



Original Research Article

Artists as engineers: Perspective of senior high school students in Ghana

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Despite several initiatives to include Art and Design in Science, Technology, Engineering, and Mathematics (STEM) education and the need for interdisciplinary training, visual art disciplines still struggle to be fully accepted into STEM related disciplines especially in sub-Saharan Africa. This study has been carried out to explore the interest of visual art students in pursuing engineering related courses at the Tertiary level and to explore the benefits of STEM education in Ghana. Consequently, four (4) Senior High Schools located in the Ho Municipality of the Volta regional capital of Ghana, West Africa, offering visual art were conveniently sampled and interviewed through a focus group discussion. Data obtained were analysed using qualitative technique of content analysis. The findings revealed a strong interest by visual art students to change the misconception about art discipline by pursuing STEM related disciplines at the Tertiary level. The study therefore, recommends that collaboration between STEM related disciplines and visual art disciplines should begin at the Senior High School level where it should be possible to integrate science and mathematics subjects with visual art courses.

Keywords: Visual art, STEM education, engineering, senior high school

INTRODUCTION

The globalization of education has led to a focus on combining two or more job tracks for economic success. Hockemeyer (2022) agrees with the argument for fusing engineering and art. She claims that the dilemma of innovation and style may be resolved by fusing engineering and art. According to Balkir et al. (2009), students who have an education in art and engineering are better equipped to come up with original, logical solutions to a variety of design challenges by using techniques like constructive analysis and craftsmanship.

According to Knochel (2018), there is a huge demand for graduates with education in the fields of science, technology, engineering, and mathematics (STEM). According to Hill et al. (2010), increasing the number of

people entering the STEM fields is a challenge for many nations worldwide. However, fewer kids are becoming interested in STEM professions (Hau et al., 2020).

Many studies discovered a decline in students' interest in STEM and subsequent decisions to study STEM-related fields (Rafanan and De Guzman, 2020). Science, Technology, Engineering, Arts, and Mathematics (STEAM) education has gained popularity as a new approach to enhance students' learning outcomes by fostering their readiness for the 21st century. This is in the context of the current industrial revolution. The purpose of the arts (A) in STEAM is to enhance students learning, the growth of their creativity, and their likelihood of success. As a result, the link between science and art has been the subject of much

debate among specialists. So that future generations of students might actually become global citizens, art and STEM education awaken "artists" in generations of pupils (Nguyen, 2020).

According to Perignat and Katz-Buonincontro (2018), the desire to boost student's interest and proficiency in Science, Technology, Engineering, and Mathematics (STEM) subjects led to the development of STEAM education as a new programme of teaching. In a similar vein, Hetland and Winner (2004) demonstrate that STEAM education integrates the arts with STEM subjects in order to enhance student engagement, creativity, innovation, problem-solving skills, and other cognitive benefits as well as to enhance employability skills necessary for career and financial advancement.

According to Felder (1987), the uniqueness of STEM and art has been leveraged as a strategy to diversify potential STEM students by integrating art education into STEM programme. The addition of an arts education, he continued, might be utilized to broaden the viewpoints of people who are studying engineering, as opposed to using art as a way to attract diverse individuals to the subject. He continued by saying that rather than "extinguishing the flames of creativity the students bring with them," it is important to cultivate and strengthen the creativity already present in students. Sochacka (2016) asserts that the arts force us to consider our assumptions about who we are and the society in which we live critically.

Rationale for the study

The call for students in the field of art to pursue engineering (STEM-related) courses is deepening. However, in a developing nation like Ghana, the school curriculum especially at the senior high level is not reflective of the current improvements seen in other developed nations to integrate the art curriculum with engineering and enable students to easily pursue these careers. As a result, visual art students who wish to pursue engineering at the tertiary level are unable to do so. The ministry of education, which is the main stakeholder in Ghana's education system, recently suggested a policy that would allow senior high school students who are interested in visual art to be accepted to study engineering-related fields at the university level. "The policy seeks to open doors to non-science students, especially visual art students who have the desire and possess the ability and creative minds to be trained as innovative and creative engineers to drive industrialization in the country" (Owusu, 2022).

In light of this, the purpose of this study is to obtain the unbiased opinions of a select group of Senior High School students regarding the viability of the call for interested visual art students to enrol in engineering programmes at the university level. The study also investigates the interests of students studying visual arts and the advantages they stand to gain from pursuing professions in STEM-related fields like engineering. Additionally, the study will pay close attention to how the proposed regulation would affect enrolment onto art-related programmes in the tertiary educational institutions in

Ghana.

