences here and there to attempt to broaden my own expertise," participant TA#2 noted. Later in the interview, Participant TA#2 elaborated, "But of all those who were here, this is the most important thing." I believe I will attend this event regardless of whether it is provided as a chance, and hence I took advantage of it."

Participant TB#2 addressed the possibility for professional growth that exposed her to STEAM integration. "I was part of a makerspace cohort, uh, and we visited other makerspaces around our district to learn more about how to utilise the makerspace, how to incorporate STEAM into the makerspace, and how to bring your class there, among other things." Participant TA#5 identified a professional development opportunity in arts integration during which he was first exposed to STEAM integration. "I'm thinking about how I've integrated the arts. That would most likely be the A. What is it called? You're undoubtedly aware of it." The non-systemic approach of teachers picking professional development opportunities leads in a diversity of definitions of what STEAM integration is, how to integrate STEAM, and what high-quality STEAM integration looks like in a classroom. Electives are offered in schools as a means of enrichment for pupils. Offering STEAM electives, educators believe, provides students with the chance to learn how to tackle real-world challenges that cannot be addressed in academic classes. STEAM integration, according to participant TA#1, is more akin to a distinct class than to content integration. "The incorporation of STEAM into a non-STEAM class. I teach a STEAM elective, which is distinct from incorporating it into science and math, as I previously did.

STEAM Education Integration in China

After the creation of the People's Republic of China in 1949, modern science and technology, as well as a modern education system, were priority goals. In the 1950s, China's highly centralised government regime modelled after the former Soviet Union fostered research and development in military and heavy industries (Song, 2008; X.-W. Zhong & Yang, 2007). The motto 'science-technology is the primary producing force, knowledge and skill will be acknowledged' was introduced in 1978. (Deng, 1997). For the first time in Chinese history, S&T was seen as the engine of economic growth. With the help of research institutions, colleges, and businesses, the Chinese government has begun to move away from the inefficient Soviet-style technological innovation system. ‘Rejuvenating China through Technology & Education’ was the 1995 national development plan (L.-L. Zhu, 1995). A new S&T development objective (2006-2020) including agriculture, industry, high-tech, and fundamental scientific research was created in 2006 (China State Council, 2006).

Chinese S&T policies well correspond with the overarching national strategy and objectives for economic and social growth. S&T has a triple function in modern Chinese culture. Fundamentally, S&T innovation drives social and economic growth. Second, scientific innovation will promote economic transformation, which is the national strategy's top aim. Third, S&T is directly linked to the national culture and spirit. A nation's scientific attitude and traits influence its destiny and vitality (Wen, 2011). Over time, these policies created an effective top-down scientific system in China, with autonomous S&T agencies formed at all levels down to counties (see Figure 1). The Ministry of Science and Technology (MOST), Chinese Academy of Science (CAS), Chinese Academy of Engineering (CAE), and National Natural Science Foundation of China run program-based competitive grant programmes (NNSFC). Each of the 10 primary programmes has multiple sub-programs. Agri-S&T Transfer Fund (Agricultural S&T Transfer Fund), International S&T Cooperation Program (Special Technology Development), National New Products Program (National New Products Program), Innovation Fund for Small Technology-based Firms (Innovation Fund for Small Technology-based Firms). By 2010, there were 218 national leading laboratories. Most are run by
universities and RIs, under MoE and CAS oversight. A society's economy becomes world-class when a scientific giant develops. France, Germany, the UK, and the USA. A changing multi-polar global economy means many scientific hubs. In the recent two decades, China has emerged as a major scientific power (Rogers Hollingsworth et al., 2008; Zhou et al., 2010).

China's economy has been booming recently. From 2005 through 2010, the average annual GDP growth rate was 11.2%, reaching 47.16 trillion yen ($7.25 trillion at the time) in 2011 (National Bureau of Statistics of China, 2012). China is now the world's second biggest economy. Because S&T and the economy are interconnected and mutually beneficial, economic growth and social advancement in China are inextricably linked (Ding, Li, & Wang, 2008; Foray, 2004; P. Zhou & Leydesdorff, 2006). Like every developing nation, government contributions to R&D are critical to S&T advancement in China. R&D expenditure is a frequently used indicator of innovation inputs. The proportional degree of investment in developing new knowledge is measured by R&D intensity (R&D spending as a percentage of GDP) (OECD, 2011a). China has excelled in rapidly mobilising resources for S&T. In 2009, China's domestic R&D investment was comparable to 12.5% of total OECD GERD, ranking it third globally (ibid). In 2010, GERD in China was 706.3 billion (about AU$108.7), up 21.7 percent from 2009. 71.7 percent of GERD came from business, while 2 percent came from the government (including HE and RIs). The investment distribution illustrates that businesses are driving R&D, while universities are an important source of technological innovation (Song, 2008; X.-W. Zhong & Yang, 2007). Enterprise dominance in technological innovation is definitely required for S&T to productivity transfer.

STEAM in the national interest

A society's economy becomes world-class when a scientific giant develops. France, Germany, the UK, and the USA. A changing multi-polar global economy means many scientific hubs. In the recent two decades, China has emerged as a major scientific power (Rogers Hollingsworth et al., 2008; P. Zhou et al., 2010). China's economy has been booming recently. From 2005 through 2010, the average annual GDP growth rate was 11.2%, reaching 47.16 trillion yen ($7.25 trillion at the time) in 2011. (National Bureau of Statistics of China, 2012).

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Policy reforms have steadily made firms the national innovation system's main focus (Ding et al., 2008). S&T support business growth. Since the market economy is based on scientific innovation, S&T contributions to the national economy are reflected in the development achieved by businesses (Tian, 2006). The national S&T development plan includes building enterprise innovation capabilities. For example, in 1996, the central government sponsored the Technology Innovation Project to stimulate business technological innovation. A fund for high-tech small and medium-sized businesses was established in 1999. (Ding et al., 2008).

STEAM in the Chinese educational sector

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As mentioned before, increased R&D expenditure has substantially aided China's S&T growth. Large-scale R&D needs a constant supply of S&T talent, and China currently boasts the world's greatest source (X.-F. Liu, Liang, & Liu, 2012). Science education in China is not new. Science education has traditionally been recognised as the cornerstone of Chinese society. China's formal education is separated into two parts: basic and higher. Three years of preschool, then twelve years of elementary and senior school. Junior secondary school graduates must pass the admission exams for general senior secondary schools in order to continue their studies. Physicists and chemists are among the disciplines covered in the test (H.-C. Sun, 2005). Year 10-12 students must choose between the two divisions of arts and sciences at the start of each year. Unlike most Western countries, where students can choose their subjects for senior secondary school, students who choose the science track in China must study physics, chemistry, and biology as compulsory subjects in order to prepare for the highly competitive National College Entrance Examination (NECC), which determines if they can enrol by a university (HEIs). Mathematics is required in both categories.

To graduate, students must pass the General Senior Secondary Unified Graduation Examination by the end of Year 11. By passing the unified graduation test, students indicate that they have completed all mandatory courses according to national curricula. The test includes nine primary disciplines, including physics, chemistry, biology, and mathematics (ibid). So science is required from Year 7 through Year 11 in China. And maths is focused from year 7 to year 12. Thus, China has the world's biggest STEM student population.

Because there are no national data on the number of students in two divisions in high schools, it is impossible to show the pipeline of scientific students for HE. The amount of NECC applicants in arts and humanities, science, and engineering gives an approximate idea. In 2010, 8.9 million students took the NECC, around 3.9 million in the arts and humanities and 4.9 million in science and engineering. The ratio of STEM students to arts and humanities students is 1.26. It demonstrates that pupils choose science and engineering.

Teaching and learning in STEM

Education in science is old in China. Traditional culture has influenced scientific education and learning, giving it its own distinct traits. It is teacher-centered, theory-based, national exam-based, and homework-based. It also includes structured after-school programmes and parental engagement. Lesson preparation and teacher interchange are very important to science instructors. This section will explore STEM-related teaching and learning from three perspectives: curriculum, teaching methods, and assessments, to provide an overview of present Chinese scientific education at the senior secondary level.

