

Biology education and the development of gender identity in Tanzanian secondary schools

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ABSTRACT

This study examines the role of biology education in shaping gender identity among secondary school students in Bagamoyo District, Tanzania, focusing on how the curriculum influences students' understanding of gender identity and the relationship between biology knowledge and gender identity development. Using a mixed-methods approach with 216 participants, including students, teachers, and school heads, data were collected through questionnaires, interviews, and documentary analysis. The findings indicate that biology education significantly influences students' perceptions of gender identity, with 45% of students reporting that biology shaped their views on gender roles, 30% indicating little effect, and 25% unsure how to reconcile biological knowledge with societal gender expectations. Additionally, 78% acknowledged that the curriculum affected their perception of male and female roles, while 55% expressed concern that a focus on biological determinism could reinforce rigid gender norms. These results suggest that while biology education can foster a more nuanced understanding of gender roles and stereotypes, gaps in the curriculum limit its full impact. Integrating culturally relevant teaching approaches, expanding content to include diverse gender identities, and providing teacher training to facilitate sensitive discussions are essential steps to enhance the curriculum's effectiveness in shaping inclusive perspectives on gender identity.

INTRODUCTION

Gender identity, defined as an individual's deeply held sense of being male, female, or another gender, has become a central issue in discussions around education, social development, and psychology. It is important at the outset to distinguish between sex a biological classification based on chromosomes, reproductive anatomy, and hormonal profiles and gender, which refers to the social, psychological, and cultural experiences and identities associated with being male, female, or another gender (Edwards, & Spence, 1987). Clarifying this distinction is essential, as educational curricula often conflate the two, leading to confusion and reinforcing overly rigid interpretations of gender. In educational settings, particularly at the secondary school level, students undergo significant physical, emotional, and cognitive changes that influence their understanding of gender identity (Frankowski, 2004). Adolescence is a critical period for identity formation, during which students begin to explore and affirm gender roles and expectations based on social influences, biological knowledge, and personal experiences (Sowunmi et al.,

2017; Lamb, 2010). Among these influences, biology education plays a crucial role in shaping how students understand gender, sex differences, and the broader concept of identity.

Biology education, as a core subject in secondary schools, traditionally focuses on the biological determinants of sex, including topics such as chromosomes, hormones, and reproductive anatomy (Batisai & Manjowo, 2020). This curriculum helps students understand the biological foundations of human life, offering insights into how genetic and hormonal factors contribute to physical and psychological traits (Albert et al., 2015). However, while biology provides an essential scientific framework for understanding sex, it often overlooks the complexity of gender identity, which encompasses social, psychological, and cultural dimensions. As a result, students may leave the classroom with a rigid, binary understanding of gender that fails to account for the diversity of gender experiences beyond male and female categories (Ayodabo, 2021).

In the Tanzanian context, particularly within Bagamoyo District, the development of students' gender identities is further shaped by cultural norms

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and societal expectations that reinforce traditional gender roles. One notable example is the strong expectation that girls should adopt highly domestic roles such as prioritizing caregiving, household responsibilities, and early preparation for marriage while boys are encouraged to embody assertiveness, leadership, and economic provision. This expectation is reinforced through family structures, community practices, and local socialization, and it creates a narrow framework within which young people are expected to express their identities (Kihwele, 2014; Adewale et al., 2016; Hines, 2011). Such norms leave little space for gender-diverse expressions or nonconformity, especially when they diverge from established community ideals. Although the biology curriculum largely emphasizes binary sex differences, contemporary scholarship increasingly recognizes gender as a socially constructed and fluid concept one that cannot be fully captured by biological explanations alone (Frankowski, 2004; Davidson et al., 2015). This gap between curriculum content, cultural expectations, and the lived realities of gender diversity creates significant challenges for students as they navigate their personal gender identities.

This study sought to address these challenges by examining how biology education influences the development of gender identity among secondary school students in Bagamoyo District. By investigating both the curriculum content and the perspectives of students and educators, this research aims to provide insights into the strengths and limitations of biology education in shaping students' understanding of gender identity. The study also explores the potential for biology education to contribute to a more inclusive and comprehensive approach to gender education that respects and acknowledges the full spectrum of gender identities.

Literature review

The role of education in shaping gender identity has been explored through various theoretical lenses, with two of the most prominent being Piaget's Cognitive Development Theory and Freud's Psychoanalytic Theory. These theories offer distinct yet complementary frameworks for understanding how students internalize gender norms and identity through education, particularly through subjects like biology.