Stem and steam-based education

In recent years, the heterogeneous, interdisciplinary, and transdisciplinary nature of STEM-based education has drawn a lot of attention on a global scale (Li et al., 2020; Ozkan and Umdu- Topsakal, 2021). A thorough grasp of the domains of science, technology, engineering, and mathematics is intended to be imparted to pupils through this integrated learning strategy (Dyrberg and Holmegaard, 2018). STEM-based education offers a distinctive method of teaching in which students are taught in a setting of transdisciplinary integration of disciplines, in addition to the relationships and linkages that exist across Science, Technology, Engineering, and Mathematics (Vasquez et al., 2013). Students can then use these abilities to solve problems and think critically, creatively, and innovatively in circumstances that they will encounter in the real world. Available literature suggests, rapid growth in scholarly contributions toward STEM education. The current international trends in research support the development of STEM fields. A systematic analysis of 798 published articles in STEM education between the year 2000 and the end of 2018 by Li et al., demonstrate that the relevance of STEM education research is rising globally and that the identities of STEM education publications are becoming more obvious (Li et al., 2020).

The constructivist theory that underpins STEAM education, on the other hand, places students at the center of the learning process (Gross and Gross 2016). Wynn and Harris (2012) claim that this method allows for "new ways of perceiving, knowing, and dealing with the world, as a strategy to widen the science and engineering toolkit". Similar to STEM, it highlights the connections between disciplines that are initially perceived as distinct; for example, it highlights how the creative design process is essential to both engineering and art (Bequette and Bequette 2012). STEAM education includes art and design as important elements of the educational process in order to prepare students for the future.

According to the report of Sousa and Pilecki (2013), combining the arts and sciences is a good method to encourage students to pursue both subjects and develop the transferable skills and creative thinking needed for success outside of the classroom. The four Cs (creativity, communication, convergence, and caring) are incorporated into education through the arts, and STEAM does the same by incorporating these skills into the classroom and providing teachers and students with opportunities to engage in challenging and integrated teaching and learning activities (Choi et al., 2017; Steele and Ashworth, 2018). The use of art and design in STEM (Science, Technology, Engineering, and Mathematics) education has gained traction in recent years, with Costantino (2018) stating that this has made STEM education more appealing to students. Technology, Engineering, Arts, and Mathematics (STEAM) is a term that is becoming more and more prominent in educational contexts. As a result of reframing STEM education, STEAM education has advantages and objectives

Table 1. Demographic Description of Participants

School	Number of students interviewed	Gender distribution	Age range
1.Wallahs Academy	19	14 males and 5 females	17-20
2.Ola Senior High School	24	all-females	15-20
3.Mawuli Senior High School	48	38 males and 10 females	15-20
4.Mawuko Senior High School	32	32 all females	17-22

that are distinct from those of STEM education (Quigley et al., 2017). Understanding this basis is necessary first because STEM is theoretically based.

In Ghana, the STEM education programme is gradually gaining grounds. Owusu (2022) reveals that the “Ministry of Education of Ghana has kicked start a one-year pre-engineering programme at the University of Mines and Technology (UMAT) and the Pentecost University in Ghana”. According to him, the one-year programme is designed to train and prepare Senior High School graduates without science backgrounds for enrolment into Bachelor of Science in Engineering programmes at the University. The policy has also been designed in accordance with the Education Strategic Plan 2001-2030 which targets 60 % enrolment of students in tertiary education pursuing Science, Technology, Engineering and Mathematics (STEM) disciplines.” (Owusu, 2022).

RESEARCH METHODOLOGY

This study adopted a qualitative research approach and used a case study design for the research. The case comprised four Senior High Schools of the Ho Municipality in Ghana whose final year visual art students were involved in the study. The schools include: Wallahs Academy, Ola Senior High School, Mawuli Senior High School and Mawuko Senior High School. The rationale for choosing this approach was to gain concrete, contextual and in-depth knowledge about the perception of visual art students towards STEM based career choices when offered the opportunity at the tertiary level. The sample population of the study was made up of 123 participants.

Data Collection and Procedure

Focus group discussion was used as the data collection technique for the study. Final year visual art students from Wallahs Academy, Ola Senior High School, Mawuli Senior High School and Mawuko Senior High School were conveniently sampled for the study. Interview guide was the main research instrument employed to collect data for the study. Data collection for the study took place over a period of two weeks within a class session. In order to achieve the aim of the study, the following research questions were considered;

1. What is the interest of visual art students in pursuing STEM related courses at the Tertiary level?
2. How will the proposal for visual art students to

pursue STEM-related programmes at the tertiary level affect STEM and visual art education in Ghana?

