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Inclusiveness in Science Education: Prospects and Challenges

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ABSTRACT

In recent times, scholars in different fields of science education have been deliberating on educational practices geared towards reducing biases, discrimination and marginalization of some learners due to their peculiarities. This move in education is as a result of widening gap between learners with regards to gender, race, ethnicity, disabilities, among others which has led to underrepresentation, underperformance and reduced social belonging of the minority in Science, Technology, Engineering and Mathematics. This paper focuses on the prospects and challenges of inclusiveness in science education. It also posits that inadequate funding of the education sector has hampered quality delivery and challenged STEM goals over the years. Consequently, products of such education sector are vulnerable to discrimination and prejudice in STEM. It therefore suggests that adequate funding of education should be priority to any government as it will go a long way to take care of other challenges facing STEM such as unconducive environment for diverse groups of learners, teachers' inability to update with current innovations in pedagogy, teaching practices and Information and Communication Technology among others.

Keywords: Inclusiveness, Inclusive Education, Science Education, Prospects, Challenges.

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INTRODUCTION

Education has been one of the major tools for national growth and development over the years (Cleopas, 2018). It is so important that the level of advancement of any nation economically, technologically, socially, among others hinges on level of education of her populace. Hence, quality education has become a yardstick to measuring success and advancement of nations globally. Education is the transmission of knowledge, skills, attitude, values and morals in order to cause a change in behavior of learners. Education is dynamic and following a trend of recent happenings around the world and science has become one of the influencers of education.

Science has received much attention in recent times due to its relevance in knowledge, application and implication to everyday life of individuals, growth and development of society. Everything about life is science. Science feature in our day to day activities. Science is evident in economy, power, health, transportation, agriculture, industries, among others. Science empowers, liberates from errors, biases, prejudice and superstition. The relevance and functionality of science teaching and learning cannot be over emphasized in our age today. The advancement of nations such as America, China, Japan, Germany, Thailand, among others in economy, health, technology, industry and education hinges on science education. Science education is becoming more encompassing than ever. It has moved from teaching and learning mathematics, physics, biology, chemistry and engineering to the art and languages in developed countries in

order to incorporate more learners in the sciences (Platz in LaForce, Noble, King, Century, Blackwell, Holt, Ibrahim & Loo, 2016). Science has become an indispensable tool of technological, scientific, economic, social, growth and development for any nation that would remain relevant and survive now and in the future. Egbunonu and Ugbaja in Obochi (2021) revealed that teaching and learning calls for more than science as a process whereby scientific skills and attitude are learnt but inculcating acquired skills and attitude and combining these skills with reasoning and thinking skills. The effective combination of these skills facilitates life skills such as leadership, social, flexibility, initiative and productivity skills which ensure personal and collective survival, hence, growth and development in the nation. To a great extent, acquisition of knowledge through science teaching and learning and its application for growth and development of any nation and Nigeria in particular is the gateway to economic, entrepreneurial, technological and educational advancement and global competitiveness in the global arena.

The frequency at which knowledge is evolving and increasing and information is racing in the 21st century is quiet alarming and nations have to run fast to catch up with it so as to be abreast with happenings of the time and facilitate national growth and development or be left behind this revolution and get outdated. Before COVID-19, some learners were excluded from education due to one reason or another and after COVID-19, many learners were further excluded due to poverty, sickness, loss of interest, death of loved ones, flood, pregnancy, among others and it is unfortunate to note that many learners are yet to return to the classroom (UNESCO, 2021). The lessons and aftermath of COVID-19 pandemic is real and we have to key into the new normal because the world is not waiting for us. There is a paradigm shift and Nigeria cannot afford to be left behind and no learner should be left behind. Most learners that came back after COVID-19 pandemic are still struggling and yet to find their foot and bearing in academics (UNESCO, 2021). Although teachers are still struggling to bridge the wide gap created by the pandemic, yet the need for inclusive STEM education is paramount.