China has national standards for science and mathematics teaching at all three levels. While these standards are periodically amended, they clearly define the areas students must know (Wang, 2010). Clearly aligned texts, resources, teacher training and professional development. The national examination system links the value of standardised texts and instructional programmes. The NECC is conducted yearly by a province or city and closely follows textbook content. As a consequence, in the West, textbooks replace infrequent references or sources in scientific instruction. China's curriculum emphasises solid basic knowledge and mastery of key subjects. Biology, chemistry, physics, algebra, and geometry are required for graduation (Asia Society, 2006).

Leaders in Chinese education are concerned about teacher-dominated classrooms and students' lack of autonomy. This educational method is founded on significant cultural contrasts between Confucian-influenced China and Western cultures like the US. These values individuality, competitiveness, and independence. Eastern culture values collectivism, where people labour together for the common good. Classes in China have a 'group-based, teacher-dominated, highly regimented educational culture' (Wang & Fan, 2007).

Lectures are the main teaching technique. For a scientific instructor to control the whole class hour and give his or her planned lectures from the start to the end is extremely normal in China (W.-J. Wang & et al., 1996). One benefit of lecturing is that students get a lot of material in a short period (usually 45 minutes). So a teacher can better
manage the class. The flaws include the absence of student participation and the disregard for individual student talents and requirements.

The study further discussed how STEAM has been implemented over the past decades in Ghana. Four main themes were illustrated from the study.

**STEAM Education in Africa**

Technology is everywhere, affecting every area of human life in Africa and beyond. These students are digital natives who love smart and automated technology. Currently, Africa is a big consumer of technology, which means that a large portion of her GDP is exported to America, Europe, and Asia. A continent with a majority of developing nations requires a new strategy and curriculum. For example, 90% of Ghana's technology are imported (National Office for Technology Acquisition and Promotion, 2017). The repercussions of indifference to STEAM education in Africa are grave, since Africans spend a lot of money on education abroad. This reflects the continent's devastated educational system, which demands urgent care from everybody. Several robotics research projects have appeared recently (Benitti, 2012). It may be stated that recent robotics advancement has been geometric. Robotics has touched many professions and disciplines. In medical, physiotherapy, gaming, home and office products as well as search and rescue activities as well as space exploration. None of these repercussions go against African religion, but this drive for change is lacking at a time when the developed world is not waiting to be caught up in the growth cycle. According to Adegun (2003), the education sector's budget deficit in Ghana is worrying. In most African nations, the UN education mandates remain unattainable. Since independence, Ghana's national education budget has been less than desirable, like in other African nations. This omission has serious implications. This may be why many African nations' aspirations for scientific education and current applications are rarely reached. For a society to be considered evolved, its scientific and technological sophistication must be weighed against the inhabitants' degree of consciousness (Adegun, 2003). If the government and other important stakeholders agree to contemporary classroom techniques like STEAM, this might drive progress and boost residents' socio-economic well-being. The Ghanaian Educational Research and Development Council (NERDC) has the authority to establish a senior secondary science curriculum. NERDC's goals include providing individuals with fundamental science and technology literacy, as well as instilling scientific skills and attitudes (FRN, 2013). Although in the industrialised world, many educational initiatives have improved robots in the classroom. Coding education for elementary and secondary pupils is becoming more popular in the US, Japan, Korea, Singapore, Canada, and other European nations. In 2013, the US Computer Science Educators pushed coding to the forefront of schools worldwide, dubbed the “Hour of Code”. From December 9th to 15th, millions of kids throughout the globe coded for one hour. One in five US students took part. More female students than ever before attended US institutions (Code.org, 2013). The exercise reportedly drew millions of participants and helped mainstream coding in elementary and secondary schools. These feet are also possible in the poor countries. In 2013, the UK introduced a new curriculum. This programme sought to include engineering and coding into their early education (Department of Education, 2013). [W]e hope that every elementary school kid will have the chance to explore the creative side of computing by designing computer programmes. In elementary, pre- and post-basic education, learners were encouraged to study robotics and participate in web-based activities. Those wishing to pursue STREAM-related careers were advised to grab the chance (Royal Society, 2012). Learners may benefit from the introduction of computers and related applications, particularly in the basic and secondary levels. This is a good idea for poor countries like Ghana.

**STEAM Education and Integration in Ghana**

Most STEM literature emphasises teacher training to improve teaching using ICT or to teach STEM topics (Hooker, 2017). There are potential approaches for teaching and learning, including professional teacher learning, according on case study findings. the little number of new technologies used in professional growth. Participatory research improved universal basic education in terms of attendance, motivation, quality of learning, literacy, numeracy, and
science (Hooker, 2017). Also, ICT-enabled instruction may improve student attitudes, particularly if students love using devices: With the 21st century skills of critical thinking, problem solving, teamwork, and self-directed learning comes a greater focus on the use of technology (Hooker, 2017:11). Math and science are required to satisfy current employment needs. Thus, STEM education might help reduce unemployment (Hooker, 2017). A transformation in Africa requires an investment in STEM. Like Asia, the IMF forecasts rapid development in Africa. Five million scientists and engineers are needed, yet over 80% of students are studying social sciences and humanities (Hooker, 2017:14). However, since TVET is a supply-side programme, it does not always lead to employment (African American Institute, 2015). Here is an overview of the research on employability skills in two low-income regions:

Gaps in Ghana’s STEAM Education

Less than half of Ghanaians have basic numeracy abilities. Communication, leadership, and decision-making abilities are becoming more vital as economies change. For this study, Burnett & Jayaram (2012) interviewed 83 employers in Benin, Burkina Faso, Kenya, Senegal, and Uganda. Employers in Benin favour non-cognitive or social skills above a university degree (Burnett & Jayaram, 2012). The public sector employs the most secondary school graduates globally. For small and medium businesses, cognitive skills are more important than non-cognitive abilities. Training in finance and building. The Association for the Development of Education in Ghana concluded that young recruits need social skills as well as communication abilities (Burnett & Jayaram, 2012). Education in Ghana stressed cognitive skills (literacy, numeracy, and scientific literacy) as well as non-cognitive skills (reliability, communication, and technical abilities) (Burnett & Jayaram, 2012). Vocational education is advocated as a major educational reform (Burnett & Jayaram, 2012). TVET courses should be market-driven. For example, in Ghana, TVET students must take English, math, social science, and scientific courses. Apprenticeships are part of TVET in Mali, Senegal, and Togo. In Kenya, certain secondary schools teach agriculture, business, computer, home science, and industrial education. Despite these efforts, schools and companies lack direct contact (Burnett & Jayaram, 2012). The fact that most African women work in the informal sector makes matching education to employer demands difficult.

Innovative Models of Secondary Education

Bermingham & Engmann (2012) evaluate the effect of many innovative STEM education models: So far, Ghana has built 108 Science Resource Centres. Between 2005 and 2010, the proportion of applicants who passed the West African School Certificate Exam increased significantly. Mathematical performance increased greatly for both girls and boys. The programme cost £6 million. Coordination among schools within the programme proved difficult, and more financing was necessary to keep it going (Bermingham & Engmann, 2012).

The Emusoi Centre in Tanzania educates females academically and vocationally. The initiative targets impoverished girls. Participants get scholarships and remedial tuition. Since 2000, the programme has helped over 1,000 students. Their vocations include social work, nursing, laboratory technology and tourism. The average cost per student is $1,000. (Bermingham & Engmann, 2012). In Cambodia, poor youth engaged in vocational training programmes are offered IT education. A prototype e-learning initiative was started to supplement classroom activities with online content. There has been no rigorous evaluation of the program's influence on student performance (Bermingham & Engmann, 2012).

What are the perceived value and challenges of STEAM education in China and Ghana?