Focus group discussions were used to allow for face-to-face interaction and unrestricted information exchange between participants and the researchers (Best, 1981; Gawlik, 2018). Consequently, the final year visual art students had the freedom to express their objective views and opinions in relation to the research questions posed during the facilitation of discussions. The verbal responses from participants were recorded using a mobile phone recorder after which they were transcribed into written form. Table 1 above presents the number of students interviewed per school, the gender distribution and their age range. The qualitative data gathered through the focus group discussion was analysed using qualitative technique of content analysis. In this case, the recorded data were coded and categorised into themes.

Research Setting and Participants

This research took place in four Senior High Schools (Wallahs Academy, Ola Senior High School, Mawuli Senior High School and Mawuko Senior High School) located within the Ho Municipality of Volta region in Ghana, West Africa. The schools offer visual art programme with specialisation in graphic design, textiles, elective ICT, metals, jewellery, general knowledge in art and picture making. This is a second cycle education programme which takes 3 years to complete after which students are allowed to pursue their bachelor degree programmes at the tertiary level. Currently, admission into any STEM related discipline at the tertiary level requires passes in science and mathematics subjects like chemistry, physics, elective mathematics, biology. The population for this study comprises visual art students from Wallahs Academy, Ola Senior High School, Mawuli Senior High School and Mawuko Senior High School.

Convenient sampling technique was used to select final year visual art students from the four Senior High Schools for the study. The schools were grouped into clusters. This was to allow for diverse range of perspectives and give participants the enabling environment to express their views. Each cluster contained a minimum of 3 groups and a maximum of 5 groups. Participants in each group range from 6 to 10 participants. This gave everyone an opportunity to participate in the conversation while also allowing for a variety of viewpoints. In total, 123 participants were categorised into 4 clusters and 15 groups as shown in Table 2.

Table 2. The Focus group cluster details

School	Number of Students Interviewed	Cluster Groupings
1. Wallahs Academy	19	3 groups (2 groups have 6 participants each and 1 group had 7 participants)
2.Ola Senior High School	24	3 groups (8 participants in each group)
3.Mawuli Senior High School	48	5 groups (4 groups have 10 participants each while 1 group had 8 participants).
4.Mawuko Senior High School	32	4 groups (8 participants in each group)
Total	123	4 clusters (15 groups)

Each group constituted a focus group session. During each session, participant face-to-face interactions and conversation lasted between one and two hours. The moderators for each session were the researchers, who asked questions, recorded, and summarized the respondents' answers.

RESULTS AND DISCUSSION

As a qualitative study, non-numerical data was collected using a semi-structured interview guide in a focus group setting. As a result, the responders provided insightful empirical data. The key themes that emerged from the data are summarized in Table 3 along with related categories. The obtained data were presented and interpreted based on the two main research questions guiding the conduct of the study.

Responses from research question 1: What is the interest of visual art students in pursuing STEM related courses at the tertiary level?

The first research question was to determine whether final year students in visual art who have the intention to attend a postsecondary institution would be interested in a policy that would enable them pursue any STEM-related subject at the tertiary level. This first research question generated two main themes: 1) Interest in STEM programmes, and 2) Interest related to the capability of the visual artist.

THEME 1: Interest related to STEM programmes

The students were questioned about their interest in any field connected to STEM. The researchers were interested in how much a person with a background in visual art would exhibit a desire to pursue a STEM-related field. The detailed results are presented in Table 4. Most visual art students perceived STEM related disciplines as extremely respectable fields, and when offered the opportunity, they would like to pursue these fields at the tertiary level. According to Quora (n.d.), students of art background can major in engineering if they have a passion for the subject and have the requisite academic qualifications. The verbal responses of the participants revealed that out of a total number of 123 respondents, about 87 representing 70%

visual art students have keen interest in STEM related disciplines at the tertiary level. This will boost their self-esteem and eliminate the myths about visual art education in Ghana. While some participants chose Geological Engineering and Agricultural Engineering, the majority of participants exhibited interest in fields including Aerospace Engineering, Petroleum Engineering, Mechanical Engineering, and Civil Engineering. However, some participants expressed concern about their inability to handle Chemistry, Elective Mathematics, and Physics because they lacked the fundamental knowledge in these subjects. Some participants, however, said, "Even though they do not have the fundamentals in Chemistry, Physics, and Elective Mathematics, they will be able to cope and compete well with other colleagues."

