Publisher: KAD International, Ghana
Co-publisher: Cherkas Global University, USA
Has been issued since 2014
E-ISSN 2508-1055
2022. 9(3): 116-123

DOI: 10.13187/jare.2022.3.116

Journal homepage:
http://kadint.net/our-journal.html

Efforts to Patch Ghana's Leaky Educational Pipeline' for Promoting Gender Equity in STEM Field of Study: A Position Paper

Dickson Okoree Mireku [a, *], Prosper Dzifa Dzamesi [a]

[a] University of Cape Coast, Cape Coast, Ghana

Abstract

This position paper aims to highlight some progressive steps by successive Ghana governments to patch the leaks in Ghana's educational pipeline for training females for careers in the field of Science, Technology, Engineering and Mathematics (STEM). Documentary analysis techniques were employed to review the literature to follow the line of discussions on the topic. After the review, it was found that at the end of British rule in 1957, Ghana adopted various science and technology policies geared towards pushing it into the class of front-runners in modern science and technology. Adopting policies became necessary after Ghana assessed the pivotal roles that science and technology would play in its economic development agenda. The Gender Parity Index in the primary and secondary school enrollments in Ghana between 2011 to 2020 increased from 0.96 to 1.01, indicating that the differences in the rates at which males and females were admitted to reading STEM programmes closed up. Through the government of Ghana's interventions, the gender gap was reduced, a situation that supported the stands of the authors against that of some social critics who were of the view that Ghana is among the countries that are still struggling to patch 'leaks' in its educational pipeline for promoting gender balance in STEM education.

Keywords: equity, gender parity, Ghana, Leaky Educational Pipeline, STEM education.

1. Introduction

During the last century, Ghana came out of colonist rule and experienced varying political, social, and economic upheavals (Amankwah-Amoah, 2016). Getting to the end of *British Rule* in 1957, Ghana started adopting various technological and scientific programmes geared toward increasing agricultural and industrial production (Ankoma-Sey et al., 2019). Thus, the importance of science and technology in production and re-development processes gained much acceptance. Forerunners of development, such as Dr. Nkrumah, then set out comprehensible policies to support the agricultural and industrial sectors using the scholarly outputs of universities and national research institutions (Amankwah-Amoah, 2016). The formulation of science and technology policies started a few years after Ghana's independence to help bolster traditional ways of production.

By 1960, Ghana was at the cutting edge of finding and infusing modern technological devices and methods in production (Anderson, Kim, 2006). This happened because, before 1960, the manufacturing sector was on the verge of collapse, and the disturbing effects of the industry on the development processes in related sectors had already been detected (Anderson, Kim, 2006).

* Corresponding author
E-mail address: dmireku@ucc.edu.gh (D.O. Mireku)

The Government of Ghana resorted to some *'politician-led'* management styles for running key industries, which later caused inefficiencies in many of its interconnected production sectors (Opoku, 2004). Sequentially, the high levels of managerial inefficiencies again became a significant hindrance to the growth of industries in the manufacturing and processing sectors (Opoku, 2004). A few years after 1970, the position of Ghana as far as technology adoption is concerned was made known on several international platforms. That position was declared because the industrial sector (of Ghana) was still stagnating in terms of performance and productivity, a situation which caused the lowest growth rate of 3.5 % per annum found in the historical records of Ghana (Adei, 1990).

Years after, Ghana rebounded, bounced back into promoting technology, and emerged as one of the stable democratic nations in Africa with a high rate of traditional inventions that caused the Gross Domestic Product (GDP) to grow by 16.30 % (Boso et al., 2013). In 2013, the country was declared lower-middle-income, a testament to its known ability to utilise many of its natural resources for development (Fosu & Aryeetey, 2008). One of the possible explanations for the growing industrialisation that finally pushed economic growth and development (Amankwah-Amoah, 2016) was the shift from social policies to the promotion of science education and local innovations. Thus, the need to move away from social policies and utilise scientific expert ideas and inventions in production was considered by incumbent governments (Amankwah-Amoah, 2016). Afterwards, there were growing concerns for Ghana to develop information and technology structures to help bridge the scientific and technological gaps between Ghana and many advanced economies. Since 2000, science and technology's importance as production engines has gained much attention in the policy space. Technology outsourcing hotspots have emerged in various parts of the world, giving Ghana signals to pay attention to STEM education to deal with the challenges of low production in the agricultural and industrial sectors (Casad et al., 2017).

