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The integration among policy, curriculum, and classroom practice in Ethiopian education: Emerging evidence for improving student learning

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Abstract

In this issue, the Bahir Dar Journal of Education features studies that examine the intersections of educational policy, curriculum, teacher practice, and student learning outcomes in Ethiopia. The articles address key issues, including the alignment between constitutional and education policy provisions on language use, the integration of information and communication technologies in teacher education, and the role of core instructional practices in promoting early-grade literacy. Additional contributions investigate the quality and problem-solving orientation of science textbooks, the application of motivational and engagement theories in science and mathematics classrooms, and the effects of innovative pedagogies—such as problem-based scenarios and guided discovery—on students’ critical thinking, motivation, and achievement. Collectively, the studies highlight the need for coherence between policy and classroom practice, the use of evidence-based instructional strategies, and contextually responsive curriculum development. The findings affirm that student success depends not only on sound policies and resources but also on their effective implementation in everyday teaching.

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Introduction

Ensuring that students not only attend school but also gain meaningful learning remains a central concern for educators and policymakers in Ethiopia. Over the past decades, significant efforts have expanded access to education and introduced reforms in language instruction, curriculum design, and teacher preparation. Yet, research indicates that greater enrollment has not always led to corresponding improvements in learning outcomes (World Bank, 2018; UNESCO, 2003). Bahir Dar journal of Education in this issue presents articles with diverse range of topics. The articles emphasized on the language issues in the education

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and training policy, curriculum development, teachers' instructional practice from early grade level to colleges, and the effect of these aspects on the students' development.

Educational policies set the foundation for learning, but their effectiveness depends on how they are implemented in schools. Initiatives such as Ethiopia's multilingual education policies and large-scale quality improvement programs have contributed to greater access and raised awareness about learning quality (Heugh et al., 2007; Tonegawa, 2025). Research on language instruction also indicates that students receiving early education in their mother tongue tend to achieve stronger literacy and broader academic outcomes than peers who switch to English too early (Daniel & Abebayehu, 2006; Ronny, 2006)

Nevertheless, when materials, teacher preparation, and practical guidance are insufficient, these policies' intended benefits are often limited (Bekalu, 2025; Fadil & Mulugeta, 2024). Historical reviews of Ethiopian education also identify persistent challenges, including teacher shortages, inconsistent curriculum quality, and limited professional support (Semela, 2014). Such evidence underscores that policy alone is not enough; adequate support systems are necessary to help teachers translate reforms into effective classroom practice.

Teachers' classroom practice remains the most immediate factor shaping what students learn. Evidence shows that structured teaching, formative assessment, and ongoing feedback strongly influence students' literacy and overall academic performance (Ayele et al., 2019; Tadesse et al., 2024). However, many classrooms continue to rely on teacher-centered approaches, limiting opportunities for discussion, inquiry, and problem-solving (Debeli et al., 2025; Faro et al., 2025). In science classrooms, the lack of practical activities and lab-based learning reduces students' engagement and understanding of key concepts (Ozdem-Yilmaz & Bilican, 2020).

Studies revealed that approaches such as problem-based learning and guided discovery, and formative assessment enhance engagement, motivation, and critical thinking (Darling-Hammond et al., 2020). In Ethiopia, these strategies are particularly effective when teachers are trained and supported appropriately. Problem- and inquiry-based methods in science classrooms, for example, help students develop conceptual understanding and higher-order thinking (Ageze et al., 2022; Brhane et al., 2025; Zeleke et al., 2022). Similarly, self-determination theory suggests that students who feel competent, autonomous, and connected to their learning community demonstrate higher engagement and achievement (Ryan & Deci, 2020; Ryan, & Deci, 2017).

While technology can support learning, Ethiopian classrooms often face challenges, such as limited digital infrastructure, low teacher digital literacy, and uneven access to training (Merga et al., 2024; MoE, 2022; Yizengaw & Nigussie, 2023). This highlights the importance of combining innovative teaching approaches with system-level support to maximize their impact.