This suggests that a strategy is required to enable visual art students to gain acceptance into STEM professions with ease. This implies that there is a need for a policy that can make it possible for visual art students to be considered for admission at a higher education institution to pursue STEM related subjects.

THEME 2: Interest related to the capability of the visual artist

Participants were interrogated about how their interests and capabilities as visual artists can advance the growth of STEM education. It was revealed from the discussions that, students with backgrounds in visual art are more adept at design, aesthetics, and utility, and they can visualize and conceptualize ideas easily. According to the participants' account; engaging in learning activities like drawing, painting, designing and other imaginative activities enable them to develop creative skills. The Raising Children Network (2022) argues that, students develop their creative abilities and imaginative power through art and craft. Participants from Ola Senior High School (n=24) said they have been taught how to sketch ideas on paper and develop concepts from nature. In Mawuli Senior High School, participants (n=48) admitted that their creative ability will help them to perform creditably when offered engineering programme at the tertiary level. According to this source, an education in the arts can give students a solid foundation in problem-solving and creativity, which can be helpful in the engineering field. Also, art subjects involve learning how to draw objects, sketch

Table 3. Synopsis of the themes and categories that emerged from the two research questions

Research questions	Themes	Categories
1. What is the interest of visual art students in pursuing STEM related courses at the tertiary level?	a) Interest related to STEM programmes b) Interest related to the capability of the visual artist	a) Course specialization b) Coping Ability c) Strength from visual art d) Strength from engineering
2. How will the proposal for visual art students to pursue STEM related programme at the tertiary level affect STEM and visual art education in Ghana	a) Effect of proposal related to STEM education b) Effect of proposal related to visual art education.	a) Agreement towards proposal b) Policy feasibility c) Career shift and implication

(with pencil, pens, and other media), and explore materials and processes. Wallahs Academy (n=19) and Mawuko Senior High School (n=32) participants also mentioned that they learn how to use their hands to make useful items such as textile prints, paintings, wall hangings, artifacts, carving, etc. A female participant from Ola Senior High School noted; "I develop the ability to create new ideas and concepts towards the production of competitive and time-tested products".

These responses suggest that there is a strong nurturing of creative talents among students with visual art background. These students will be able to apply imaginative and creative skills in the various STEM fields to create innovative products and services. Therefore, it is essential for STEM educators to embrace the power of visual art as a tool for influencing STEM education and growth.

Responses from research question 2: How will the proposal for visual art students to pursue STEM-related programmes at the tertiary level affect STEM and visual art education in Ghana

The second research question was intended to establish the effect of the proposal on STEM and visual art education in Ghana. The two themes that emerged from the focus group discussion were; the effect of the proposal related to STEM education and the effect of the proposal related to visual art education.

THEME 2.1: The effect of the proposal related to STEM education in Ghana.

The response from participants about how the proposal to enrol non-science students into STEM-related disciplines will influence STEM education in Ghana suggests that, students with visual art background stand a better chance of possessing the requisite skills and competencies required for effective STEM education. The multi-disciplinary nature of STEM requires collaboration among disciplines. Visual artists create and engineers also create. This policy will encourage such collaborations and make STEM education more competitive. As a result, there is strong support for this policy to be successfully implemented. From the perspective of participants of

Wallahs Academy (n=19); art is an integrated field that combines other disciplines. Therefore, its integration into STEM fields will not pose any negative impact. Participants from Ola Senior School (n=24) concur that this policy would allow visual artists to explore new fields of knowledge and expertise while generating employment opportunities for young people. According to the opinion expressed by participants from Mawuli Senior School, this policy would promote diversity and broadens the breadth of the STEM profession.

It can be deduced from the responses that enacting a policy like this will be essential for the advancement and promotion of STEM, predominantly for a developing country like Ghana. This is crucial for socio-economic development, particularly for a nation that requires creative solutions to improve its manufacturing and industrial sector. Accordingly, Ghana will be equipped with the human capital needed to advance its industrialization and production.

THEME 2.1: The effect of the proposal related to visual art education in Ghana.

Participants affirmed that this policy has the potential to alter how Ghanaians perceive the study of visual art. Visual art shall be accorded the same respect and reputation as other subjects, especially at the senior high school level. Participants from Mawuli Senior High School attest that their parents and guardians would not prevent them from choosing visual art because they know that they will qualify to pursue other STEM-related subjects. Mawuko Senior High School participants were of the view that this will prove to the world that visual artists are capable of pursuing STEM subjects. In Ola Senior High School, the students noted that artists also create, manufacture and follow processes, therefore it makes it easy to collaborate and share similar expertise with other fields. Another participant from Whallahs Academy said that enrolment into visual art-related disciplines will increase while entrance to any STEM-related field would rely on interest, qualification, and the ability to pass requisite subjects.