The term inclusive education is ambiguous because it has many definitions. It focuses on teaching and learning of learners with or without disabilities in the same learning environment. It is the education of learners with special needs or disabilities and regular learners in the same classroom setting. National Science Foundation (2019) defined inclusive education as the integration of women, minorities and persons living with disabilities in STEM and employment. Its aim is to give the same quality of education and opportunities to all learners irrespective of their challenges. It is inclusion of learners in education irrespective of their weaknesses, strength, race, culture, ethnicity, gender, disability, among others. The move for inclusive education is the movement to equip learners for the 21st century technological advancement due to changes in learners, learning styles, science, technology and society. It is the movement of education of the unknown future. The question is who, what, when and how to teach the learners to live in a new world (LaForce et al., 2016). Inclusive education in STEM is an issue of urgency and demands prompt actions due to the speed of global technology economic transformation. The aim of movement for inclusive STEM education across the globe is to improve STEM education and involve more diverse learners into STEM majors and

careers (LaForce et al., 2016). Inclusive STEM education is one of the strategies to improve STEM education, develop learners' interest and achievement by laying more emphasis on STEM subjects, use of modern approaches and innovative strategies (LaForce et al., 2016). This is to capture all learners regardless of their background, demographic, socio-economic status and achievement. National Policy on Inclusive Education in Nigeria (Federal Ministry of Education, 2016) defined inclusive education as the inclusion of the neglected, marginalized, slow learners, passive learners, introverts, physically challenged, psychologically challenged, abused, stigmatized, impoverished, hungry, rural learners, disadvantaged, homeless, drop-out, among others in education.

According to National Science Foundation (2019), learners with disabilities are underrepresented in science and engineering. Kahn, Lanouette, Agyarko, Lee and Wiredu (2021) opined that this unfairness reveals a weakness in commitment and capability to developing talents, interest and opportunities for all learners in STEM. It also shows a neglect of scientists with disabilities to contribute to science. More dehumanizing is the biases in society about "who is able to do science" (Michigan State University, 2019) and who can do science" in school, workplace and so on (Cech & Waidzunas, 2018). Williams, Ernst and Rossi (2021) reported that some countries have implemented the inclusive education in STEM and teachers are faced with increasing number of learners with disabilities in the classroom and more especially, their behavioural challenges. This has also paved way for new experiences as general teachers had to work with special education teachers in order to achieve inclusive education in STEM objectives. UNESCO (2013) reported that gender inequality in science has been a long age challenge to our world. Gender is a social construct that contribute to people's belief, emotions, disposition and manners. Gender related concerns have continued to receive attention in recent times in regards to science education (Ogunleye, 2012). Kembler (2010) reported that science and information and communication technology are not different from culture that has treated female gender unfairly and unequally compared to the male gender. Abdulraheem (2012) reported that gender inequality is interconnected with ethnicity, social status, disability and several factors that influence science. These researchers (Ndioho, 2010; UNESCO, 2013; Ajaja, 2011) opined that issues facing gender in science are manmade, artificial and external. Ndioho (2010) discovered that females exhibit fear and anxiety on science related activity. Obochi (2016) revealed that gender concern both on teachers and students affect science. Furthermore, Adebanjo (2014) also discovered that gender and science are linked with behavioural forms. There can be no social justice when there is gender inequality.

The emphasis on inclusive STEM education is due to the gap the current education program has created by not meeting some groups of learners is worthy of note. Global preparation of learners has increased and accepted in many countries (Montgomery & Fernandez, 2018). According to (UNESCO, 2018), 16 million girls will never see the walls of the classroom, 2/3 of 750 million adults which represent the women folk are without elementary literacy skills. It becomes more worrisome considering the wide margin in access, active involvement and equity in STEM education, hence, the need for inclusiveness in science education.

Benefits of Inclusiveness in STEM Education

Regardless of the challenges in executing Inclusive STEM education, tremendous benefits abound in its successful implementation (Agyemang et al., 2022). Some of the benefits include bridging gender inequality, national growth and development, preparation for the present and unknown future challenges, lifelong education, and relevance in the global arena and improved standard of living of the populace.