2. Purpose of the study

Several authors have asserted that there are leaks in Ghana's pipeline for training and developing girls in STEM fields of study and careers. Against this assertion, this study focuses on reporting some programmes and projects implemented by the Government of Ghana to patch the leaks along the educational pipeline for training females in STEM fields of study or careers.

3. Results and discussion

Reasons for Promoting STEM Education and Training in Ghana

There are many reasons why the world's scientific community has encouraged girls' participation in and contributions to STEM fields of study. Gender-equity reasons alone constitute a strong argument. On several platforms, the United Nations Educational, Scientific and Cultural Organization (UNESCO) (2018) has announced the progress that some developing countries have made in promoting balanced gender participation in STEM programmes of study. In its 2018 Annual Toolkit Newsletter, UNESCO gave the main reason why growing economies must improve the rate of girls' education and participation in STEM fields of study. According to the Organisation, the increased numbers of girls and women at lower levels can potentially be translated into increased numbers at higher employment levels. Still, on the international front, the UNESCO International Symposium and Policy Forum 'Cracking the Code: Girls' Education in STEM, held on 28-30 August 2017 in Bangkok, (proposed that STEM training for females and their representation in STEM careers should be balanced contributions) to economic growth and development. The above indicates that training females in STEM fields to transfer their scientific qualifications into scientific occupations to increase production to the same degree as men have gained international acceptance and must therefore be of much concern to Ghana.

Furthermore, the focus of SDG 5 is to promote gender equality and empowerment of girls and women. Concerning the main focus of SDG 5, UNESCO is poised to remove all forms of discrimination against females and discourage gender-based violence. And also, campaigning against the marriage of underage girls, promoting female involvement in decision-making at all heights, and growing worldwide access to reproductive and sexual well-being (UNESCO, 2017). The African Union (AU) also got involved in the campaign to help to address issues related to gender inequality in many areas of growth and development of nations. In its Agenda 2063, the AU supported teaching and learning institutions in countries in sub-Saharan Africa (SSA) to enrol more girls in STEM subjects to bridge the gender gap in STEM for balanced participation in development (AU, 2015). Following the advice, Ghana has attempted to bridge the gap between males and females to build capacity in STEM training.

Daddieh (2003) observed that several factors constrain progress and access to higher education among Ghanaian women. According to Daddieh (2003), attrition, subject choices for areas of specialisation, and recruitment preferences in higher educational levels have gendered solid motivations. At the basic level, choices for programmes to be studied at the Senior High levels are mainly based on gender-traditional home influences, with more females than males being motivated by their parents and peers (Mastekaasa, Smeby, 2008). For example, the traditional belief that boys are more competent in mathematics-related subjects than girls usually results in more boys moving towards STEM-related subjects (Boateng, Gaulee, 2019). A report by the Global Education Monitoring Team (2018) has emphasised that in Ghana, women go in for less than one-quarter of all Science, Technology, Engineering, and Mathematics (STEM) degrees. Though permitting girls an equal opportunity to read STEM-related subjects is a fundamental right supported by the laws of Ghana (European Commission, 2012; Marginson et al., 2013; Lee, Pollitzer, 2016), there are so many challenges that await the woman, particularly when she has entered the career field and is not supported to combine marriage responsibilities with job demands (Ankoma-Sey et al., 2019).