Insight from studies in this issue underscores the need for alignment. When policies, curricula, and classroom practices work in harmony, students are more likely to succeed; when they are disconnected, reforms often have limited effect (Bekalu et al., 2024; OECD, 2018). In Ethiopia, improving alignment means designing policies informed by classroom realities and providing ongoing support for teachers implementing new curricula and instructional strategies. Collaboration among policymakers, teacher educators, school leaders,

and researchers ensures that reforms are evidence-based and contextually relevant (Fullan, 2016). It has to be noted that achieving such alignment is an ongoing process of reflection and adaptation, not a one-time effort. The articles presented here provides guidance on both the challenges and opportunities for creating a coherent educational system that promotes meaningful learning.

Thus, this issue of Bahir Dar Journal of Education brings together a compelling collection of studies that illuminate the dynamic relationships among educational policy, curriculum materials, teacher practice, student motivation, and learning outcomes within the Ethiopian context. Collectively, the contributions underscore a central message: meaningful educational improvement requires coherence across policy frameworks, instructional design, and classroom implementation.

At the policy level, Bekalu Atnafu Taye critically examines inconsistencies between the Constitution and the 2023 Education Policy regarding language issues. His analysis highlights tensions between constitutional provisions and policy directives, raising important questions about national unity, political influence, and the need for education policy to operate within stable constitutional principles. The study serves as a timely reminder that educational reform must be anchored in legal and societal coherence.

Bridging policy and practice, Adane Sifer, Getachew Sime, Mulugeta Yayeh Worku, and Girma Tilahun explore ICT integration among biology teacher educators in southern Ethiopian colleges. While a strong majority of educators recognize the pedagogical value of ICT for teaching complex biological concepts, actual classroom utilization remains inconsistent. Structural challenges—including limited access, insufficient training, and inadequate pedagogical support—underscore the gap between technological aspiration and instructional reality. Their findings call for systematic capacity-building efforts to ensure that technology meaningfully enhances teaching and learning.

At the classroom level, Tsegaye Girma, Marew Alemu, and Selomie Zewdalem provide robust empirical evidence on the predictive power of teachers' core instructional practices in early-grade Amharic reading achievement. Their findings demonstrate that effective planning, classroom management, and assessment substantially influence literacy outcomes, reinforcing the foundational role of teacher quality in early learning. Although phonemic awareness showed weaker associations, the overall results affirm that structured instructional practices are central to literacy development.

Curriculum quality is further interrogated by Derejaw Yesgat Woldemariam and Solomon Melesse Mengistie, who evaluate the Grade Eight General Science textbook through the lens of problem-solving skill development. While the textbook incorporates collaborative strategies and graphic organizers, it remains largely confined to lower-order cognitive objectives and lacks sufficient real-life contextualization and metacognitive scaffolding. Their analysis signals the need for curriculum revision that promotes higher-order thinking and authentic problem-based learning.

Similarly, motivation and engagement emerge as cross-cutting themes in several contributions. Alemayehu Berhanu and Tesfaye Semela apply Self-Determination Theory to Ethiopian science and mathematics classrooms, providing empirical support for the role of teacher support in satisfying students' psychological needs, which in turn enhances

engagement and academic achievement. Their structural modeling highlights the mediating role of engagement, reinforcing the importance of need-supportive instructional climates.

Finally, Kiros Tareke Nigussie, Bizuayehu Kerisew Semahagn, Baye Sitotaw Mersha and Alemayehu Bishaw Tamiru demonstrate the effectiveness of paper-based problem scenarios in strengthening critical thinking skills in secondary biology classrooms. Their mixed-methods findings indicate significant gains in students' higher-order reasoning, suggesting that structured, scenario-based approaches can cultivate analytical competencies essential for scientific literacy.

Taken together, the studies in this issue offer converging evidence that improving student learning in Ethiopia requires: alignment between constitutional principles and education policy, contextually responsive curriculum reform, sustained professional development and instructional support, and pedagogical approaches that nurture motivation, engagement, critical thinking, and problem-solving.

By addressing systemic challenges while presenting empirically grounded innovations, this issue contributes valuable insights for policymakers, curriculum developers, teacher educators, and classroom practitioners committed to strengthening instructional quality and advancing equitable, evidence-based education in Ethiopia.

Generally, the studies in this issue demonstrate how closely intertwined policy, curriculum, and classroom practice are in shaping student learning in Ethiopia. Improving outcomes requires more than simply increasing access to schooling—it demands coherent policies, well-supported teachers, and instructional practices that actively engage students. Therefore, we believe the January 2026 issue will contribute meaningfully to advancing quality education by highlighting research on language policy, teacher practice, instructional innovation, and student achievement, this issue contributes to the ongoing conversation about how to strengthen educational quality. We hope that these insights will guide policymakers, educators, and researchers in efforts to improve learning outcomes for all Ethiopian students.