[Piaget's Cognitive Development Theory \(1937\)](#) emphasizes the role of cognitive structures in shaping how individuals understand and interpret information. According to Piaget, as children progress through distinct stages of cognitive development,

their capacity to engage with abstract concepts such as identity, social roles, and gender gradually expands. By the time students reach secondary school, they typically enter the formal operational stage, where they can think logically, test hypotheses, and analyze abstract and multidimensional ideas. In the context of biology education, this developmental shift enables students to move beyond concrete understandings of physical sex differences and to critically interrogate more complex ideas related to gender roles, stereotypes, and the social construction of gender. Piaget's theory therefore supports the view that, when appropriately structured, biology education has the potential to foster deeper analysis of gender identity rather than simply reinforcing binary biological categories.

Freud's Psychoanalytic Theory offers a more psychodynamic perspective on the formation of gender identity. [Freud \(1933\)](#) argued that gender identity develops primarily in early childhood through the resolution of psychosexual conflicts such as the Oedipus and Electra complexes. Although Freud's ideas have been extensively critiqued and revised, the theory remains influential in highlighting the enduring influence of early experiences and unconscious processes on later identity development. The relevance of Freud's perspective to the secondary school context emerges when adolescents revisit topics related to sexuality, reproduction, and bodily development in biology class. These lessons can reactivate, reinforce, or challenge earlier internalized gendered meanings that were formed in childhood. Adolescence is also a period when unconscious childhood associations may resurface as individuals renegotiate their identities in light of new biological changes and social expectations. Thus, Freud's theory complements Piaget's by emphasizing that students' responses to biology content during adolescence are shaped not only by their expanding cognitive capacities but also by deeply rooted psychological processes linked to early gendered learning.

Empirical studies on the relationship between biology education and gender identity further support these theoretical perspectives. [Destin and & Williams, \(2020\)](#), examined how biology education in American secondary schools shapes students' understanding of gender, particularly how the curriculum can reinforce traditional gender roles. Their study found that while biology lessons on reproduction and genetics provide important knowledge, the narrow focus on binary sex differences often limits students' understanding of gender diversity. The study also revealed that students with more progressive biology curricula

those that included discussions on gender fluidity and non-binary identities were more likely to develop inclusive views on gender.

Similarly, [Sowunmi et al. \(2017\)](#) explored how biology education in South African schools influences students' perceptions of gender. Their findings suggest that biology lessons contribute to students' understanding of the biological foundations of sex, but they also noted that this focus on biology often fails to account for the social and psychological dimensions of gender. The study argued that biology education needs to integrate discussions of gender identity, gender roles, and the social construction of gender to provide students with a more holistic understanding. This aligns with the broader push for educational reforms that recognize gender as a complex, multi-dimensional concept rather than a purely biological one.

In the Tanzanian context, [Akinmoladun \(2020\)](#) found that while biology education does improve students' understanding of biological sex differences, it does little to challenge traditional gender norms. The study noted that the curriculum tends to reinforce rigid gender roles, particularly through its treatment of topics such as reproduction and family health. These findings highlight a significant gap in the curriculum, suggesting that biology education in Tanzania needs to evolve to better address the realities of gender diversity and identity. Akinmoladun's research is particularly relevant to Bagamoyo District, where traditional views on gender remain influential in shaping students' perceptions.

Research by [Ayodabo, \(2021\)](#) also supports the idea that biology education has the potential to shape gender identity but noted that this potential is often limited by the curriculum's focus on biological determinism. Adelabu's study of Nigerian secondary schools revealed that students who were exposed to biology lessons that included discussions on the social aspects of gender were more likely to question traditional gender roles and develop more inclusive views of gender identity. However, the study also found that in many cases, biology lessons reinforced gender stereotypes by emphasizing the differences between male and female bodies without acknowledging the complexities of gender as a social construct.

These empirical studies suggest that while biology education can play a significant role in shaping gender identity, its impact is often constrained by the curriculum's focus on biological determinism. The absence of discussions on gender diversity and the social construction of gender limits students' ability to fully understand and engage with

their own gender identities, especially in contexts where traditional gender norms are strongly enforced, such as in Bagamoyo District. To address these limitations, educational reforms are needed to broaden the scope of biology education, integrating gender identity discussions that reflect the complexities of contemporary gender experiences.