The UNESCO Institute for Statistics (2022) data on Gender Parity Index (GPI) from 2011 to 2020 for Ghana, presented in Table 1, shows that both males and females have equal access to primary and secondary education. In the case of tertiary education, this access is yet to be achieved, though they have been improvements over the years. As illustrated in Table 1, the parity index on gender difference for the 11 years is below 1 for enrollment into tertiary institutions. GPI below 1 indicates that access to education favours males. Otherwise, access to education favours females if the gender parity index is above 1. Although the index has improved over the years due to some interventional programmes introduced by stakeholders and successive governments, it has not grown to bridge the gap in STEM education since the GPI is less than 1 (equal access to education among females and males).

Table 1. Gender Parity Index (GPI) for School Enrollment at Primary, Secondary and Tertiary (gross) levels in Ghana

YEAR	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
GPI for Primary and SHS Enrollment	0.96	0.96	0.97	0.98	0.98	1.00	1.00	1.00	1.01	1.01
GPI for Tertiary Enrollment	0.62	0.63	0.65	0.67	0.70	0.72	0.73	0.77	0.85	0.90

Source: UNESCO Institute for Statistics (2022).

The gender gaps in Ghana's primary and secondary school enrollments in 2011, 2013, 2015, 2017, and 2019 were 0.96, 0.97, 0.98, 1.00, and 1.01, respectively, indicating differences in the rates at which males and females were admitted to reading STEM programmes were closing up. Again, at the tertiary level, UNESCO Institute for Statistics (2022) observed a narrowed gender disparity in the enrollment of students from 2011 to 2020 (see Table 1). Earlier, Nguyen and Wodon (2013) reported a vast gender disparity in participation in education among people in the age class of 21 to 24 years in Ghana. Furthermore, the authors mentioned that 84.1 % of females, compared to 90.7 % of males, enroll in primary school with a completion rate of 86.5 % for females and 92.7 % for males. Similarly, Nguyen and Wodon (2013) noted that the completion rate of females and males from junior high school was 51.2 % and 65.1 % respectively. Interestingly, according to Dune et al. (2007), before enrolment and completion of education, accessibility is a negotiated gendered process that is a common practice among parents, families, schools, and society at large (Humphreys et al., 2015). Moreover, McClelland and Holland (2015) sum up by saying:

"Not only do women have less probability of getting access to education in Ghana but also have fewer odds of presenting themselves for programmes in STEM as a result of stereotype thinking held over the years.".

Much evidence of females' low involvement in STEM-related subjects in secondary and tertiary education is partially due to the dislike for STEM-related jobs (Xie, Shauman, 2003). That is, it is worthwhile for one to say that few females are in STEM-related occupational areas because relatively few females enrol in STEM-related programmes at the lower levels of study. For this agenda of more girls enrolling in STEM to materialise, more girls must enrol in STEM-related programmes in higher education (Daddieh, 2003; Dunne et al., 2007; UNESCO, 2017). In Ghana, the decision to enroll more females in STEM-related is crucial at the Senior High School (SHS) level. After completion, students are sometimes forced to select a variety of programmes for their further studies at the tertiary level (Boateng, Gaulee, 2019). Extensively, other studies on gender and STEM have been conducted using various populations (female faculty and students already in STEM, including students of both sexes in STEM fields of study and those not in STEM-related occupations) (Acheampong, 2014; Awan et al., 2017; Bahar and Adiguzel, 2016; Boateng, 2017; Boateng, Gaulee, 2019; Edzie, 2014).

Essentially, the key presentations of UNESCO (2017) indicate factors that hinder girls' participation in STEM in Ghana include stereotype thinking, low creation of awareness on the relevance of STEM, gender, and unfavorable insensitivity to the understanding needs of girls during the teaching of STEM-related subjects. Other factors, as identified by UNESCO, were inadequate funds from the government through the gender unit of Ghana Education Service (GES), unclear gender policy guidelines in the education sector, and limited inter-sectoral partnerships among the several government agencies and ministries in promoting STEM training for females. Scholars like Erinosho (2019) have ascribed the low participation of females in STEM to social, biological, and psychological factors. Considering the biological factors, Erinosho (2019) listed issues concerning the phenotypical formation of females in connection with their visual-spatial and analytical skills required for intangible.