To end, we would like to express our sincere appreciation to the authors, reviewers, and editors whose dedicated efforts made this issue possible. Your strong commitment to expanding knowledge and improving education is greatly valued. Through our collective efforts, we can foster meaningful progress and enhance the quality of education in Ethiopia and beyond. We are grateful for your important role in this endeavor.

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The inconsistency between the constitution and the education and training policy document on language issues

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The objective of this article was to scrutinize a policy contradiction between the Education Policy Document and the Constitution. Having this objective, the researcher used a case study design which analyzed a particular case using secondary data, such as constitutional and policy documents and published articles. The findings revealed that the 2023 Education Policy stands in sharp contrast to the Constitution and the Ethiopian Education Roadmap, and it might pose a significant threat to the nation's unity. This might happen due to the fact that the Education Policy Document was crafted within an ethnically influenced political context. The Ethiopian Education Policy needs to operate without the control of political decisions.

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Introduction

The influence of the Western world is so pervasive that many non-Western countries find it difficult to visualize education outside of the Western frame of thought. Owing to this, the legacy of Western colonization has eroded indigenous cultural values. The policies aimed at molding African minds by negating their native values and knowledge and substituting them with European values which were accepted as superior appears prevalent (Annamalai, 2005). Although the World Bank, OECD, and other international agencies continue to pursue the re-Westernization project and the neo-liberal education agenda associated with it, many education researchers and policymakers have challenged this “new” policy regime for imposing Western-centric lens to understand education across different contexts (Silova et al., 2020). Like other ancient nations, Ethiopia may have overlooked the value of incorporating its own ancient scholarly heritage into a more diverse and representative system. As a historically significant nation with strong values, Ethiopia should uphold its traditional values. In this regard, Messay (1999) argues that the only way out for countries like Ethiopia is to anchor modernization on the traditional values and beliefs of the Ethiopian people.

One of the traditional values of the country is its linguistic richness, well over 80 languages along with about 200 dialects thereof. In this regard, Tekeste (2006) states that the most viable strategy for the reconstruction of Ethiopian education is the use of national languages as medium of instruction at all levels of education including at the university level. It is a fact that no developed country has developed on the basis of using a foreign language,

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since development involves the participation of all citizens in nation-building. Batibo (2005) clearly argued that the fast-developing countries of Asia, such as China, Korea, Taiwan, Malaysia and Thailand, base their development strategies on their indigenous languages as this is the only way to involve the whole population in the development effort and to meaningfully bring about technological advancements within the country's cultural framework.

Using indigenous languages for medium of instruction (MoI) could influence the atmosphere of the classroom. Higher mental processes have their origin in social processes (Driscoll, 2005) and learning takes place through social interaction. Considerable number of studies supports the notion that teacher-student interaction is indispensable for better academic achievement of students. If students do not use English to communicate, students avoid engaging in classroom discussion, an effect sometimes described as 'silencing by English' (Annamalai, 2005). This showed that using indigenous languages for classroom instruction may potentially support students' understanding of the subject content by fostering classroom interactions.

Thus, the policy implications of using home language or working language as the medium of instruction in higher education institutions, where English is the language of instruction, should be considered (Bekalu et al., 2023). This is because the use of learners' home language or working language in the classroom has the potential to make learners be involved in the learning process and enhance learning. However, there is no a single country in sub-Saharan Africa that uses an African language as the language of instruction at secondary or tertiary level except South Africa's use of Afrikaans in some universities (Brock-Utne, 2015).