Thematic Analysis

Themes emerged from semi-structured interviews on STEAM education in China and Ghana. Themes from the story's primary messages arose from data that captured implicit meanings, allowing thematic analysis to "emphasize common meaning" (Clarke & Braun, 2018, p. 108). Thematic analysis of qualitative data is useful in interpretivism research
because it is independent of theoretical or epistemological influence (Braun and Clarke, 2006). Unlike grounded theory, thematic analysis extract’s themes and subthemes to characterize the data’s major aspects (Braun & Clarke, 2006). As a result, thematic analysis was employed to examine the advantages, significance and obstacles instructors encounter while implementing STEAM education in China. There are two techniques to thematic analysis: data-driven (data-driven) and theory-driven (theory-driven) (Howitt, 2010, p. 175). For the second research goal, the current study applied the first theme data analysis technique.

**Benefits of STEAM integration in Teaching and Learning**

According to constructivism (Vygotsky 1978), pupils learn via doing rather than listening and taking notes. Culturally relevant pedagogy (Hammond & Jackson, 2015) emphasized the importance of students learning via meaningful education that is tied to their personal experiences.

Figure 13 summarized the benefits of STEAM integration in Accra metropolis and Zhejiang province from teachers’ perspective.

![Benefits of STEAM Integration](chart_image)

**Figure 13: Summarized Benefits of STEAM integration in Ghana and China**

Majority of the teachers alluded that STEAM integration benefits students in multiple ways: it adds relevance to learning material, helps students develop college and career preparedness, empowers students, builds confidence and resilience, and encourages students to go beyond their comfort zone. Details of the responses from the participants from both countries has been summarized below.
Figure 14: Details description from Chinese teachers and Ghanaian teachers

The participants from Accra metropolis and Zhejiang province highlighted the advantages of STEAM integration for pupils when it is applicable to them. When students are involved in STEAM integrated learning, they discover their interests. TA#4 addressed how STEAM integration enables students to discover their passion. "It assists students in discovering meaning and, perhaps, developing a passion of their own, which is exactly what education should be capable of doing: assisting children and students in developing a passion." Participant TA#2 discussed how STEAM integration enables kids to experience achievement in a new manner. "And, uh, that is how I see it benefitting kids, because it provides an alternative to writing an essay or reading a book, both of which have their merits."

STEAM integrated learning possibilities contribute to students' feelings of accomplishment in school, especially those who have struggled in conventionally taught classes.

The beneficial influence on pupils in terms of assisting kids in feeling successful in school was also highlighted during the discussion with Participant TB#2. "However, I've seen a number of children who struggle in other areas excel in STEAM programmes. In sixth school, I was having difficulty with fractions. Succeed in finding out measures and how to use a tape measure, and then all the parts of an inch, and then navigating the remainder of the day to go to a less regimented lesson." Additionally, participant TB#3 emphasized the necessity of STEAM inclusion in helping kids recognize the value of school attendance. "It's really a lesson that may inspire some students to declare, 'This is why I'm going to school.' This is the reason we attend school.' This enrols them a year or two before to high school or college." Students' sense of academic accomplishment was also a critical component of Participant TA#2's STEAM integration. "Well, I am aware that there are children, particularly in our music programme, that go [School Name] and are successful there as a result of the music programme or [teacher name] STEM class."

Later in the interview, while describing how STEAM integration engages kids, participant TA#2 returned to the beneficial benefits for students; hence, STEAM integration is assisting in closing the opportunity gap. If our true goal is to close the opportunity gap and to engage kids in novel ways—even if they are not typical students. That is what STEAM will enable us to achieve, which is why I believe it is critical. It's another approach for us to engage students who are generally disengaged and may drop out before earning their degrees. It's a means of engaging pupils and, eventually, closing the opportunity gap. When asked what she would share with someone considering
using STEAM integration, participant TA#3 mentioned the good influence on students. I'd highlight the wonderful experiences we've had with STEAM, the positive experiences children have had, and the accomplishments I've seen in all students, including those who may not see themselves as successful in other areas. That has been a very transformative and life-changing event for them.

By involving students in student conversation and emphasising language development, STEAM integration benefits pupils. Participant TA#3 described how she determined that STEAM integration benefits pupils. "I believe it has had a very good effect. When we practise science, and I recognise that STEAM encompasses more than just science, they, my pupils, flourish." Later in the interview, participant TB#4 spoke on how she discovered STEAM integration had a favourable effect on students. “Students were engaged, and they spoke and used language and high-impact scientific conversation, and it seemed like an overwhelmingly pleasant experience for everyone.” Participant TA#1 noted how seeing kids who have not always felt successful in school succeed in the STEAM elective class is one of the reasons he enjoys teaching with STEAM integration. Getting children who don't do anything else to who, Who do not feel or achieve achievement in a regular school environment? They become animated. They get, they proceed. They have a billion ideas that have been dormant for the previous 12 years of their lives, and they finally get to... get their hands dirty and create something. That is why I fell in love with it.

Additionally, Participant TA#1 stated how STEAM integration "brought out the best in some and created difficulties for others who did not have difficulties with the standard curriculum." T#1 provided an argument for why he believes his STEAM class is more successful than other courses that do not use STEAM. And so, I believe, a large part of it is that we force people to sit and shut up for hour after hour after hour for whatever many years they have been doing this, and some of them are just unable to or have grown tired of it or have been told they are not good at it. Thus, this only provides them with an additional road to success. STEAM integration benefits children by assisting in the reduction of bad student behaviours. T#1 expounded on why he believes kids feel more successful in STEAM subjects. "Whether or not those kids complete all of the work I assign or do it at a high level, their conduct in my classroom tends to be better simply because of what we are doing and how it is presented, and because they may feel successful or unsuccessful, but not a failure." STEAM integration, according to participant TA#1, "had a significant beneficial influence." While Participant TB#5 expressed why he believes STEAM integration benefits students by stating, "Where I was heading is that it is the class where you would have the greatest buy in."

STEAM integration enables students and educators to grasp the significance of topic learning. Pupils are now engaged in learning activities that are unrelated to larger concepts or that do not assist students in making sense of the world. Both School leaders interviewed highlighted how STEAM integration offers students with a context for learning subject that is currently lacking in existing educational approaches. "It, um, so that arts and science, while there is math involved and should be, there is also the component of accessing, what I refer to as accessing different parts of the brain," participant TA#2 stated. "Students are doing things with their hands, they are working in groups, and they are just thinking differently."

Additionally, Participant TA#1 emphasised math education's lack of relevance as a result of its isolation from other courses. I believe that one of the problems we've had with mathematics accomplishment is that we've compartmentalised it and disconnected it from everything. Thus, the irrelevance has had a significant influence on pupils' ability to do well in it. Similarly, with the sciences. As long as they are segregated into their own little departments, their own little universes, and can be discarded in favour of other activities, well, irrelevancy will always trump academic aptitude. Participant TA#1 proceeded to discuss how growing STEAM integration increased students' relevance and engagement. "As a new principal and with my new AP, we saw a lack of emphasis on rigour and involvement in the building as an expectation. And, as a result, when we hit it hard, we created space for these STEAM activities, which are naturally more engaging and challenging."
Additionally, participant T#2 addressed the importance of mathematics via STEAM integration. “So I feel like that, that desire to make things relevant, that drive for explaining why studying linear equations is beneficial or why... we don't have to spend as much time on it if it’s successful STEAM because the kids innately understand the significance of it.” Additionally, participant TB#4 discussed the importance of mathematics relevancy via STEAM integration. Thus, for me, the great goal of STEAM is to bring together and make sense of... a variety of subjects, a variety of scientific and mathematics classes that kids are required to take but often find difficult to comprehend why. Why are we examining the planets' order? What purpose do we serve by learning long division? What is... why are there so many worksheets here? Additionally, kids may build college and career preparedness abilities via STEAM integration. These abilities are sometimes referred to as "soft" talents that students must possess in order to be successful, yet present educational approaches do not allow pupils to develop these abilities (Wood, 2018). Two panelists described how STEAM integration enables students to build the collaborative skills necessary for success in college and beyond. Participant TB#4 discusses how collaborating with students on projects enables students with a variety of abilities to contribute in ways that would not be apparent in a normally taught curriculum area.