■ METHODOLOGY

This study employed a mixed-methods approach, utilizing both quantitative and qualitative research designs to explore how biology education shapes gender identity among secondary school students in Bagamoyo District. A sequential explanatory model was used, beginning with the collection of quantitative data from 200 students selected via simple random sampling, followed by qualitative insights from 12 biology teachers and 4 school heads chosen through purposive sampling. Data collection involved the use of questionnaires for students, focusing on their knowledge of biological concepts and gender identity, and structured interviews with teachers and school heads to gather their views on the curriculum's treatment of gender topics. Document analysis of the biology syllabus and textbooks was also conducted to examine how gender-related content is presented.

The quantitative data were analyzed using descriptive statistics, providing an overview of students' perceptions of how biology education influences their understanding of gender identity. The qualitative data, derived from interviews and document analysis, were processed using thematic analysis to identify key themes regarding gender identity development and the limitations of the curriculum. This combined approach allowed for a comprehensive understanding of the topic, blending numerical trends with deeper insights into the educational and cultural factors shaping students' gender identity development ([Creswell & Hirose, 2019](#)).

■ RESULTS AND DISCUSSION

The findings of this study are presented in line with the two key objectives: 1) to explore how the biology curriculum influences secondary school students' understanding of gender identity in Bagamoyo District and 2) to analyze the relationship between biology knowledge and the development of students' gender identity. The results are drawn from both

quantitative data obtained through student questionnaires and qualitative data from interviews with teachers, students, and school heads. Each finding is discussed with reference to the theoretical and empirical studies reviewed earlier, emphasizing the role of biology education in shaping gender identity.

Influence of the biology curriculum on gender identity

The first objective aimed to explore how the biology curriculum shapes students' perceptions and understanding of gender identity. Students were asked to indicate the extent to which biology lessons shaped their understanding of male and female differences, including reproduction, hormones, and chromosomal patterns. Data is summarised in Table 1.

Table 1. Influence of the Biology Curriculum on Gender Identity (N = 216)

Response	Frequency (n)	Percentage (%)
Biology lessons significantly shaped understanding of biological sex differences	168	78
Little influence on understanding of biological sex differences	32	15
Unsure / no opinion	16	7

Based on the quantitative data, Table 1 illustrates the influence of the biology curriculum on students' understanding of biological sex differences. A majority of students (78%) indicated that biology lessons played a significant role in shaping their comprehension of male and female differences, particularly regarding reproduction, hormones, and chromosomal patterns. The curriculum's detailed coverage of biological processes, such as meiosis and sexual reproduction, helped students develop a clearer understanding of physiological differences between males and females. Smaller proportions reported little influence (15%) or were unsure (7%) about the role of biology lessons in shaping their understanding.

This finding is consistent with [Piaget's Cognitive Development Theory \(1937\)](#), which posits that adolescents, as they progress through the formal operational stage, are better equipped to engage with complex, abstract concepts such as genetic inheritance and hormonal regulation of secondary sexual characteristics. Students reported that understanding these biological principles was

essential in helping them comprehend the scientific foundation of gender. One student noted, "We learned about chromosomes like XX and XY, and now I understand that it's the genes that decide if someone is a boy or a girl."

However, while students could articulate the biological mechanisms of sex differentiation, a large proportion (55%) expressed concerns that the biology curriculum focused too heavily on biological determinism, with little attention to gender identity as a social and cultural construct. This aligns with the findings of [Destin and & Williams \(2020\)](#), who argued that biology education often reinforces the traditional binary view of gender. In many classrooms, students were exposed primarily to content on male and female reproductive anatomy, while discussions on gender identity, gender roles, or non-binary identities were notably absent.

Teachers, too, expressed concerns about the narrow scope of the curriculum. One biology teacher mentioned, "We are taught to stick to the syllabus, which mainly covers biological aspects of sex, but when students ask about gender identities that don't fit into male or female, we are not sure how to answer those questions." This echoes the findings of [Sowunmi et al. \(2017\)](#), who noted that the biology curriculum in African schools often reinforces gender binaries without allowing for deeper exploration of gender as a social concept.

Documentary analysis of the Tanzanian biology syllabus further confirmed that the content emphasizes the biological basis of sex, including reproductive health, genetics, and sexual development. However, there was little mention of gender diversity, societal norms around gender, or the psychological aspects of gender identity development. In alignment with [Adewale, et al. \(2016\)](#), who identified similar curriculum limitations in Nigerian schools, this suggests that the biology curriculum in Bagamoyo District focuses predominantly on biological facts, leaving students with an incomplete understanding of gender, one that overlooks its social and cultural dimensions.