The social point of view hinged on the crucial roles of the home, society, and school in indoctrinating females with feminine ideologies (Ankoma-Sey et al., 2019; Erinosho, 2019; Witt and Wood, 2010). These social activities, for some time, manifest in psychological traits (personality) in the form of self-concept, interest and attitude (Moss-Racusin et al., 2012). Thus, the above points have been made to support the that most girls in Ghana are trained to develop emotions, concern, and feelings for nature more than for mechanical associations with physical substances (Erinosho, 2019). The social, psychological, and biological issues display dismal statistics about female engagement in STEM in Ghana. At various educational levels females in STEM bump into a conscious teacher bias due to issues of gender (Moss-Racusin et al., 2012). However, their male counterparts are given greater chances in the education process because of their active participation of teachers (Hall, Sandler, 1982; Johnson, 2007). Of particular concern in the discussion on widening STEM participation are the under-representation of females, racial minorities, and students of low socioeconomic status (SES) (Anderson, Kim, 2006; Herrera, Hurtado, 2011; Schultz et al., 2011).

Position on Attempts to Promote STEM Education in Ghana

In the debate on promoting gender balance in STEM education in Ghana, social critics argue that there is a yearly reflection of a consistent decrease in female representation (Bissell et al., 2003). Others also believe that data insights from industrial and occupational studies show that women's temporary or short-term work rate is greater than that of men (Aikenhead, 2003), citing examples where women are paid significantly less than their male counterparts for the same work done. This problem has been described and endorsed by UNESCO in the Organisation's Annual Toolkit Newsletter for 2018 as the *'leaky educational pipeline'* for developing girls in STEM fields. To confirm the existence of the leaky educational pipeline, Lukas and Mattews (2018) observed it to be steady attrition of girls and women from Science and Technology arenas at primary education levels to tertiary levels and in decision-making for future choices of work. Though Ghana is listed among the developing countries that Aikenhead (2005), Alsop and Watts (2005) have predicted to have a problem *'leaky pipeline'* in promoting gender balance in STEM education, I object to the prediction because there are some exit points in the '*Ghana educational pipeline*' for developing girls for STEM careers fields that are being patched. The following is the discussion on the steps taken by successive Ghana governments to deal with the *'leaky educational pipeline.'*

The first leak identified by social researchers in the field of education, such as Aikenhead (2005), is the deliberate creation of *'gendered trends'* to allow boys to learn STEM subjects and ignore their female counterparts. In line with the above discovery, Clewell and Campbell (2012) conducted a study on approaches to promote gender equity in Ghana and discovered that the preference for male children to pursue STEM subjects is high, particularly in rural communities. After a rigorous gender analysis, Asuma (2017) concluded that the male child is preferred to the female in the first place in traditional Ghanaian societies. We argue that even if the female fetus is fortunate to escape abortion, the social customs of feeding the male child first is enough signal to her to know that they are incapable of dealing with mathematically inclined subjects, which essentially forms a core part of STEM subjects. This assertion, which is primarily supported in many traditional societies, is refutable on the basis that the education of females in STEM-related courses or subjects became an issue of concern for successive governments from the mid-80s and even at present.

It is worth noting that a few decades ago, Ghana was identified as one of the West African countries that made meaningful progress towards increasing access for girls to learn STEM subjects. For example, the National Vision for Girls was implemented in December 1995 after Ghana participated in the Beijing Conference (Fredua-Kwarteng, Ahia, 2005). Afterwards, the country Ghana designed the National Plan of Action (NPA), which led to the establishment of the Girl-Child Education Unit (GEU). This unit was mandated to ensure equity in girls' education regarding access, participation, retention, and achievement in STEM fields (MoE, 2003). In addition, a renewed commitment towards achieving parity in science education was reechoed in the policy Goals One and Ten of the Education Strategic Plan (ESP) (2014–2018) is being followed to provide girls an equal opportunity to read STEM programs at all levels. For example, through the Ministry of Education's collaboration with World Vision, UNESCO, and Campaign for Female Education (Camfed), STEM clinics have been developed in all Tertiary Institutions in Ghana to address the challenges of females pursuing STEM-related degrees. In 2017, the Kwame University of Science and Technology developed a *Science and Mathematics* clinic to address some critical academic challenges of females in pursuing science-related programmes.