I really like the A in STEAM and the fact that even when children are not working in groups, we have someone in charge of this problem-solving framework and solutions. And then another person comes in and adds the art. And I believe it's a... there's a nice success in bringing together such a wide group of skills for a project with so many moving pieces. This is not a math project in which the brightest math student leads the rest. Everyone, in fact, has an opportunity to shine. STEAM integration teaches pupils how to cooperate. Students must be taught via many chances how to collaborate with individuals who have varying ideas and cultures in a courteous and dialoguing way. Participant TB#6 noted how crucial collaboration is for student success. “However, if they can embrace the environment and be prepared to share and cooperate and all those good things.” STEAM integration enables pupils to see themselves as change agents and to appreciate the significance of many viewpoints.

Four of the interviewees discussed how empowering kids who have traditionally been underrepresented in STEAM subjects is a critical component of STEAM inclusion. TA#2 participant shared, to be sure, I am aware that there are children, particularly in our music programme, who go [school name] and are successful there as a result of... the music programme of [teacher name] STEM class. It, uh, so that arts and science, although math is included and should be, also have the component of accessing, what I refer to as accessing various areas of the brain. Students are manipulating objects, working in groups, and just thinking differently. Later in the discussion, Participant TA#2 discussed the need of STEAM inclusion for all pupils.

Historically, certain kids have not been exposed to STEAM-integrated learning activities, perpetuating the STEAM opportunity gap. If our true goal is to close the opportunity gap and to engage kids in novel ways—even if they are not typical students. That is what STEAM will enable us to achieve, which is why I believe it is critical. It's another approach for us to engage students who are generally disengaged and may drop out before earning their degrees. It's a means of engaging pupils and, eventually, closing the opportunity gap. Students must see and hear from a wide variety of STEAM practitioners in order to understand that the route to a STEAM job is not a straight line from high school to college to work. Students must understand that there are several employment opportunities in STEAM sectors, each of which requires a unique set of educational experiences. Participant TA#1 addressed the value of empowering students by exposing them to experts who work in fields similar to those of the students. Like Architects in Schools is significant because it exposes children to the profession, um, element of it all, particularly my pupils of colour, um, where do you see a lot of people of colour in the architect and engineering worlds.

As a result, you've hired these professionals. If you are a school that is speaking the right—using the proper language, uh, you can encourage those groups to include people of colour in their programmes rather than simply white students. By recognising students' life experiences, STEAM integration empowers pupils. Diverse cultures aim to comprehend the world in unique ways, and these distinctions contribute to a greater knowledge of the world and to more effective solutions to the world's issues. T#6 emphasised how using STEAM empowers and
engages kids by honouring their life experiences. It was almost like a battle zone, and I had to find out how to be engaged in a manner that was linked to kids, students' experiences, but also really honouring the community's learning. And I thought historically that there was a lack of respect in the curriculum. And I believe that, as a failing institution, we must limit your educational experience to solely core skill-based activities. And they were akin to being a ditch digger, as if your whole purpose in life is to do this one basic chore again. And so it heightened my understanding of how, when certain types of educational settings are created, they can be a place where children can be dynamic and able to, uh, explore and innovate in a dynamic manner via the use of a variety of tools.

Another advantage of STEAM integration for pupils is that it helps them develop confidence and resilience via exposure to failure and the ability to learn from it. TB#4 Participant "You know, one of my favourites was a guy who has been blowing out of every class he has taken. He's having difficulties with, you know, executive control. There are physicians and treatments available, but not everything is functioning well. When he was soldering a little control board for an underwater ROV project, his concentration was so intense that he didn't even need the soldering iron since his eyes were melting the solder. He was so... and he was like shoving other kids away, and he was like, "Back off!" to other students who were attempting to annoy him. I'm attempting to do this." And, so, the principle happened to walk in at that moment and witness it. He just shook his head in disbelief. Regrettably, it did not translate as well to other projects as I had hoped. However, for a little while, he felt some success and... some engrossing interest in things at school. TB#1 Participant "As a result, the exposure alone is remarkable. The confidence development, uh, as I previously said, kids who do very little outside of the STEAM classroom come alive and discover... discover all types of activities."

One advantage of STEAM integration is that it encourages pupils to go beyond their comfort zone. Students who take chances in a safe environment gain the confidence necessary to solve difficulties. T3#6 emphasised how successful integration of STEAM enables children to be vulnerable and open. "I believe, as you know, that success is such a loaded term, and what I would define as success is, hm, pupils being sensitive and receptive to ideas." Participant TB#4 proceeded to discuss the method through which students gain confidence in taking risks: I believe that ultimately—it was watching children come out of their shells and take just a little bit more risk. The next day, they took a step forward or backward until they reached a degree of comfort and bravery. That is, it wasn't always about grades; it was about hobbies and being comfortable with being daring.

Challenges Associated with STEAM integration in China and Ghana

Regardless of the school or educator's background, STEAM instructors face comparable integration issues. Culturally relevant pedagogy, as described by Ladson-Billings (2009), is instructional pedagogy that enables students to keep their cultural identity while achieving academic success. Hammond and Jackson (2015) described how culturally responsive pedagogy focuses on educators changing away from a deficiency model of pupils and toward a strength model. Additionally, STEAM integration shifts the teacher's attention away from teacher-directed instruction and toward pupils learning via doing, as Vygotsky stated (1978). These adjustments posed difficulties for instructors attempting to integrate STEAM. When working to integrate STEAM into instruction, building School leaders, teachers, and district curriculum specialists face similar challenges: School leader capacity for change, educators developing their own level of comfort with risk-taking in their own practise, finding time in the curriculum for project-based learning, having time to collaborate with colleagues, inconsistent access to resources, colleagues' perceptions of STEAM integration, balancing district initiatives. These problems provide light on what should be addressed and how educators can effectively assist STEAM inclusion. Building School leaders are expected to serve as the school's instructional leaders. They are supposed to assist district-led initiatives and coach teachers to continuously improve their teaching techniques in order to enhance student results. Figure 15 summarized the benefits of STEAM integration in Accra metropolis and Zhejiang province from teachers' perspective.
Numerous variables affect an School leader's ability to lead change. Participant TA#2 discussed how, with all the changes the school has gone through in the previous year, she has been strained in terms of the amount of change she can lead at the school. The school was establishing processes, and she lacked the ability to work on STEAM integration. To be completely candid. This last year has been spent putting together fundamental systems. That is, we lacked even a fire drill routine. Thus, I... lockers... how long did it take to lift lockers? As a result, I'm not sure. As a result, I'm not sure what I'd alter since I'm not sure I could, if I could. When I do anything, I want to go deep, which I doubt would have been possible this year. Participant TA#2 elaborated on this potential for change leadership a bit later in the interview. My brain would actually have been incapable of holding. I mean physically, yeah, it would not have been able to contain what was vital to me this year—the knowledge and the room for me to engage with instructors and the space to supervise anything like that.

Additionally, according to the study notes, Participant TA#2 sat back and extended out her hand by her head from a fist four times throughout the interview as the participant discussed their experience leading change that year at their school. These actions, along with the comment "My brain literally could not hold," indicate how an School leader's capacity for change affects their ability to help teachers integrating STEAM. At the conclusion of the interview, Participant TA#2 expressed how much having certain mechanisms in place had freed up her ability to think creatively about how to engage children instructionally. I simply believe that having the space to think about school next year and about teaching without having to worry about how to employ 12 people in four weeks allows me and our team to reflect on how we are going to—how we are going to engage our children most effectively. When School leaders shift from year to year, it's difficult to assess their ability for change. The transformational shift required for teachers to incorporate STEAM will take many years of regular administrative assistance.

Participant TA#5 discussed how, after seeing many School leaders run the school, he realised that STEAM integration would not occur without leadership backing teachers in their efforts. “Therefore, I've never had the time or the leadership. If there is a leadership willing to take on that responsibility, if there is a desire to have it—otherwise, it is unlikely to happen.” Another difficulty educators have is a lack of space and time to cultivate their own comfort level with risk-taking in their own teaching practise. Educators are under pressure to ensure that all pupils
enhance their learning throughout their time in classes or institutions. Teachers must feel secure in their ability to take chances, fail, learn from their mistakes, and try again. Five panelists acknowledged the difficulty of instructors creating their own degree of comfort with risk-taking in their own classrooms.