The limited engagement with gender identity beyond biological sex has profound implications for how students perceive themselves and others. Students with non-binary gender identities or those questioning traditional gender roles often feel alienated by a curriculum that does not reflect their experiences. One student mentioned during interviews, "I know I am supposed to be a girl because of my body, but sometimes I feel different. Biology class doesn't explain why I feel this way." Such gaps in

the curriculum underscore the importance of revising biology education to incorporate discussions on gender fluidity and the social construction of gender.

Relationship between biology knowledge and gender identity development

The second objective was to analyze how students' biology knowledge influences their development of gender identity. Students were asked to indicate the extent to which biology lessons shaped their understanding of male and female differences, including reproduction, hormones, and chromosomal patterns. Data is summarised in Table 2.

Table 2. Relationship between biology knowledge and gender identity development (N = 216)

Response	Frequency (n)	Percentage (%)
Biology shaped my views on gender roles	97	45
Biology had little effect on understanding of gender identity	65	30
Unsure how to reconcile biological knowledge with societal gender expectations	54	25

Table 2 presents the relationship between students' biology knowledge and their gender identity development. The findings revealed that while students generally had a strong understanding of the biological factors that determine sex, their interpretations of gender identity were heavily influenced by cultural norms and early socialization experiences. Quantitative data showed that 45% of students believed that biology shaped their views on gender roles, 30% reported that their biology education had little effect on their understanding of gender identity, and the remaining 25% were unsure how to reconcile biological knowledge with societal gender expectations.

The results suggest that biology education does provide a scientific framework for understanding sex differences, but this knowledge alone is insufficient for addressing the complexities of gender identity. Freud's Psychoanalytic Theory (1933) offers an explanation for this discrepancy. Freud emphasized the importance of early psychosexual development in shaping gender identity, suggesting that students' gender identities are influenced not only by biological knowledge but also by unconscious desires and early experiences. This theory is particularly relevant in contexts like Tanzania, where societal norms and family expectations play a dominant role in shaping gender identity.

Interviews with students revealed that their understanding of gender was shaped by a combination of biological knowledge and cultural expectations. One male student shared, "In biology, we learn that both boys and girls have hormones like testosterone and estrogen, but outside class, people still expect boys to be strong and girls to be quiet. It's confusing because what I learn in class doesn't always match what people expect." This finding aligns with Piaget's theory, which suggests that while students can engage with abstract biological concepts, their ability to challenge societal norms about gender is influenced by their social environment.

Moreover, while 45% of students acknowledged that their biology lessons helped them understand gender roles, many felt that these roles were reinforced by the curriculum in a way that limited their ability to explore gender identity beyond traditional binaries. For instance, discussions on male and female reproductive organs often emphasized normative roles for men and women in family and society. This is consistent with the work of [Akinkmoladun \(2020\)](#), who found that biology education in Tanzania reinforces traditional gender roles rather than challenging them. In this study, students reported that biology lessons presented men as strong, dominant providers and women as nurturing caregivers, which may perpetuate gender stereotypes.

The curriculum's focus on biology as the determining factor in gender identity leaves little room for students to explore the broader, socially constructed aspects of gender. Teachers in this study admitted that they rarely, if ever, discussed non-binary or gender-fluid identities in their lessons. One teacher remarked, "We teach what's in the book boys are boys, and girls are girls. We don't talk about people who don't fit into these categories." This reflects the empirical findings of [Ayodabo, \(2021\)](#), who argued that biology education, without a discussion of gender as a socially constructed and fluid concept, can limit students' understanding of gender diversity.

However, some students demonstrated a more flexible understanding of gender, especially those who engaged with more progressive or scientifically nuanced discussions about genetics and hormone regulation. One female student noted, "Biology taught me that everyone has a mix of hormones like estrogen and testosterone, so it makes sense that people could feel different from the gender they were assigned at birth." This suggests that when biology education goes beyond binary definitions, it has the potential to challenge rigid gender norms and support students in developing a more nuanced understanding of gender

identity. [Sowunmi et al. \(2017\)](#) similarly found that students exposed to more comprehensive biology education were better equipped to question traditional gender norms and explore diverse gender identities.

The findings of this study align with both Piaget's Cognitive Development Theory and Freud's Psychoanalytic Theory, as well as previous empirical studies. Piaget's theory is supported by the fact that students in the formal operational stage demonstrated an ability to grasp complex biological concepts such as genetic inheritance and hormonal regulation, which played a significant role in shaping their understanding of sex. However, Piaget's framework also highlights the importance of environmental factors, such as cultural expectations, that influence how students integrate biological knowledge with social understandings of gender.