The second leak believed to be causing a leak in Ghana's educational pipeline for training girls in STEM fields of study was identified by Armah et al. (2018). In a documentary review, Armah et al. (2018) revealed that teachers have the habit of answering males more often than females in mathematics and pure science classes and pay more attention to females in non-science classes. According to the authors, the practice sent clear signals to girls in the class to find other alternative subjects for themselves. The findings of Armah et al. (2018) are questionable because some programs are designed to sensitise girls to move towards learning STEM subjects for greater career opportunities. To cite a few are the *Robo Competition in Robotics and the Best Data Bundles Program,* designed to improve girls' knowledge in STEM-related courses (Hasan, 2016).

Nonetheless, there is also some evidence that teaching materials, textbooks, and lectures have now been structured to depict S & T as a female domain, making science attractive for girls. Gyedu (2017) writes, 'there is increasing evidence that girls benefit from teaching methods that emphasise the excellent application of knowledge from science and technology domains. Gyedu's (2017) statement support that the leaky pipeline is being patched as girls have been given support through teaching to learn STEM subjects.

Third, analysts in the Educational Resource Administration and Management field have said that the lack of equipment to support girls in learning STEM subjects is one of the clear leaks in the Ghanaian educational system. The UNESCO (2019) Education Statistics Report listed four African countries, including Ghana, that was found to have a serious dearth of "functional laboratories" in most schools in Ghana. The Report showcased some schools without laboratories for practical work. It concluded that the situation forced teachers to largely stick to the theoretical curriculum for teaching STEM subjects (Ministry of Education, 2011). Even though the assertion cannot be rejected entirely, the word 'serious' presents a very high degree of absence of functional laboratories, which can be debated. An examination of Ghana's educational hierarchy, namely junior high, senior high and technical/vocational and tertiary education levels, reveals some practical steps governments took to restore science laboratories.

To substantiate the above, reference can be made to the 76 million pounds approved by the government for the delivery and installation of Basic Science Technology, Engineering and

Mathematics equipment and training to improve the quality of Science and Mathematics Education within the basic education system in Ghana after the government introduced engineering and technology into the syllabus of basic schools. Also, a colossal amount of GHS 88 million was approved by parliament in 2019 and was used for the construction, provision of equipment, and training of trainers for regional science Technology Engineering Arts and Mathematics Centres for the SHS System in Ghana (Mathews, 2019).

Finally, factors such as poverty, traditional cultural beliefs, and traditional gender roles have been advanced to support the argument that the female child has not been promoted in the STEM fields of education. Key among the factors largely advanced against the motion that "females are less promoted in STEM fields of education" is traditional. Critics argue that traditional beliefs have caused many parents to prefer sons to daughters. This stand has been supported by Ananni-Akoller (1999), who has re-iterated that many girls engage in extensive household chores or work in the markets alongside their mothers and care for younger siblings while their brothers attend school to study and play. As a result, if parents have to choose between educating their daughter or son, they will more than likely select their son, who will have access to civil service work compared to his sister's agricultural and informal economy work. Gender-biased curricula in schools train women to be petty traders, farmers, housewives rather than scientists, professionals, and civil service workers. Several females lack role models and mentor teachers to guide them to higher achievement. A lot of them are the first females in their immediate families to attend school, and most of their teachers are male. According to such critics, although they attend school, females are still expected to "perform their everyday family duties such as laundry, cooking, and selling goods in the market" (Ananni-Akoller, 1999).