Parents have been concerned that the policy of ethnocentrism which encourages the use of only local languages might negatively affect their children if they are unable to speak Amharic or English, which might cause them to fail the Grade 8 regional examinations (Benson et al., 2012). Even the researchers' visits to rural schools in the regional state of Oromia revealed that Amharic is not well understood by many learners and by some not at all (Benson et al., 2012). In the Ethiopian context, regional states are allowed to use their own vernacular languages. In the process, the unifying agent, a lingua franca, has been missing. Thus, as students progress into higher learning institutions, they do not find a common language among themselves for communication. Due to this, members of many ethnic groups regret their inability to communicate in Amharic when they go to large cities like Addis Ababa (Bekalu, 2019). Being sympathetic to Ethiopian students, Küspert-Rakotondrainy (2014) stated that students may suffer from the lack of political strategies, as they undoubtedly need a thorough knowledge of Amharic for any kind of formal employment. This happened because the measures taken by the government on language issues are often more informed by political and ideological considerations than strictly educational ones (Ferguson, 2012; Daniel & Abebayehu, 2006). Owing to this, people have been observed lamenting their failure to speak the language that serves as a bridge among the population of well over a hundred million (Bekalu, 2019). With regard to the importance of using Amharic as a lingua franca, Tekeste (2006) stated that as a trans-ethnic medium of communication, teaching Amharic only as a subject is not sufficient. Amharic needs to be used as a medium of instruction across the country. In this regard, Benson (2010) noted that Ethiopia does the

best job of using mother tongues to promote literacy and learning, but misses opportunities to use bi- or multilingual methodologies and to maximize the effectiveness of L2 Amharic. In a similar manner, Tekeste (2006) also expressed his surprise as to why Ethiopian governments, especially in the last 30 and 35 years, did not make use of the country's rich tradition in literacy and develop the Amharic language to be used in secondary education.

Beyond these empirical findings, numerous studies have also shown that families have been known to move from mother-tongue areas to cities where classes are taught in Amharic (Trudell, 2016). Urban populations from all language backgrounds also demonstrate a marked tendency to shift to Amharic, often losing the language spoken by their parents (Cohen, 2005). For example, parents from Sheger cities near Addis Ababa tend to send their children to schools in the city, where Amharic functions as the primary language of communication (Bekalu, 2025). Contextual circumstances are likely to influence the decisions of the parents to send their children where Amharic is used as the medium of instruction. Despite the demands of the society to make children learn in Amharic, politicians appear to minimize the role of Amharic language in the country (Bekalu, 2025). Amharic has been taught as a subject across the county and some regional states (such as Beneshangul Gumuz) have also used Amharic as a working language in their local administration. Linguistically diverse regions such as Southern Nations, Nationalities and Peoples Region (SNNPR) and BeneshangulGumuz have decided to use Amharic as the designated language of regional communication (Cohen, 2005). The Constitution (Article 5) and the Ethiopian Education Development Roadmap (MoE, 2017), respectively, suggest that Amharic need to be used as a working language and it should be given as a subject starting from early grade as a second language. Against the Constitution and the Ethiopian Education Development Roadmap, the new Education Policy (MoE, 2023) article 4:3 attempted to reduce the role of Amharic, and it is found to be incompatible with the existing situation and also inconsistent with the Constitution. This article depicts this contradictions.

Theoretical framework

Some believe that the history of education in Ethiopia is at least three millennia old (MoE, 1990). According to this view, legend traces traditional education in Ethiopia back to the time of the contacts King Solomon of Israel made with Queen Sheba of Ethiopia. The roots of traditional education can be traced back to the ancient Biblical religion of Israel. In connection to the above, Ephraim (1971) stated that the elaborate account of the visit of the Queen of Sheba to King Solomon is preserved in a sacred book of the Ethiopian Orthodox Church, called the *Kebrā Negast* (Glory of the Kings). Others (Ephraim, 1971; Teshome, 1979) claimed that education began in Ethiopia right after the introduction of Christianity in the fourth century with the coming of nine clerics from Asia Minor (known as the nine saints in the Ethiopian Orthodox Church education). To reconcile this controversy, Germa (1967) noted that even though the exact date when the church started offering formal education is not known, it is safe to assume that its educational activities go back to the earlier days of Christianity in Ethiopia, 'Abba Selama', the first Christian metropolitan of the country. In a similar manner, Pankhurst (1974) stated that we cannot date the beginnings of church education but it might have originated in the Axumite kingdom when Christianity was introduced at the court of King Ezana in the fourth century.

Although Christianity was rooted in Ethiopia for long, it is not only Christianity that has been a source of indigenous traditional education; Islam also provided another source of education system in the country (Bahru, 2005). Thus, any account of Ethiopian education must recognize the contributions of Christianity, Islam, 'Falash' and paganism that have coexisted in Ethiopia for centuries and founded schools for their adherents (Ephraim, 1971; Teshome, 1979). In view of the above, before the emergence of modern education, traditional education had been carried on exclusively by the Ethiopian Orthodox Church and this was supported by Islamic educational system which served their own members (Ephraim, 1971). As a result, Ethiopia is well known for its indigenous education which has been used for religious services. It is the sum of these facts that has made Ethiopia the only sub-Saharan country in Africa that has ancient written literature using Ge'ez scripts which has been used by Amharic language speakers.