- **Bridging Gender Inequality**

Gender inequality in science has been an issue for decades and it is quite worrisome to note that it is phenomenal in society today (UNESCO, 2013). Factors contributing to gender inequality in STEM could be attributed to belief, tradition, culture, society among others (Kahn et al, 2021). According to Fatokun and Idagboyi (2010) science related subjects and courses are termed masculine while commercial and art related subjects and courses are termed feminine. The male gender is seen to be stronger than the female gender but no scientific evidence to show that the male gender is more scientifically intelligent than the female gender (Alordiah, Akpadaka & Oviogbodu, 2015). Studies (NSF, 2019; Ndioho, 2010; UNESCO, 2013) show that females are being discriminated against in science classes and this could have made females to loss interest in science, thus, causing underrepresentation, underperformance of the female folks in science, poor social status and inhibiting growth and development in the nation. A saying goes that, empower the women, empower the nation. So also, gender equality in STEM or better still, more female gender in STEM, more advancement in science and technology which will lead to unprecedented growth and development nationally and internationally. There is need for motivation of females to do STEM in terms of scholarship, bursary, low cut off in securing admission into higher institutions, among others. Motivation and incentives will arouse learners' interest, compel learners to do science, sustain their interest and encourage hard work which will help in producing desired results thereby promoting STEM in the female world.

- **National Growth and Development**

Inclusive education in STEM is a vital tool for eliminating biases, prejudice and discrimination. It will ensure equal representation of all groups of learners such as the vulnerable, disadvantaged, excluded, poor, rural communal and disabled, among others to participate actively in science, economy, technology, growth and development. United Nations (2020) reported that girls and women are excluded from active involvement and biases are pushing them farther away from STEM related jobs. This implies that skills and knowledge from these groups that would have added to economy and advancement of the nation will not be utilized. Inclusive education in STEM gives opportunity to people with different challenges to contribute to science, hence, national growth and development (Kahn et al., 2021). No doubt, when all the groups of learners in our world are fully represented in STEM, there will be more resourceful individuals to make useful

contributions and impact in different sectors such as power, economy and education to the betterment of the nation and the globe at large.

- **Preparation for Present and Unknown Future Challenges**

Considering recent events around the world, new skills and knowledge are required to make life meaningful and to survive and if the present is so challenging, then, there is need to prepare better for the unknown future. The move for inclusive education is significant at such a time like this. Employers of labour and other stakeholders have noted that there are deficiencies of suitable skills and attitude to interact and work proficiently in today's learners (Clark in Agih, Paulley & Offor 2018). Inclusive education recognizes diversity of culture, religion, ethnicity, languages, among others. It embraces access, involvement and equity of learners with different needs. It also, inculcates life skills, social skills, leadership skills, science skills and attitudes which enable learners to solve everyday problems and position them better for unknown future challenges.

- **Lifelong Education**

The changing activities in the work places is driven by technological development as a result of the fourth industrial revolution (World Economic Forum (2018). This requires extensive use of data, figures, machines, robots, Artificial Intelligence and other technologies to accomplish tasks (World Economic Forum (2018). It is crucial for learners to be actively engaged in lucrative ventures after school in order to be more responsible adults. Inclusion exposes learners to life skills which empower learners to be independent thinkers, enterprising, creative, innovative and survive in a dynamic world. It develops digital literacy, entrepreneurial skills, team work, patriotism, critical thinking, and creative skills and provide an intense knowledge of the real world around us which learners can use throughout life. Inclusive education enhances lifelong education by inculcation and acquisition of skills and attitude which learners need for life outside the classroom. Learners are, therefore, engaged in personal development as a result of self-motivation to pursue patriotism and social responsibility. Lifelong education liberates the mind, equip the learners with the 21st century skills and attitude for survival. According to Igwe in Cleopas (2020) lifelong education is a necessity for national survival and hence, the dawn of national transformation. Lifelong education will further enhance peaceful coexistence between individuals, among individuals, communities and nations. National Science Foundation in Cleopas (2020) advocated for the need for a new normal in teaching and learning whereby learning, literacy and life skills would be developed. In support to this, Association of American Colleges and Universities in Cleopas (2020) stated that education should emphasize production of independent and critical thinkers who are purpose driven and link cognitive ability with personal experiences and life after school