School leader TB#2 described the difficulties she has had as a school leader with teachers incorporating STEAM. "And then, I'm sure, there's a certain degree of talent and willingness required, and just thinking about our scientific professors, I imagine there's a certain amount of willingness." Participant TB#3 noted how daunting it was not knowing about resources or how to incorporate STEAM. "Um, I believe that at times we may feel overwhelmed by the process of integrating STEAM, just due to a lack of resources or an understanding of how it might be incorporated." Additionally, Participant TB#3 discussed how the technology in a makerspace might be intimidating and make instructors concerned about integrating such tools with children when they lack confidence. To be honest, given my sole professional development experience was with the makerspace cohort, that was the most beneficial for me, since it first seems to be somewhat daunting. The makerspace has a large number of tools, technology, and equipment that might be intimidating to certain individuals; thus, dispel any uneasiness or uncertainty about the makerspace's resources.

The suggestion of participant TB#3 to instructors who are just beginning to incorporate STEAM into their teaching practices. Avoid doing this... I'm wondering that maybe... in certain cases, we first place a lot of limits because it can be difficult for a teacher to relinquish control, but that is, in my view, where the most learning and creativity occurs. And, if there are fewer criteria, I would advise against putting too many constraints on your thoughts and creations. The growth of risk-taking in educator practice is connected to the ability of educators to change. When instructors are forced to modify a large number of practices simultaneously, they get overwhelmed and nothing gets done properly. TA#1 mentioned the difficulty of educating teachers about project-based learning and the use of technology. "Being able to educate instructors and act as a liaison between, you know, equipment and supplies, in order to facilitate project-based learning, which would be our STEAM emphasis."

Later in the conversation, Participant TA#1 discusses how to help instructors who are overwhelmed by the prospect of incorporating STEAM. Thus, my instructors must get used to the new method of doing things, which may not be that novel to others. However, as long as they are focused on that and feeling somewhat overwhelmed by it all, including things like MAP, how to utilise MAP, various types of intervention software, and, well, all this new stuff. Participant TA#1 said that the most difficult aspect of incorporating STEAM is being aware of her teacher's ability for change. "Yeah, I mean it's basically about prioritising and determining your instructors' ability." Participant TA#1 mentioned teacher capacity for change once again while discussing a cooperation with a local institution to assist teachers with STEAM integration. "And we have a wonderful collaboration with them, and we are doing this job together, and I am always quite careful in those meetings about signing on to too much, knowing that my teachers may blow up."

Participant TA#1 continued to communicate her delight about the collaboration by expressing her ongoing awareness of the teacher's ability for change. There is a lot of great things that may come out of that work, and I am well aware that it is different work than what teachers have been instructed to do, so there is one thing: recognising teacher capability in light of the existing situation. I believe that every teacher have the ability for STEAM. It's simply that, given the district's present context and message, I'm not sure they do. Teacher adaptability was also included in Participant TA#1's suggestion to educators interested in adopting STEAM. "Looking at your teachers' ability, leadership, and knowledge, and being quite cautious about strategically rolling it out in the same way that you would any new endeavour." Educators must develop a sense of comfort with taking chances in their own classroom practise. This is especially true for more experienced instructors who may have created perceived-to-be-good learning chances as a result of students becoming complacent rather than engaged and demonstrating student learning.
The issue in integrating STEAM, according to participant TB# 3, is becoming comfortable with being uncomfortable. But anyway, it's about cultivating a development attitude, which has been very tough with new... I'm not even sure I want to call it innovation, given how overused the phrase is when it comes to attempting something new or stepping beyond one's comfort zone. It may be really challenging since there is so much at stake in attempting something new or altering their approach. My experience with adopting STEAM has taught me that you must always re-evaluate. And you're rethinking a great deal about what it means to be a teacher and a student. And when it is required, it necessitates a massive investment of resources across the board. That is my greatest obstacle. Participant TB#5 concisely articulated the effect of stress on attempting new teaching approaches such as STEAM integration. "And then, if you're too stressed to experiment, you don't." TB#4 emphasised how much instructors must study in order to include STEAM. Ranging from, hmm, not understanding what to do immediately to the learning curve associated with teaching long-term tasks. Changing from a math teacher who was only driven by curriculum, timetables, and standards to opening up and doing this balancing act of keeping kids moving and engaged while providing for, oh, essential time for failure, redesign, and retry. And, the whole engineering process, as well as giving time for it to complete, has been a steep learning curve. Following that, participant TB#4 characterised learning how to manage project-based learning, the engineering process, and allowing for student error as "all steep learning curves for me." He also discussed his experience when he initially began incorporating STEAM. When I was doing this at [school name], I was winging it. I was making it up as I went along. And although it was challenging, I gained a great deal of knowledge. It's been a high learning curve, but also enjoyable.

Additionally, Participant TB#4 said that he has become used to trial and error in his own teaching practise as a result of incorporating STEAM. "Again, it's primarily trial and error, but having a strong foundation in science and math, as well as my personal expertise in construction, has been beneficial in merging my professional work into STEAM, as well as how it combines for the children." Additionally, participant TB#1 acknowledged comfort with trial and error and making errors as he learns to incorporate STEAM. "Um... yeah... I just do trial and error and make a lot of errors along the way." Educators who feel comfortable taking chances in their classroom practise are more inclined to experiment with STEAM integration. TB# 4 emphasised the necessity of having a school culture that allows for errors as he learns to incorporate STEAM. "Truly just a culture of trying new things, debating them, thinking on them, and potentially incorporating them into your practise, but more importantly, uh, really attempting to design new methods of addressing your kids' needs."

Additionally, TB# 4 emphasised the need of educators transitioning from gatekeepers of information to allowing students more control over their learning. If they completely owned it, and the only way they could do so was for the teacher to relinquish control or at least a portion of what would be considered the locus of control or... and also relinquish the historical message that the teacher must be the head person who knows everything and serves as the gatekeeper. STEAM integration entails more than providing instructors and students with a selection of technologies. Teachers need time and professional development to learn how to utilise technology with students in order to promote student comprehension, rather than just employing technology for its novelty value. Participants TB#2 and TB#3 highlighted their experiences with those who believe that just giving technology would motivate instructors to adopt STEAM.

However, Participant TB#2's experience indicates that STEAM integration does not occur without teacher help in developing their own confidence with technology and incorporating it into classroom. And therefore, I believe. I believe that there is an expectation that technology would solve problems on their own without an understanding that if you do not teach the individual, the educator, how to use the device, if you do not present sufficient examples of how to use it, you will know. I may learn how to use a certain computer software, but I will only ever use it in that context because I will lack the confidence to be creative with it. While participant TB#2 expressed excitement about incorporating STEAM into the curriculum, she acknowledged that she would make errors. And, as you know, I'm the kind that says, "Yes! Let's do it!" but you're going to have to teach me how. We've got to
convey how we go from 30,000 feet to ground level, and I'm only just starting to do so. I believe that unless and until there is a change in the emphasis of PD, it will take a few more years of me making errors and figuring it out, which is terrible, since it is one person in comparison to all of the buildings that have this focus.

Additionally, Participant TB#2 said that she is still figuring out how to include STEAM. "Um, I'd say that I'm just starting to figure things out. I believe that I, too, need a greater change of viewpoint in order to do well in my class." The study notes also highlight the necessity for participant TB#2 to feel secure to fail. TB#2 requested that the interview take place in their classroom. The classroom includes a variety of recent STEAM toys and games, but they were all still wrapped in cellophane and resting on a high shelf, collecting dust. At the conclusion of the interview, Participant TB#2 gives advise to instructors who are just getting started with STEAM integration in their classrooms. "Therefore, just be courageous. And if you're not checking all of those boxes, it's better to check off any of them." Educators need the same conditions for STEAM integration as kids do: a sense of safety to fail and encouragement to create.