During the 'Dergue' and 'imperial' regimes, Amharic was perceived as a unifying force that ties the multilingual societies of Ethiopia. The then official language, Amharic, has served as a platform for social solidarity, and the revised constitution of Ethiopia declared Amharic as the only official language of the whole empire (Constitution, 1955, Article 125). The primary objective of having one official language was to secure the national unity of the country. In this regard, Cohen (2005) notes that the assumption of the imperial regime's language policy was to produce national unity; it was necessary to have one language, an assumption that was widely shared at the time. Moreover, the country could make it impossible to try to develop all languages at equal footing due to lack of resources. In the pursuit of having a common language for all its citizens, the linguistic rights of others were not threatened in Ethiopia. They were allowed to use their languages for communication although the indigenous languages were not used as media of instruction.

The Amharic language was the official language of Ethiopia for centuries even though the ethnic affiliation of rulers might have been from any of the nation's tribes. Ethnic identity was not the basis of conflict among regional lords in the imperial periods. For example, during the imperial era, the struggle was expressed through continuous disputes between the central king or emperor and the regional lords and princes (Bahru, 2002). This power struggles between the central and the regional rulers changed from a struggle for territorial expansion into a class struggle. Owing to this, the twentieth century Ethiopian elites, participating in the All-Ethiopia Socialist Movement (MEISON) and the Ethiopian People's Revolutionary Party (EPRP), viewed the problems in Ethiopia as a result of class conflicts and not as an outcome of struggles between ethnic groups (Aalen, 2002). Thus, any power struggle during the former times barely used language as a political tool. It was selected for its significance as a means of communication.

Despite this reality, the Tigray People's Liberation Front (TPLF) leaders asserted that the early 20th century students' movement was a struggle among ethnic groups. In disagreement with the allegation of the TPLF leaders, however, a number of scholars teaching at the then Haile Selassie I University (HSIU) asserted that the reaction to the massive oppression and exploitation of the people of Ethiopia appeared to be a class struggle (Young, 2006). According to Gebru, the peasants rebelled against the state not particularly because it was controlled and dominated by the Shoan Amhara, but primarily because it was

oppressive (Gebru, 1977). It was in this context that ethnic politics emerged and divided the country in various linguistic zones.

Statement of the problem

For the largest majority of Ethiopians, Amharic has been used as lingua franca (Ronny, 2006; Bekalu, 2025). Thus, the 1994 Education and Training Policy designates Amharic as a language of countrywide communication (Article.3.5.4). The Constitution of the Federal Democratic Republic of Ethiopia also affirms that Amharic is the working language of the Federal Government. Despite this, the 2023 Education and Training Policy is decentralized in the sense that it allows regional states to select their second language at will without reference to Amharic. Hence, there are concerns that this new move could break the bond Ethiopians had for centuries. In a multilingual country like Ethiopia, a national or working language alongside native mother tongues is the most significant determinant in creating unity and efficient communication. In this regard, Okal (2014) stated that multilingualism practice in education should embrace the indigenous, national/official and foreign languages as equal partners in the language policy development and education. However, this is not the case in Ethiopia; the federal language of the country, Amharic language, which could play the role of official or national language, has not been given the required status in the Education and Training Policy of 2023.

In view of this, the main objective of this article is to scrutinize the inconsistency between the Constitution and the Education and Training Policy documents on language. With regard to this theme, no one has made an inventory of the present Education Policy on language. The problems and deficiencies of the new Education Policy and its failure to address the critical aspects of teacher education provisions were highlighted by researchers. Kidist and Gebrie (2024) noted that the Education Policy inadequately addresses the critical aspects of teacher education provisions, and it is misaligned with the Ethiopian Education Roadmap. However, the aforementioned study did not examine the language issue. Accordingly, the present study tried to fill this gap and scrutinized the policy contradiction.