- **Relevance in the Global Arena**

Nigeria has been behind current industrial and technological revolution even before the emergence of COVID-19 pandemic (World Economic Forum (2018). The movement of inclusive education in STEM is apt at such a time like this when knowledge is universal and technological advancement around the globe is emerging and moving at

the speed of light. Agyemang et al. (2022) revealed that women have been in the minority group in STEM jobs and over the years, the percentage of females in STEM jobs has not increased. Carr (2013) in Agyemang et al. (2022) reported that ratio of engineers is a woman to seven men. The excluded are denied opportunity to contribute meaningfully to development. Agyemang et al. (2022) opined that should women be given well paid jobs in STEM and prospect for development in STEM, hence, creating an enabling environment for healthy competition in the global arena, innovation and creation of more jobs for sustainable development. The timing Nigerian learners will be better equipped with the 21st century skills and competence that will help them compete favourably with their counterparts in the global arena. The ability to involve the traditionally excluded, speakers of minority languages and bridge gender inequality which contribute to exclusion of learners through recognition of diversity distinctive contributions from different learners will further encourage healthy competition globally by expanding STEM workforce capacity.

- **Improved Standard of Living of the Populace**

STEM education provides one of the best chances to make life meaningful and significant. Inclusive STEM education integrates science, technology, engineering and mathematics into a whole and break biases surrounding them in order to make it easier for learners to learn (Morrison et al. in Agyemang et al., 2022). The United State of Bureau in Agyemang et al (2022) revealed that certification in STEM courses provide more paying jobs which pave room for improved standard of living. It also revealed that women enjoy better pay in STEM jobs than men. An adage put it thus, "educate a woman, you educate a nation". Catalyst Research in Agyemang et al. (2022) opined that it is important to motivate and support females in STEM by ensuring acquisition of relevant knowledge, skills, attitude and gender equity through inclusive education in STEM to help today's learners improve on present standard of living in Nigeria. Due to impact of teaching and learning of STEM, there will be improvement in agriculture, economy, health, power, transport and so on which will thereafter enhance individuals, national growth and development.

Challenges of Inclusiveness in STEM Education

Some of the challenges facing teaching and learning of STEM include inadequate fund, dwindling implementation of inclusive education policy, societal obstruction and lack of training and retraining of teachers (Obera, 2020; Jegede & Owolabi in Cleopas, 2020; Kahn et al., 2021).

- **Inadequate funding**

The issue of inadequate funding of education in Nigeria has been lingering in recent times. Incessant industrial action by different groups of educators due to non-payment of salaries, allowances and others are prevalent in Nigeria. Education in Nigeria is retrogressing in quality and quantity everyday due to lack of fund by the government (Obera, 2020; Akinyemi & Isiugo in Cleopas, 2020). If education without inclusion is not properly funded, how then can inclusive STEM education play out? Fund is a vital tool in ensuring execution of this project. Modification of present educational style to be more

inclusive requires funding to take care of supportive environment, inclusive learning materials, training and retraining of teachers, among others. So, if regular education is experiencing inadequate funding, then, it will be more challenging for inclusive education because it requires more fund due to its peculiarities to accommodate all learners irrespective of their needs.

- **Dwindling Implementation of Inclusive Education Policy**

The teaching and learning of science in most developing countries like Nigeria cannot be compared with learners in developed countries and this could be why developing countries lag behind in terms of science and technology. The function of STEM in developed countries around the globe is evident. Young people are involved in production of simple devices with help of knowledge and skills acquired from teaching and learning of STEM. The inability or partial implement of educational policy has been a prevalent issue to the Nigerian government. Jegede and Owolabi in Cleopas (2020) reported that a wide gap exist between statement of policy and implementation of policy and this has adversely affected education and science in particular. Nigerian Policy on Education (Federal Republic of Nigerian, 2013) stated that, special provisions and incentives in form of allowances shall be made for the study of science at each level of education system. Many teachers are complaining of non-complaint of the government to pay the science allowance for a long time now to enhance teaching and learning of science. National Policy on Inclusive Education in Nigeria was dated 2016 and in 2023, not much has been achieved in terms of inclusive education. Should the government delay in acting out the plan, it will assume the state of former education.