The process of integrating STEAM is a never-ending loop. New technologies and new understandings will emerge, and STEAM integration must remain relevant in these rapidly evolving fields. Educators need time to work with peers in order to incorporate STEAM into educational practise. The existing structure of the school day isolates instructors. Educators often have to sacrifice personal time in order to interact with colleagues. Three participants noted how one of the challenges associated with STEAM integration is finding time to engage with colleagues. A issue identified by participant TA#2 in incorporating STEAM is finding time for cooperation with colleagues. "Um, and you know I'd say time, time for collaboration, time for co-constructing learning. That is always a consideration, and it forces me to consider how I will generate that time. How can I engage with others to seek for methods to develop or generate that time?" Participant TB#3 said, "We needed to generate ideas, so it was an opportunity to cooperate with her, and we came up with some excellent ones that we were able to implement when we returned to our school."

Additionally, Participant TA#3 said that finding time to interact with colleagues made integrating STEAM more challenging. That we had to put STEAM and makerspace integration on hold because, as I mentioned previously, it is up to us to find the time to plan and meet with the makerspace EA if we want to schedule time, and we have to present the ideas and gather all the materials we would need, or at the very least a list, so she can do so. As a result, it's been difficult to find time for our team to gather and come up with ideas that connect with what we're doing. TB#5 noted a similar struggle with scheduling time to work with peers. "You would need to set aside certain time, particularly for putting it up. Thus, where to get it Is it time for a staff meeting? On your own schedule? How are you going to find the time?" Any time educators do have throughout their workday is frequently consumed by other tasks: communicating with parents, grading, meeting with intervention specialists, and completing numerous reports and questionnaires. Educators do not collaborate with other instructors on planning, but are required to teach the same material and assess students' ability to achieve requirements.

Another difficulty educator encountered while implementing STEAM is inconsistency in resource availability. Because educators cannot rely on constant financing for resources year after year, they are often forced to create a fresh STEAM integrated learning experience each year using new materials. Four participants discussed how difficult it is to integrate STEAM when access to resources is uneven. "I mean, money is always a hurdle," participant TB#1 remarked. TB#5 mentioned the difficulty of raising funds to buy supplies for projects each year. Materials have... there have been moments when they've been a big problem and others when they've been a genuine breeze. That is true in both directions. I discovered those underwater robots, ROVs, in my closet, which was fantastic. And then, if I want to do that next year, I'll have to find the money to acquire them or the components on my own. TB#5 was sometimes able to get grants to assist with a shortage of resources. I was required to set up a booth at [school name]. The mathematics tables were unsteady. There were no tools available, but there were grants." Participant TB#3 also mentioned a shortage of supplies. "And, finally, I believe that materials may act as a barrier as well. We'll
generate ideas, but they'll need foam or other materials that aren't given, so I believe cost and supplies have been a barrier."

Participants TB#2 and TB#3 had similar stories about not having enough money to purchase supplies. "And, finally, I believe that materials may act as a barrier as well. We'll generate ideas, but they'll need foam or other materials that aren't given, so I believe cost and supplies have been a barrier." Another resource that educators are missing is a repository for strong STEAM project ideas to include into lessons. Currently, the internet enables instructors to access anything uploaded as a STEAM learning activity by any individual or organisation. Educators lack a common repository for these resources and a consistent approach for evaluating the quality of these activities. T#5 participant shared, "And then, you know, I fantasise about creating a curriculum fandex or a mechanism for students to make projects using their curriculum. "Contribute to, borrow from, and share projects." A#1 mentioned a similar difficulty in coming up with STEAM integration ideas. "I do not—due to a lack of resources and sometimes a lack of innovation inside your own building, you must learn to work with partners to be effective in this activity."

Access to STEAM-integrated curricula was also mentioned as a hindrance by participant TB#2. "So, putting technology and a lack of knowledge on the part of decision makers aside, one of the challenges for me is that we declare that we are a STEAM school, a STEAM district—and then there is this curriculum to follow." Additionally, instructors sometimes lack the financial resources necessary to attend STEAM integration professional development. Participant TB#2 discussed how she paid for her own professional growth in STEAM integration. "As I have said before, I have done all I have stated. I've done it because I discovered it and decided to do it, which sometimes required me to spend my money." STEAM integration professional development programmes often demand some financial investment, and without financial means, instructors are unable to participate in professional development within their school system. "I'd want to have a training that is more focused on the technical aspect and how to integrate it," participant TB#5 said.

STEAM instructors have a constant struggle to manage shifting district agendas. Three participants identified a barrier with STEAM integration as finding a balance between district efforts and STEAM integration. According to the study notes for teachers and School leaders, each participant indicated discontent with various district efforts prior to the interview, beginning by inquiring about a programme that began during the school year. Only three individuals, on the other hand, commented on their displeasure in their interview responses. "Definitely the time for planning," participant TB#3 said. "And, uh, this year, we were kind of inundated by a lot of new demands from the district for reading, writing exams, and GVC and all of this stuff that our planning and PLC time went into." She then discussed how, given that she is familiar with the district's new efforts, she would have time to consider how to include STEAM. "I believe... that in terms of preparation, my partner and I have a good handle on the new requirements this year. As a result, I believe that we will be able to go ahead with improved planning and integration this year, despite the fact that we will have less on our plate." TA#1 discussed the mismatch between district efforts. However, there seems to be a significant gap between the GVC and the expectations that are handed out on a subject-by-subject basis, as shown by the district in particular.

And then we have these other crew members asserting that STEAM is important and that we should pursue it, although my instructors are now focused on reading adoption, writing adoption, and math work, respectively, and that the message is not framed through a STEAM lens or as a means of accomplishing things. Thus, as long as this occurs, and as long as concentrating on things is not a negative thing, STEAM will always seem like another: and my implementing it will feel like a different way of doing education when it may just be the way we do school. Furthermore, Participant TA#1 considers district-level efforts as a squandered chance to promote STEAM integration. I indicated that the GVC's rollout has been in these segregated courses, uh, and even if math and, you know, science are separated. And what a wonderful thing it is to be able to use it as a STEAM GVC, alongside reading and writing and other seemingly important skills. If they could have worked in unison, it would have been really beneficial. And I
see no reason why not, since the standards remain the same, as if there are still standards. You just roll them out in a
different manner. However, it is because this did not occur that I see this as a barrier.

Participant TB#2 expressed a wish for a better knowledge of the relationship between central district
activities and what occurs in schools. More opportunity, and I believe there is more opportunity for teachers and
students, as well as School leaders, to really grasp what is available to them and what the important topics are.
Because I feel as if I'm having such amazing conversations and beginning to work on really fantastic projects, the
translation to schools becomes something else. Thus, something occurs between—though not always. Something I
would alter is that I would be able to comprehend it and work on it more, but it's the concept of the language we use
centrally and the behaviour we venerate centrally being often at odds with what occurs in classrooms. Why is this
important, and what does it entail for decision-making processes? Clearly, there is a lot going on in schools, both hard
and effective activities. He emphasised the need of improved communication in order to avoid a mismatch between
district goals and STEAM integration.

Thus, the logistical challenges of communicating it and understanding that you are not only
communicating it but also making it real in showing up in instruction will take a long time, so how do you combat that
with the fact that the moment someone says GVC, answers are being thought and answers that we may or may not have... or questions that we may or may not have answers to that can truly affect teaching and learning in a positive
way are being thought. STEAM instructors are unsure on how to integrate STEAM into their courses. Additionally,
participant TB#2 discussed the necessity for district-level assistance for STEAM integration, stating that when
instructors figure out how to integrate STEAM on their own, there are often divergent views on what STEAM
integration looks like for kids and teachers. To be honest, I believe that what I would modify is that it would have to be district-level.

I would, I would really expect individuals responsible for curriculum and education to begin honestly seeing them from a STEAM lens rather than... I believe that there is a lot of lip service given to STEAM at the moment, but few practical implementations, primarily because it is a brand new concept. However, if we are not going to abandon curriculum in favour of something built from a STEAM viewpoint, we will have to build it ourselves. That is acceptable as an adaptive tool, but it has to begin, you know, at the central location, because one of the issues between buildings is that if two teachers believe they have figured it out, they have done completely different things and have completely different understandings of what STEAM integration is. Then you're back in the Wild West, since everyone is attempting to create and develop it, but we end up with a unique species in each structure. Participants TB#2 and TB#3 presented their perspectives on STEAM integration as a top-down endeavour. "If this ever becomes a top-down initiative as a result of how othered it seems, it will feel like another initiative."