Methods

As stated above, the main objective of this article is to show the inconsistencies between the Constitution and the Education and Training Policy issued in 2023. Due to this, the method used in the study was qualitative, and document analysis was used as a data collection instrument. A case study design which analyzed a particular case using secondary data such as constitutional documents, policy documents and published articles was employed. Data sources used in the study were the Constitutions of 1955 and 1994, the Education and Training Policy of 2023, the Ethiopian Education Roadmap and published articles.

Findings

This section points out the inconsistency between the Constitution and the Education and Training Policy on language issues. Notably, the current government demonstrates a lack of coherence in its policies. For example, the Constitution of the Federal Democratic

Republic of Ethiopia, article five states that ‘Amharic shall be the working language of the Federal Government’ (Constitution, article 5, 1994, page 2). Needless to say, the Constitution is the highest form of law in a country and all other laws, policies, and government actions must follow the rules and principles laid out stated in the Constitution. In connection to this, the Constitution itself states that the Constitution is the supreme law and any law, customary practice or a decision of an organ of state or a public official which contravenes this Constitution shall be of no effect (Constitution, Article 9). That is, any policy or government action that contradicts the Constitution can be considered invalid. Cognizant of this, MoE (2017) in the Ethiopian Education Development Roadmap recommends three language policies; that is, mother tongue which is a medium of instruction in primary schools, Amharic which is the federal working language and English which is considered as the language of science and technology. The Roadmap also suggests starting teaching Amharic (Federal working language) as a subject from early grade, considering Amharic as a federal language because before the Prosperity Party came to power, the only federal language of the country had been Amharic.

But after 2020, five federal languages (Amharic, Oromiffa, Tigrigna, Somaligna and Afarigna) were introduced by the Council of Ministers (Getachew, 2020) which is against the Constitution and it has not been endorsed by the House of Peoples’ Representatives (HoPR). Following this, MoE (2023) in the Education and Training Policy of 2023 endorsed the decisions of the Council of Ministers and states that, apart from the home language, an additional language from the Federal Languages will be offered from grades 3 to 10, taking into account the student's and parents' preferences, as determined by the educational structure at each level (New Education Policy, 2023, Article 4:3). This article of the Education Policy stands in sharp contrast to the Constitution and the Roadmap and it poses a significant threat to the nation's unity.

Other than the second language, each regional state has its own vernacular, first language being used as a medium of instruction for primary education. In addition to this, each regional state has the right to choose a second language. Suppose the Somalia Regional State decides to make Afan Oromo as a second language in its educational structure, it is possible to go ahead with this interest. Similarly, let us assume that the Afar Regional State opts to learn Somaligna as a second language in its educational structure. In a similar manner, other regional states also take up a second language from the five federal languages designated by the Council of Ministers. How could the various regional states communicate to each other without having a national lingua franca, in our case Amharic? Reaffirming this statement, Glanz (2012) stated that language policy that fosters linguistic diversity will lead to fragmentation and conflict instead of national unity. In this regard, the World Bank (2006) suggested that education policy development should be built upon a longer-term vision and strategic principles. However, in Ethiopia, absence of a stable policy foundation has led to enormous problems in the country.

Discussion

This section discusses the inconsistency between the Constitution and the Education Policy in light of Amharic which is a lingua franca. Every education, economic,

social and political policy or proclamation comes next to or under the Constitution and every policy needs to follow and align with issues stated in the Constitution. However, contradiction happened due to the fact that political decisions were not made by professionals through conscious planning and consultation (Getachew & Derib, 2006). Furthering the discussion, Ferguson (2012) stated that the choices made are often more informed by political and ideological considerations than strictly educational ones. In the history of modern education in Ethiopia, there has been a lack of sustainable education policy. Education policies have been changed along with the change of governments making the country suffer from policy inconsistency over time.

In the same fashion, education policies become instruments for the mission of politicians. A case in point is the Ethiopic script. The *Dergue* regime decided to use Ethiopic script for transcribing Afaan Oromo, Sidama, Wolayta and other languages because most of them were unwritten until that time and the use of one script meant a united system of writing (Záhořík & Wondwosen, 2009). However, any linguistic attempt that unifies the country has never been encouraged and the government spread false narration that divided the nation.