- **Societal Obstructions**

Societal obstructions are blocks such as stigma, discrimination and biases from society that fence out learners with disabilities, minorities and others to make them more excluded from society (Kahn et al., 2021). The recognition of learners with special needs by society is more challenging today. A world where discrimination, biases and prejudice against female and learners with special needs is a concern to inclusive education (Kahn et al, 2021). Teachers, learners, parents, among others, are members of society, whose disposition, emotion, characteristics, among others contribute to learners' interest, attitude and achievement in science. Some researchers (Arokoyu & Chukwu, 2017; Gbore & Daramola, 2013) opined that learners' interest, attitude and achievement in science hinge to a great extent on teachers' attitude to teaching of science. For STEM to be more inclusive today, today's teachers' attitude must be adjusted and improved to suit modern teaching approach. The teacher who is to nurture learners from diverse groups regardless of their peculiarities must be more patient, creative, innovative and shun malpractices in all its form, vulgar languages, use of corporal punishment, gender and all forms of discrimination in science classes.

- **Lack of Training and Retraining of Teachers**

Training and retraining of teachers have long overdue in education sector. Most teachers are outdated in content / pedagogy, Information and Communication Technology (ICT), skills and attitude due to lack of training with new technology. The technical know-how to manage emerging challenges of inclusive STEM education can only be acquired

through training. Williams, Ernst & Rossi (2018) revealed that both general and special education teachers have inadequate training to manage inclusive education in STEM. There is a need for teachers to be well equipped in terms of knowledge, skills, attitude, welfare so as to manage effectively and efficiently the enormous challenges of learners with peculiarities in STEM education (Williams, Ernst & Clark, 2018). Most importantly, opportunity for learning for all must occur in the classroom. However, training and retraining of teachers is a vital aspect to breakthrough of learners of all sort in an inclusive environment.

The Way Forward

Some measures as evident in Literature, for a successful inclusive STEM education include adequate funding of inclusive education, planning of time and STEM lessons, training and retraining of teachers, use of innovative methods, modern teaching approaches and teachers' welfare. These measures are discussed hereunder:

- **Adequate Funding of Inclusive Education**

Education, inclusive education in particular, has huge cost implication especially when quality delivery is at stake. A lot of money is needed to executive the plans on paper. The federal government in partnership with relevant stakeholders should invest more in education, inclusive education in particular in order to catch up with the train of revolution in the globe. There is a saying that says "if you think that education is expensive, try ignorance". Adequate funding will take care of provision of inclusive instructional materials (Reynaga-Peria et al., 2019: Oleary, Shapiro & Toma, 2020), captivating learning environment (Olasehinde & Olatoye, 2014), employment of more regular and special teachers due to high population, among others and solve to an extent a great deal most of the challenges facing education and especially inclusive STEM education.

- **Planning of Time and STEM Lessons**

This is necessary for a successful implementation of inclusive education and practice. Nwosu (2017) opined that effective planning is paramount in achievement of any objectives in education. Mostly, failure of STEM objectives is as a result of poor planning of STEM lessons that lack learners' experiences and real-life situations to drive home main points. STEM classes will be more successful when teachers' positive thinking skill, creativity and innovative skill are weaved into planning STEM lessons. Teachers' preparedness and adequate knowledge in subject matter are significant in facilitating learning (Tatar, Tuysuz, Tosun & Iihan, 2016). Developing real life scenarios, using materials that are common in learners' environment, inculcating learners' everyday experiences into the subject content, questioning, among others, will be helpful in teaching and learning of science to accommodate all categories of learners (Olasehinde & Olatoye, 2014: Oleary et al., 2020).