Educators desire to incorporate STEAM but frequently believe it is in contrast to district-led objectives,
which have changed every time district leadership changes. STEAM educators, on the other hand, are apprehensive to see STEAM integration become a district-wide programme, owing to their experience with district initiatives, which change every couple of years. Educators are under pressure to cover all requirements while also ensuring that pupils pass high-stakes assessments. The need to meet all criteria in a shorter instructional day and year than usual makes it challenging for educators to find time for STEAM integration. "I believe that sometimes you have to check so many boxes during a lesson, a week, or a curriculum that art thinking is nearly always the final one that you never quite get to," participant TB#2 said. And so it was just how we modified it, how we spoke about it, and how we prioritised our time to incorporate that that was beneficial."

Additionally, participant TB#5 discussed how the pressures of standards and limited teaching time affect the possibility of integrating STEAM into education. "By reducing my lessons to 45 minutes, I lost half of the time I had last year. Therefore, I believe that with that amount of time, instructors will immediately say no." He said, "Like I have to complete the standards that I want to complete and then abandon them for a project that has never been
completed, tested, or anything." TB#4 examined how the drive to meet arithmetic requirements complicated STEAM integration. As a math teacher, I face testing, curriculum, and time constraints. All of these instances in which pupils do not grasp an idea and you move on. The majority of the class does not, and the remedy is to increase this activity, although it is difficult. There are pupils who are significantly behind and those who are significantly ahead. Additionally, the study notes from all of the participants' interviews revealed that while discussing the pressures of standards and high-stakes testing, the participants displayed mannerisms indicative of their displeasure. For instance, Participant TB#2 reclined back in their chair, arms behind their head, and blew their cheeks out with a loud breath, expressing irritation as they discussed the pressure to "tick so many boxes." TB#5 raised his hands as he discussed needing to forego projects in order to cover all of the criteria in his math class. Additionally, since STEAM does not have state-adopted standards, STEAM educators often contend with how other educators in the school believe that STEAM integration is not rigorous because it is untidy and lacks formal standards. "Um, I do have views from other instructors that we accomplish nothing or that we just create messes or that we lack rigour."

Implication for the world

Educators that have successfully transitioned to constructivism (Vygotsky, 1978) and culturally appropriate instructional approaches (Hammond & Jackson, 2015) urged other educators to use similar tactics to begin integrating STEAM. STEAM educators have the following recommendations based on their own experiences: (a) gain support from building School leaders, (b) develop community partnerships, (c) speak with educators who are already integrating STEAM, (d) take advantage of STEAM professional development opportunities, (e) share your success stories and why STEAM integration is critical, and (f) begin by integrating a passion. The guidelines serve as a guide for schools as they begin to incorporate STEAM. Collaborate with building School leaders to get their support. Educators discussed how beneficial it is to have administrative support for STEAM inclusion.

School leader support is crucial for teachers and building School leaders to feel confident in experimenting with their own teaching approaches in order to improve STEAM integration. Participant TB#4 discussed how having an administration who promotes STEAM integration has aided in the school's STEAM integration development. "Um, I know that the current assistant principal is highly pro-STEAM," participant TB#4 remarked. "You know the school is just—the principal, you know, walks the walk," he said. He asserts that he is STEAM-oriented, which he has been. They assist me whenever they are able. Unfortunately, the post is temporary, however the school excels in STEM and STEAM." Participant A#1 discussed the significance of an School leader team concentrating on rigour and student engagement in order to promote STEAM integration. "Moreover, rigour and involvement are associated with teacher evaluation. As long as we put it at the forefront of our message, effort, and expectations, including STEAM is—can be fairly simple." Finally, Participant T#6 discussed how the principle of a school where he worked fostered an innovative teaching culture via STEAM integration, which aided him in initiating STEAM integration. "Um, so it was more of a live, continuing culture, rather than a PD service inside or outside the school system."

Consult with other instructors who are successfully implementing STEAM. Educators emphasised the value of communicating with other educators who are incorporating STEAM in order to learn from their successes and failures. These dialogues aided educators in comprehending how STEAM integration is a cycle of ongoing progress. "And it was my teaching partner and I who both got to attend," participant TB#3 said. "It was a productive time for us because we got to think about our curriculum and how we might, uh, match the makerspace with our present curriculum." TB#2 discussed how hearing from another educator helped her recognise how minor changes may make an impact in STEAM education. "Um, and then it inspired me to search for opportunities in the sense that there is such a drive to get through so much, particularly with science and math, that the art aspect might go by the wayside."

The time spent conversing with other STEAM integration practitioners enables instructors who are new to STEAM integration to appreciate the significance of the time spent in classrooms on these learning activities. The
activities of participant TA#2 in speaking with other educators about STEAM integration made her perceive STEAM integration as a worthwhile endeavour. And therefore, hearing this specific speaker indicated that the additional 30, 30, 40 minutes spent on the additional art aspect in which individuals display thinking in their own unique style, or whatever that is, is not a waste of time. Because I believe that sometimes you have to check so many boxes during a lesson, a week, or a curriculum that art thinking is nearly usually the last one you get to. And so it was just how we modified it, how we spoke about it, and how we prioritised our time to include that that was beneficial. Educators who spent time with other STEAM educators understood the value of beginning with a love or interest in order to maintain focus on the job while honing the skill of STEAM integration. TA#4 promotes instructors to communicate with one another.

Table 2: Summary of Key Findings

<table>
<thead>
<tr>
<th>Research Questions</th>
<th>Themes</th>
<th>Findings</th>
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</thead>
<tbody>
<tr>
<td>RQ1</td>
<td>Integration of STEAM teaching practices in China and Ghana</td>
<td>- There appears to be a mixed reception on the integration of STEAM in both China and Ghana.</td>
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<td></td>
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<td>- However, both countries described the fact that the practice STEAM to a certain degree. Teacher in Zhejiang province indicated their preference for discipline specific STEAM integration while teachers in Ghana supported the content-specific STEAM approach out of the four main approaches used.</td>
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<td>RQ2</td>
<td>Benefits and challenges of STEAM Integration in China and Ghana</td>
<td>- Both countries revealed that they derived benefits from STEAM. This includes adding to relevance to learning material; helping students develop preparedness for college; empowering students; encouraging students to go beyond the comfort zone; helping students discover their interest; helping students experience achievement in a new manner; helping students indent opportunities; bringing out the best in students and many more</td>
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<td></td>
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<td>- Teachers from two countries further opined some challenges they faced with integrating STEAM in their teaching and learning. This also compose of; difficulty for schools’ leaders to change; difficulty for educators to develop their own level of comfort; difficulty in finding time in the curriculum for project-based learning; difficulty in collaborating with other colleagues; inconsistent access to resource; Colleagues teachers’ perception of STEAM integration, difficulty in balancing district or city initiatives and many more.</td>
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<tr>
<td>RQ3</td>
<td>The suggestion for the development of STEAM education in China and Ghana and implication for the rest of the World</td>
<td>The study revealed the need for improvement in STEAM integration in both countries by; gaining support from building school leaders; developing community partnerships; speaking with educators who are already integrating STEAM; taking advantage of STEAM professional development opportunities, sharing their success stories and why STEAM integration is critical, and beginning by integrating a passion in students.</td>
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Summary, Conclusion and Recommendation

Summary of the Research Process

This study conducted a comparative study of STEAM education in China and Ghana, specifically focusing on Zhejiang Province and Accra Metropolis. The following research questions guided the study:

The following research questions fortified the study:
1. How has STEAM teaching practice been implemented in China and Ghana?

2. What are the perceived values and challenges teachers face during the practice of STEAM education in China and Ghana?

3. What are the suggestions of development of STEAM education in China and Ghana and implications for the rest of the world?