In connection with the belief in the previous paragraph, Clewell and Campbell (2012) conducted a study on 'Approaches to Promote Gender Equity in Ghana and discovered that the preference for male children to pursue STEM subjects is high, particularly, in rural education settings. In a related study, Asuma (2017) found that the male child is preferred to the female in traditional Ghanaian societies. The author argued that even if the female fetus is fortunate to escape abortion, the social customs of feeding the male child with proper nutritious foods are enough signals to a female child to know that she is less critical. The author pointed out this as a factor affecting the child's self-esteem. To strengthen the argument, Asuma (2017) added many similar examples of demoralising comments about the female child that makes her feel inferior or have reduced self-confidence, which, according to him, is among the reasons why girls are unable to take bold decisions to study STEM subjects. The above incidents commonly found in many traditional societies are refutable because the campaign for promoting girls in STEM subjects that started way back in the mid-80s has yielded some expected results (Asuma, 2017). Much of the results by Asuma (2017) show that the persistent breaks in the implementation of national STEM programmes in Ghana for promoting girls to higher levels in the study of S & T subjects have been detected and are being reversed.

4. Conclusion

In conclusion, several authors have argued that there are leaks in Ghana's pipeline for training and developing girls in STEM fields of study. To the assertion, the above write-up has brought out some programmes and projects against the argument. The contradictory view has been expressed in a discussion that highlighted the major steps taken by the government of Ghana to block the exit points where leaks have been observed while developing girls' skills. Four exit points have been identified, and arguments have been advanced to show that they are being blocked to pave the way for girls to have equal opportunities to develop their skills for STEM occupations.

5. Declaration of Competing Interest

The authors of the manuscript declare that there is no interest in conflict, and all reference materials were dully acknowledged.

References

Acheampong, 2014 – *Acheampong, AB* (2014). Inequality of gender participation of females in STEM disciplines in higher education a case study of KNUST: Ghana (Master's thesis, University of Oslo, Norway).

Adei, 1990 – *Adei, S.* (1990). Technological capacity and aborted industrialization in Ghana: The case of Bonsa Tyre Company. *World Development*. 18(11): 1501-1511.

African Union, 2015 – African Union. Agenda 2063 framework document: The Africa we want. Addis Ababa: African Union Commission, 2015.

Aikenhead, 2003 – *Aikenhead, G.S.* (2003). STS education: A rose by any other name. In R. Cross (Ed.). A vision for science education: Responding to the work of Peter Fensham. New York: RoutledgeFalmer, pp. 59-75.

Aikenhead, 2005 – *Aikenhead, G.S.* (2005). Science-based occupations and the science curriculum: Concepts of evidence. *Science Education*. 89: 242-275.

Alsop, Watts, 2003 – *Alsop, S., Watts, M.,* (2003). Science education and affect. *International Journal of Science Education*. 25(9): 1043-1047.

Amankwah-Amoah, 2016 – *Amankwah-Amoah, J.* (2016). The evolution of science, technology and innovation policies: A review of the Ghanaian experience. *Technological Forecasting and Social Change*. 110: 134-142.

Anderson, Kim, 2006 – *Anderson, E., Kim, D.* (2006). Increasing the success of minority students in science and technology. Washington, DC: American Council on Education.

Ankoma-Sey et al., 2019 – *Ankoma-Sey, V.R., Nsoh, J., Quansah, F.* (2019). Phenomenological experiences of the girl child in accessing technical education in Ghana. *American Journal of Social Science and Humanities*. 4(4): 498-505.

Ankoma-Sey et al., 2019 – *Ankoma-Sey, V.R., Quansah, F., Nsoh, J.* (2019). Determinants of students' enrolment in home economics programmes in senior high schools in Ghana. *European Journal of Education Studies*. 6(4): 339-349.

Armah et al., 2018 – *Armah, A.T, Kumah, F., Sasu, S.* (2018). *Linking STEM education to commercial markets*: Issues and strategies. Secondary Education Series. Washington, DC: Human Development Network, World Bank.