The EPRDF regime made Afaan Oromoo, the language of the Oromo people, use the Latin alphabet while Ethiopic script has been proved to be suitable to serve the same purpose (Baye, 1992). Ethiopic letters or alphabet would have been more suitable to write Oromiffa language instead of adopting the Latin alphabet from outside traditions. After mentioning the advantages of using Ethiopic scripts, Baye (1992) stated that for a multi-lingual, under-developed country like Ethiopia, it is uni-script and not multi-script that holds a clear advantage. Adding multi-script to a multi-lingual society results in more problems. If we had used Ethiopic letters to write Oromiffa, we would have saved time and paper. For example, a book that would take 300 pages in Ethiopic letters takes some 700 pages on average if we write it in Latin letters. We can have some samples below.

Milkaa'inni barnootaa amala barattootaan madaalama (45 letters)-

ምልክእን ባረኖታ አማላባራቶታን ማዳላማ (21 letters)

Afaan faayidaa Aadaaummataa ibsa (30 letters)-

አፋን ፋይዳ ዓዳኡማታ ኢብሳ (14 letters)

Dhugaan yeroo mara mo'ataadha (25 letters) –

ዱጋን የሮማራ ሞአታዳ (11 letters)

Paartii Badhaadhiinaa (20 letters)- ፓርቲ ባዳዲና (7 letters)

The act of using the Latin alphabet was made during the reign of TPLF. The leaders of TPLF who learnt the principle of divide and rule from European colonists have propagated the gospel of ethnic division (Alemante, 2003). As the Italians encouraged the expansion of Islam as a better weapon for dividing Ethiopia (Ephraim 1971), the TPLF launched covert and overt campaigns to encourage and strengthen division. In this regard, Matthew (2004) asserted that the world cannot afford to ignore the hidden agenda of the TPLF any longer because TPLF was abusing the international legal principles of democracy and self determination in order to further their illegitimate aims. Upon receiving the TPLF's legacy, the Prosperity Party seems to intensify and promote particularistic interests (Bekalu, 2025).

The phenomenon is evident across both educational and political policymaking spheres. For example, national unity and cultural identity are not necessarily incompatible educational goals, but struggles for ethnic dominance by the politicians put the societies as polar opposites (Odugu, 2011). To stay in power, politicians appeal to sentiments of national unity and ethnic identity. That is, political leaders capitalize on cultural identity and national unity at different times to boost their popularity and influence and attract people they claim to have come from. For example, the EPRDF elites adopted a renewed discourse of 'Ethiopianness' using historical symbols and myths used by previous regimes when they mobilized the society for the Ethio-Ertrean war in 1998-2000; that is, EPRDF's nationalism and ethnic federalism articulations have been determined by specific circumstances (Bach, 2014). That is, national unity and cultural identity are frequently exploited by politicians for their own benefit.

The use of one unifying language, Amharic, is advantageous to the ruling party when seen from a neutralist perspective. In the first place, a language per se is not harmful to anyone; it is rather vital to make ties between communities and people of any geographic location. Most importantly, from a scientific perspective, no language can be said to have an owner.

Nobody is born with a language and no one will die with a language. For example, if one knows English, they use it with speakers of the language despite their other identities, and the same applies to users of Amharic. Logically, a person cannot acquire all the 80+ languages spoken in Ethiopia, but one can use Amharic to communicate with people of other linguistic background in Ethiopia. Amharic has nothing to do with those who speak it as a mother tongue, and it was and still is a preferred national language due to its widespread use among all Ethiopian ethnic groups (Ronny, 2006). Its role to serve as a bridge or unifying language made it more preferable than others; preferable in terms of the services it provides, rather than for any other practical or imagined reason. A person might hate Americans and the Britons, but the significance of English as a universal lingua franca cannot be overlooked. A language is neither less nor more than a spoon to eat or a pen to write. We have to know and understand the demarcation between languages and their original speakers as well. Having many speakers as a mother tongue does not enable a language to be an official or national language; it needs to be spoken by diverse nationalities to serve as a common language. Had this been the case, the Chinese language, Mandarin, which has over a billion speakers only in China and neighboring countries like Taiwan would have been the language of the world.

The implementation of a unifying national working language is therefore an economically rational decision that can promote efficiency and growth while being consistent with regional linguistic diversity. It can help reduce transactional and administrative costs through seamless communication between entities in the market. A unifying working language can promote labor mobility since all citizens can work anywhere in the country that can promote internal trade through the unification of the domestic market. This in turn promotes productivity through coordination and knowledge sharing at the national level.