- **Training and Retraining of Teachers**

Training and retraining of teachers is essential in teaching and learning of STEM as this will keep teachers abreast of latest information and innovative approaches in teaching and learning around the world. Akinwumi & Falemu (2017) opined that training of teachers with better strategies for teaching and learning will be achieved through

conferences, seminars and workshops. Teacher quality cannot be relegated as it is a vital facilitator of learners' achievement. Seminars, workshops and conferences should be given attention by government, stakeholders and teachers so as not to be outdated and ensure quality delivery in education of STEM. Teachers should be involved in professional training to acquire latest skills and attitude to ensure a more inclusive teaching and learning in the 21st century as this will help prepare learners for today and the unknown future in literacy skills, digital skills, competence and life skills so as to make remarkable impact in the global arena. Investing in teachers to be highly skilled in the use of Information and Communication Technology and entrepreneurial skills to work with modified curriculum will further enhance quality delivery in STEM to be more inclusive. Training of teachers to manage diverse learning environment is important. Since both general education and special education teachers are needed, training of both teachers should be such that will enhance teaching and learning of all categories of learners in STEM education. Strengthening teachers' capacity in the new technology for transformation in education to meet with the new trend in education around the world is of utmost importance to meeting with best practices in education and achieving success in today's world. Aina in Cleopas (2018) supported the view that government should schedule courses, workshop, conferences and seminars for STEM teachers to update their knowledge, skills and attitude for result oriented teaching and learning.

- **Use of Innovative Pedagogical Methods and Approaches**

The use of innovative pedagogy for effective teaching and learning in STEM cannot be overemphasized for the 21st century teachers as it will pave way to efficiency and effectiveness which will enhance academic achievement, arouse interest in science, encourage enrolment in science, among others. Practical activities in teaching and learning of STEM make science more real to learners unlike rote learning that makes science more abstract to learners (Nzewi, 2010; Nwagbo, 2010). Innovative methods for STEM lessons include inquiry, phenomenon-based, problem-solving, experimentation, process-based, project, jigsaw and questioning. Teachers should be able to translate theory to practice with methods of teaching that promotes learners' interest, motivation and understanding. The need of novel approaches cannot be over-emphasized in teaching and learning of STEM irrespective of whatever technology we have at our disposal. It is important to deliver lesson effectively and efficiency. Modern teaching approaches entail interesting and thrilling approaches that tilt toward learners' centeredness, activity-based, interactive and meaningful understanding of concepts and ideas. It is highly integrative and inclusive. It revolves around teachers' activities, learners' activities and acquisition of core values. It also involves the use of real life specimen from learners' immediate environment to drive home vital points in the lesson (Neji & Meremikwu 2016; Ntibi & Neji 2018; Falemu & Akinwumi 2021).

- **Teachers' welfare**

The 21st century teachers are faced with many challenges, work in challenging environment and do not have enough support from the government. No nation can rise above her education, as only happy teachers can impact quality education. If teachers' welfare is not critically looked into, there is not much they can do in education. The role

of the teachers has gone beyond impacting knowledge and skills to becoming parents to the orphans, advisers to the confused, coach to navigate the path of life, facilitators, problem solvers and supporters of learners. Before the teachers can teach the hungry, homeless, disturbed, traumatized, abused, challenged, excluded, among others, the teachers must be financially, emotionally and psychologically stable and have met basic needs of life to be in the right frame of mind because the teachers cannot give what they do not have.

CONCLUSION

Education is no more modifying the child to fit in school but modifying itself to accommodate all categories of learners. The issue surrounding the excluded learners such as the disadvantaged and vulnerable is so difficult and complex and has been before COVID-19 outbreak. Nigeria is one of the countries that even before COVID-19 pandemic has not met the Millennium Development Goals (MDG) in education. The challenging situation of inclusion is the ability to cater for all learners irrespective of their peculiarities in the classroom. Education, as a tool for transmission of culture from one generation to the other should embrace culture of inclusion as it strive to achieve its objectives. The urgency of the matter demands quick and prompt response from all stakeholders in and outside the country to partner with the government to build the new today and better tomorrow in STEM education.

SUGGESTIONS

1. Full implementation of policy of inclusive education in order to meet the learning needs of all, irrespective of their peculiarities.
2. Adequate funding of education to unsure the provision of necessary materials and equipment to enhance teaching and learning in order to achieve objectives of inclusive education in STEM.
3. Teachers should be trained and retrained in the use of innovative teaching and learning approaches in inclusive classroom settings, for the benefit of all learners..

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