Asuma, 2017– *Asuma, M. (*2017). Education for all gender groups in Ghana? Proceedings of the 8th Symposium of IOSTE (Vol. 1. pp. 292-300). Faculty of Education, Ghana: College of Jackson.

Awan et al., 2017 – *Awan, R., Sarwar, M., Mehdi, M., Noureen, G., Anwar, N.* (2017). Interests and recruitment in science: Factors influencing recruitment and retention in STEM education at University Level in Pakistan. *Bulletin of Education and Research*. 39(3): 19-43.

Bahar, Adiguzel, 2016 – *Bahar, A., Adiguzel, T.* (2016). Analysis of factors influencing interest in STEM career: Comparison between American and Turkish high school students with high ability. *Journal of STEM Education*. 17(3): 64-69.

Bissell et al., 2003 – *Bissell, C., Chapman, D., Herman, C. and Robinson, L.* (2003). Still a gendered technology? Issues in teaching ICT at the UK Open University. *European Journal of Engineering Education*. 28(1): 7-35.

Boateng, 2017 – *Boateng, F.K.* (2017). Unfettering the ball and chain of gender discrimination: Gendered experiences of senior STEM women in Ghana. *Cogent Education*. 4(1): 1418135.

Boateng, Gaulee, 2019 – *Boateng, F.K., Gaulee, U.* (2019). From studentship to academia. *Journal of Underrepresented & Minority Progress*. 3(1): 67-86.

Boso et al., 2013 – *Boso, N., Story, V.M., Cadogan, J.W.* (2013). Entrepreneurial orientation, market orientation, network ties, and performance: Study of entrepreneurial firms in a developing economy. *Journal of Business Venturing*. 28(6): 708-727.

Casad et al.,2017 – *Casad, B.J., Hale, P., Wachs, F.L.* (2017). Stereotype threat among girls: Differences by gender identity and math education context. *Psychology of Women Quarterly*. 41(4): 513-529.

Clewell, Campbell, 2012 – *Clewell, B.C., Campbell, P.B.* (2012). Taking stock: Where we've been, where we are, where we're going. *Journal of Women and Minorities in Science and Engineering*. *8*(3&4): 255-284.

Daddieh, 2003 – *Daddieh, C.K.* (2003). Gender issues in Ghanaian higher education (Occasional Paper No. 36). Accra, Ghana: The Institute of Economic Affairs.

Dunne et al., 2007 – *Dunne, M., Akyeampong, K., Humphreys, S.* (2007). *School* processes, local governance and community participation: Understanding access. In Create Pathway to Access. Research Monogram No. 6. CIE, University of Sussex: CREATE.

Erinosho, 2019 – *Erinosho, S.* (2019). Perspectives on women in science and technology in Nigeria. Ibadan, Nigeria: Bookman.

European Commission, 2012 – European Commission. Meta-analysis of gender and science research: A synthesis report. Luxemburg: Publications Office of the European Union, 2012.

Fosu, Aryeetey, 2008 – *Fosu, A., Aryeetey, E.* (2008). Ghana's post-independence economic growth. The economy of Ghana: analytical perspectives on stability, growth, and poverty. Oxford: James Currey, 36-77.

Fredua-Kwarteng, Ahia, 2005 – *Fredua-Kwarteng, Y., Ahia F.* (2005). Ghana flunks mathematics and science: Analysis (2). [Electronic resource]. URL: http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID= (date of ccess: 18.07.2005).

Global Education Monitoring Team, 2018 – Global Education Monitoring Team (2018). Gender review: Meeting our commitments to gender equality in education. Paris: UNESCO.

Gyedu, 2017 – *Gyedu, A.K.* (2017). Science education for rural Latino/a student's: Course placement and success in science. *Journal of Research in Science Teaching*. 42(4): 376-402.