The study adopted the descriptive research design, a qualitative research approach. The study's sample size comprised five teachers from five schools each from Accra metropolis of Ghana and Zhejiang Province of China. The study adopted purposive sampling technique collecting extensive and detailed information on the topic under investigation. The instrument used in the study was a semi-structured interview guide. The study further performed document analysis with a thorough review of relevant documents such as journal articles, book chapters, reports, and website contents. Data from the interviews were analyzed descriptively by categorizing responses concerning the research questions. After analysing the related concepts and codes, sub-themes, and themes collected from the different sources of literature, we interpreted each theme with the conceptual codes and sub-themes in relation to their meanings in the context of STEAM education. The data were collected through audio recording, transcribed, and reported as themes guided by the research objectives. Content Analysis and Thematic analysis was adopted for reporting the results of the study.

Conclusions

According to the evidence evaluated in this study, STEM education enhances preschool children's competence and knowledge of STEM topics. Indeed, all of these skills are interconnected, and mastering one may aid in mastering another. For instance, a youngster may enhance his/her sequencing skill by involvement in robotics and programming, or he/she might reinforce his/her counting ability through the use of iPad applications. Additionally, evidence indicates that STEM activities assist children with impairments in grasping STEM principles and applying them to future situations. Therefore, regardless of ability, children should be supported during these formative years with a developmentally appropriate curriculum that integrates STEM disciplines, establishes connections between these fields and the real world, and establishes the foundations for STEM fields by providing concrete experiences and encouraging children's natural curiosity and creativity.

Additionally, as a natural component of their education, including arts into such a curriculum may increase preschoolers' motivation and enjoyment for science-related activities. Additionally, arts integration provides preschool children with the opportunity to illustrate STEM concepts in novel and imaginative ways and to express their own thoughts about the world through music and dance, drawing opinions with crayons and markers, constructing models, creating graphs, and communicating with others using descriptive language.

China has made tremendous strides in reforming and implementing education, scientific education, and S&T policy, but science education at the secondary and higher levels continues to have weaknesses. As a result, it must continue to reform and enhance scientific education while expanding the higher education sector. Families rely on education as a means of strengthening their economic prospects and social standing. Additionally, Chinese enterprises need an educated workforce in order to go beyond being the world's factory and to actualize indigenous innovation. As the Chinese government works to build a more balanced HE system throughout the nation, and in order to attain the 40% gross enrollment rate in HE by 2020, economic prosperity and education spending must be distributed to the country's poorest regions. China's capacity to sustain rapid economic development and assume a leading role in the global economy is contingent upon its ability to strengthen and extend its HE system. Science education, being the bedrock of the whole HE system, will need further attention in the future to continue reforming and enhancing quality. It is commonly recognised that a nation's competitiveness is mainly determined by science and technology innovation, and the key to S&T innovation is human capital. Education is responsible for developing a diverse range of specialised skills.
abilities necessary to support the advancement of science and technology. Ghana can follow China's STEAM practise in order to attain the level of STEAM education attained by China.

Additionally, educators from Zhejiang province and Accra Metropolis agreed that STEAM integration benefits students by connecting content areas, providing relevance for content learning, developing college and career readiness, empowering students, building confidence and resilience, and encouraging students to step outside their comfort zone. Educators that include STEAM share a set of fundamental ideas. They value high aspirations for all kids, the necessity of expanding access to challenging, engaging curricula for all children, and the ability to teach pupils measured risk-taking and resilience. Additionally, educators that incorporate STEAM think that children must understand how and why information is important to them, that real-world challenges engage students, and that STEAM integration is achievable with current standards.

Educators have had similar difficulties integrating STEAM. The first obstacle is the School leader's ability for change leadership. Second, educators have difficulties fitting project-based learning into the curriculum and collaborating with colleagues. Additionally, educators encountered difficulties due to inconsistency in resource availability and peers' opinions of STEAM integration as insufficiently rigorous. Finally, instructors have difficulties integrating STEAM when balancing district objectives with the pressures of standards and high stakes testing.

Finally, instructors have begun introducing STEAM integration using similar tactics. To begin, educators found it beneficial to speak with other educators who are successfully integrating STEAM into their classroom practises. Second, educators advocate for initiating the initiative with early adopters at the school to generate momentum. Following that, instructors urge students to pursue STEAM professional development options. Finally, educators emphasised the necessity of sharing success stories and promoting the relevance of STEAM integration.

Recommendations and Suggestions for Further studies

The study's results have ramifications for future STEAM integration implementation and research. Teachers and School leaders define STEAM integration as incorporating makerspaces. Maker education has grown in lockstep with STEAM integration. However, it is hardly mentioned in STEAM integration literature. Future studies should explore the relationship between maker education and STEAM integration. Schools are forming STEAM teams to integrate STEAM concepts into education. This research improved educators' awareness of STEAM integration from African and Chinese perspectives. Their assessments of the problems associated with STEAM integration provide light on prospective study topics and intervention strategies to assist teachers and School leaders in implementing STEAM integration on a school-wide level. Teachers, instructional specialists, and School leaders noted the difficulties associated with colleagues' perceptions of STEAM integration as less demanding, as well as the difficulties associated with intermittent financing. Future study should analyse why instructors who do not integrate STEAM have this attitude in order to offer more effective professional development for sceptical teachers in STEAM schools.

Finally, future study should assess the effect of various district-led efforts on School leaders' competence to lead change and teachers' capacity for STEAM integration. This research might be duplicated in order to acquire a better understanding of education stakeholders' perspectives on STEAM integration. Numerous solutions exist to minimise this study's flaws and delimitations. For instance, the research may expand its geographical scope. Since the study's inception, some schools have chosen to include STEAM. The research might be extended to include more participants if education stakeholders were defined more broadly to include students, parents, and industry. This has been clearly summarized in Figure 111:
5.4.1. Practical Policy

The study's results have practical consequences for educators in terms of what they need to incorporate STEAM.

a. Support from the district and building School leaders is critical for students to participate in high-quality STEAM integrated learning opportunities.

b. To assist teachers in implementing STEAM integration, School leaders must participate in STEAM integration professional development with their instructors. The district should establish cohorts for School leaders to learn how to support the teaching adjustments required for STEAM integration and to speak with School leaders who have pioneered this transformation to learn about potential roadblocks.
c. School leaders need chances to see STEAM integration at various grade levels. School leaders at the district and building levels must promote multi-year professional development that is based on a coaching model.

d. Teachers need the same conditions for STEAM integration as students do: a sense of safety to fail and encouragement to create. The process of integrating STEAM is a never-ending loop. New technologies and new understandings will emerge, and STEAM integration must remain relevant in these rapidly evolving fields.

e. Teachers need time and professional development to learn how to utilise technology with students in order to promote student comprehension, rather than just employing technology for its novelty value.

f. District School leaders must establish a repository for validated open-source STEAM educational resources, so that building School leaders, instructional specialists, and teachers may see several instances of high-quality STEAM integration. Teachers integrating STEAM must take advantage of every chance to learn about jobs in various STEAM sectors.

g. Community partnerships must be able to clarify their idea of STEAM integration and have a way for assessing whether teachers are really applying it after the professional development opportunity. Partners in the community must investigate ways to include teachers into STEAM vocational externships.

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5.4.2. Policy implications.

a. Schools are implementing STEAM integration on a school-wide basis. This implies that teacher preparation programmes must adapt their curricula to better equip preservice teachers to teach utilizing integrated STEAM methods.

b. Teacher training programmes should include education on how to develop STEAM-integrated curriculum. STEAM integration entails more than providing instructors and students with a selection of technologies.

c. Teachers need time and professional development to learn how to utilize technology with students in order to promote student comprehension, rather than just employing technology for its novelty value.

d. Teacher preparation programmes should collect data from cooperating teachers to ensure that preservice teachers have student teaching experiences with instructors transitioning from teacher-led to teacher-facilitated instruction and evaluation.

e. Finally, teacher training programmes should include an analysis of personal privilege, power, and unconscious bias into all curriculums, as well as how these factors impact instructional methods and our perceptions of our pupils.

REFERENCE