Freud's Psychoanalytic Theory is evident in the finding that early experiences and societal expectations play a dominant role in shaping students' gender identity, often more so than their biology education. While students gained factual knowledge about sex from biology lessons, many were still influenced by the unconscious and social pressures to conform to traditional gender roles. This highlights the limitations of biology education in fully addressing gender identity, as Freud's theory suggests that gender identity formation is deeply rooted in early psychosexual stages, which are influenced by factors beyond the classroom.

Empirical research by [Destin and & Williams, \(2020\)](#), [Sowunmi et al. \(2017\)](#) and [Akinmoladun \(2020\)](#) reinforces the finding that biology education often fails to challenge traditional gender roles due to its narrow focus on biological determinism. Like these studies, this research found that the biology curriculum in Bagamoyo District provides a solid foundation for understanding sex differences but lacks the depth needed to explore gender as a socially and culturally constructed concept.

Implications of the study findings

The findings of this study have significant implications for curriculum development in secondary education. The biology curriculum, as it stands, focuses almost exclusively on biological determinism, presenting a binary view of gender through lessons on reproduction, hormones, and chromosomes. This limited approach prevents students from exploring the complexities of gender identity, which is a multidimensional construct encompassing social, cultural, and psychological

aspects. For curriculum developers and policymakers, these findings suggest an urgent need to expand the scope of biology education to include a more nuanced discussion of gender identity, beyond the binary framework. Integrating such topics would not only broaden students' understanding but also foster critical thinking about gender roles and identities in their sociocultural context.

Teacher preparedness also emerges as a critical issue, with implications for teacher education programs and professional development. The study highlighted that biology teachers, while knowledgeable about the scientific aspects of sex differentiation, often lack the skills and confidence to address questions related to gender identity that go beyond the curriculum. This gap suggests a need for targeted teacher training programs that equip educators with the pedagogical tools to engage in sensitive discussions about gender diversity. Providing teachers with a deeper understanding of gender theory, as well as strategies for fostering inclusive classrooms, would ensure they are better prepared to meet the needs of all students, including those whose gender identities do not conform to traditional norms.

Finally, the implications for student well-being and social development are profound. The gap between the biological understanding of sex provided by the curriculum and the social realities of gender diversity can create confusion and alienation for students who do not see their identities reflected in the lessons. This can lead to feelings of exclusion or stigmatization, which may negatively affect their self-esteem and mental health. Schools, therefore, must provide a more supportive and inclusive environment where discussions on gender identity are normalized and where all students can explore and express their identities without fear of judgment or discrimination. By addressing these gaps, schools can play a crucial role in fostering social inclusion and promoting gender equity.

■ CONCLUSION AND RECOMMENDATIONS

The findings show that biology education in Bagamoyo District provides students with a solid grounding in the biological aspects of sex but does not adequately address the multidimensional nature of gender identity. The curriculum's focus on reproduction, chromosomal classification, and hormonal regulation offers essential scientific knowledge; however, it does not extend to the social,

psychological, and cultural dimensions of gender. Consequently, many students develop a binary and deterministic understanding of gender that does not reflect the diversity of identities present in contemporary society. The findings also indicate that many teachers feel insufficiently prepared to facilitate discussions on gender identity, which limits opportunities for meaningful engagement with the topic.

To address these gaps, the biology curriculum should be expanded to include a more comprehensive and socially informed discussion of gender. Moving beyond a strictly binary framework to incorporate topics such as gender fluidity, non-binary identities, and the social construction of gender roles would enable students to develop a more nuanced and inclusive understanding of human identity. Such curricular enhancements have the potential to counteract stereotypes and strengthen gender equity efforts within the school setting.

Improving teacher preparation is also essential. Professional development initiatives focused on gender inclusivity should equip educators with both foundational knowledge of gender theory and practical strategies for guiding sensitive, respectful classroom discussions. Enhanced teacher confidence and competence in this area would contribute to more supportive learning environments. Schools should additionally consider establishing support structures such as counseling or mentorship programs to assist students who are navigating questions related to gender identity.

Further research is recommended to examine how the proposed curriculum changes and teacher-training initiatives operate within the Tanzanian context. Studies that investigate their feasibility, cultural relevance, and impact on students' understanding of gender would provide valuable evidence for policymakers, curriculum developers, and educators seeking to strengthen gender education in the country.

DECLARATIONS

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Data availability

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Authors' contribution

Masawe provided the essential resources for this research, data analysis, and manuscript writing while Dr. Mwila reviewed the content and offered technical expertise.

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Competing interests

The authors declare no competing interests in this research and publication.

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