Hall, Sandler, 1982 – *Hall, R.M., Sandler, B.R.* (1982). The classroom climate: A chilly one for women? Washington, DC: Association of American Colleges.

Hassan, 2016 – *Hasan, O.* (2016). Important but not for me: Students' attitudes towards secondary school science in England. *Research in Science and Technological Education*. 23(1): 41-57.

Herrera, Hurtado, 2011 – *Herrera, F.A., S. Hurtado* (2011). Maintaining initial interests: Developing science, technology, engineering, and mathematics (STEM) career aspirations among underrepresented racial minority students. Paper Presented at the Association for Educational Research Annual Meeting, New Orlean.

Humpherys et al., 2015 – *Humphreys, S., Moses, D., Kaibo, J., Dunne, M.* (2015). Counted in and being out: Fluctuations in primary school and classroom attendance in Northern Nigeria. *International Journal of Educational Development*. 44: 134-143.

Johnson, 2007 – *Johnson, A.C.* (2007). Unintended consequences: How science professors discourage women of color. *Science Education*. 91(5): 805-821.

Lee, Pollitzer, 2016 – *Lee, H., Pollitzer, E.* (2016). Gender in science and innovation as component of inclusive socioeconomic growth. London: Portia Ltd.

Marginson et al., 2013 – *Marginson, S., Tytler, R., Freeman, B., Roberts, K.* (2013). STEM: Country comparisons. Melbourne, Victoria: Australian Council of Learned Academies.

Mastekaasa, Smeby, 2008 – *Mastekaasa, A., Smeby, J.C.* (2008). Educational choice and persistence in male-and female-dominated fields. *Higher Education*. 55(2): 189-202.

McClelland, Holland, 2015 – *McClelland, S.I., Holland, K.J.* (2015). You, me, or her: Leaders' perceptions of responsibility for increasing gender diversity in STEM departments. *Psychology of Women Quarterly*. 39(2): 210-225.

Ministry of Education, 2011 – Ministry of Education. Teaching syllabus for science at junior secondary school. Ministry of Education. Accra, Ghana, 2011.

Moss-Racusion et al., 2012 – *Moss-Racusin, C.A., Dovidio, J.F., Brescoll, V.L., Graham, M.J., Handelsman, J.* (2012). Science faculty's subtle gender biases favor male students. *Proceedings of the National Academy of Sciences*. 109(41): 16474-16479.

Nguyen, Wodon, 2019 – *Nguyen, M.C., Wodon, Q.* (2013). The gender gap in education attainment: A simple framework with application to Ghana. *Journal of International Development*. 26(1): 59-76.

Opoku, 2004 – *Opoku, H.N.* (2004). Policy implications of industrial ecology conceptions. *Business Strategy and the Environment*. 13(5): 320-333.

Schultz et al., 2011 – *Schultz, P.W., Hernandez, P.R., Woodcock, A., Estrada, M., Chance, R.C., Aguilar, M., Serpe, R.T.* (2011). Patching the pipeline: Reducing educational disparities in the sciences through minority training programs. *Educational Evaluation and Policy Analysis*. 33(1): 95-114.

United Nations Educational…, 2017 – United Nations Educational Scientific and Cultural Organisation (UNESCO). (2017). Cracking the code: Girls' and women's education in Science, Technology, Engineering and Mathematics (STEM). Paris, France: Author.

United Nations Educational…, 2018 – United Nations Educational, Scientific and Cultural Organization. (2018). The leaky pipeline of women in physics and astronomy. [Electronic resource]. URL: http://lasp.colorado.edu/~bagenal/WIS/Pipeline.htm (date of access: 11.12.2022)

Witt, Wood, 2010 – *Witt, M.G., Wood, W.* (2010). Self-regulation of gendered behavior in everyday life. *Sex Roles*. 62(9-10): 635-646.

Xie, Shauman, 2003 – *Xie, Y., Shauman, K.A.* (2003). Women in science: Career processes and outcomes. Cambridge, MA: Harvard University.