It is clear that putting this policy into practice will encourage inclusion, diversity, and cross-disciplinary cooperation among students, teachers, degree programmes, and higher education institutions.

Table 4. Interest related to STEM fields

Name of School	Areas of Interest	Total Number Interested
Wallahs Academy	Mechanical-2, Aerospace-8, Petroleum-1, Electricals-3, Materials-2, Geodetic-1, Civil-1	19
Ola Senior High School	Mechanical-3, Aerospace-5, Computer-4, Civil-1 Material-2 Electricals-2, Petroleum-1	18
Mawuli Senior High School	Mechanical-5, Aerospace-3, Civil-7, Materials-3, Agric-2, Electricals and Electronics-8	28
Mawuko Senior High School	Mechanical-4, Aerospace-5, Civil-4, Geological-3, Agric-2, Electricals and Electronics-4	22
TOTAL		87

DISCUSSION OF FINDINGS

It emerged from the discussions that, career shift from a visual art discipline to a STEM related discipline will have a significant impact on improving human capital for national development. The participants for the study were optimistic about visual artist's capabilities and what they can contribute to national development when offered the opportunity. They expressed their belief vividly that when artists work alongside engineers or pursue STEM related studies, it results into the development of a unique set of human capital, capable of accelerating socio-economic development.

It became evident that the current generation of visual art students are prepared to challenge the unfavourable perception of visual art vocation by exploring other disciplines like STEM. They believed that because of their strengths in creativity and the capacity to create something new, they would be able to succeed if given the chance to advance their careers in fields other than visual art.

To achieve this effectively, the participants recommended that collaborations should begin at the Senior High School level, where it should be possible for science courses to be integrated with visual art courses so that those who want to pursue engineering at the tertiary level can gain background knowledge in science subjects like Mathematics, Chemistry and Physics.

Domestication and "the need for us to produce for us and used by us" emerged strongly from the discussions. A clear indication that when we work together, we can reduce the huge burden on foreign exchange and the fact that we have to import everything from outside. This policy will be a confidence booster for visual art students since most of them admitted that they feel shy pursuing visual art as a result of the negative perceptions towards the discipline. Innovation, creativity, precision, accuracy coupled with the need to collaborate with the artists and the engineers together towards empowerment and improvement in the overall well-being of our people will be realized.

Conclusions and implications

The key objective of this study was to solicit for the objective views of selected Senior High School students on

the feasibility of the call for interested visual art students to pursue engineering programmes at the tertiary level. The study was also carried out to explore the interest of visual art students and the benefits they stand to derive from pursuing careers in STEM related disciplines such as engineering.

There was a positive demeanour of participants towards the whole concept of giving visual art students the opportunity to pursue non-art programmes like engineering at the tertiary level. Participants generally perceived this proposal as a game changer towards domestication and industrialization of Ghana's economy. This is because, artists naturally have been trained to use their creative abilities to imagine, recreate, re-engineer or improve upon old things. When they collaborate with the scientists and engineers, they can work better in improving on the industrial revolution of Ghana. Most of the participants debunked the notion that the policy will negatively affect the enrolment of visual art related disciplines at the tertiary level. This is because, they believed that students will be admitted based on their qualification and the ability to pass the required subjects.

Despite the positive posture of participants toward the policy, a few expressed the lack of foundational knowledge in chemistry, physics and mathematics. They believe this will inhibit their performance and ability to cope when enrolled on any STEM related programme at the tertiary level. It is therefore recommended that chemistry, physics or mathematics subjects should be introduced into the visual art curriculum at the Senior High School level. Additionally, parents and guardians should guide and support their wards in developing interest towards integrated STEM disciplines.

Results obtained from participants on the policy were positive. Participants were generally optimistic that when fully implemented, this policy will help boost the image of visual art students, increase enrolment into STEM related disciplines and improve the human resource capacity of Ghana. The study is integrated with current research on educational policy review to train students to be technologically inclined. It is hoped that the results of the study will provide useful information for stake-holders in the education value chain especially the Ministry of Education of Ghana in implementing this policy. It is

believed that the results of this study would help provide a better outlook of the educational system in Ghana and promote the future of STEM education in Ghana.

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