Ethnocentric elites who have had soft hearts for an ethnic federal government system have accused the imperial government of Ethiopia for using Amharic as the only official language of the country (Aalen, 2002). However, using one language policy that unified the

country was being practiced in other parts of the world. In this regard, Batibo (2005) notes that England, France and Spain adopted monolingual policies in their respective countries at the expense of minority languages like Alsatian, Basque, Breton, Catalan, Cornish, Irish Gaelic, Lorrainian, Scottish Gaelic, Welsh and others. Even liberal states and governments have explicitly or implicitly assumed that linguistic minorities should accommodate the majority language (Archibugi, 2005). Since that time, there has been a prevailing assumption that “national cohesion” is possible only through a single common language (Spolsky & Shohamy, 2000).

This view is widespread in both Western and Eastern Europe (Michael, 2007; Jong, 2011) and it was an idea shared by former Ethiopian governments. Owing to this, the then national language Amharic served as a platform for social solidarity and the revised constitution of Ethiopia declared Amharic as the only official language of the whole empire (Constitution, 1955, Article 125). The primary objective of having one national or official language was to secure the national unity of the country. In this regard, Cohen (2005) notes that the assumption of the imperial regime’s language policy was to produce national unity; it was necessary to have one language, an assumption that was widely shared. Moreover, the country could not make it possible to try to develop all languages at equal footing due to lack of resources although there was no lack of political willingness on the part of the imperial regime.

Arguably, it is too costly to make many languages national, even the developed countries cannot afford it. For example, Canada has only two official languages (English and French); India has only two official languages (Hindi and English); Belgium has only three official languages (Dutch, French and German). If multilingual developed countries limit themselves to two or three official or working languages, how can Ethiopia afford the cost of adopting many official or working languages? It is paradoxical that a country struggling with hunger spends such a large amount of money on language issues. This is because ethnocentric politicians often see language diversity as a means to gain political power, and they disregard the costs involved, because political power is their ultimate source of influence. The choice of national languages in Tanzania, Hong Kong, Malaysia and Singapore show how, apart from political and cultural considerations, economics is also a key consideration (Minister of Public Works & Government Services Canada, 1995).

Another commonly held misconception pertaining to mother tongue education is the act of using many languages as medium of instruction. Although education in mother tongue is the order of the day and is also proposed by international organizations like UNESCO, the organization further recommended the use of national and official languages from languages which have wider communicative reach, along with some global languages (UNESCO, 2003; Singh et al., 2012). In Ethiopia, there are more than twenty languages which are used as media of instruction and state funding allocated to medium of instruction is a huge amount. There is a substantial body of academic research about mother tongue-based multilingual education. Many people hold the belief that introducing mother tongue-based multilingual education will be too expensive and yet, costs need to be compared to the benefits (Glanz, 2012). Similarly, Mtenje (2012) noted that multilingual education is very expensive since it requires the development and use of an enormous amount of materials in several languages. In terms of maintaining national cohesion, Kioko (2012) stated that a number of key

politicians view the encouragement of multilingualism as being a divisive force because they think that national unity is to be achieved through the use of one national or official language, and they view Kiswahili in Tanzania as a case in point, which, as a national language, has united the nation. If many languages are media of instruction, the situation could risk tearing the country apart.

The other controversial issue in introducing many media of instruction in a multilingual society is the choice of the language. Batibo (2005) stated that the number of speakers may not be the only criterion and it is difficult to decide which languages to promote and which to leave out. The language to be chosen can be an extremely difficult decision to make especially in multilingual societies where many languages still have no script (Kirkpatrick, 2012). Amharic is eligible to meet the requirements of Batibo and Kirkpatrick. All languages in sub-Saharan Africa, except Amharic and Tigrigna that have used Ethiopic script, did not have their own scripts. That means many languages in Africa have not been used as instruments for the preservation of cultural heritage. Although languages spoken do not necessarily justify their inclusion in the school curriculum, Amharic is exceptional, as a lingua franca. Amharic using indigenous Ethiopic script is standardized and developed, and it has been serving as the medium of instruction in Ethiopia before the introduction of ethnic federalism in Ethiopia in 1991.

Amharic has been strong because it is grounded on social, economic and political institutions and it needs to be the medium of instruction in Ethiopia apart from being a unifying language. According to Wiley and Dwyer (1980) and Abdulaziz (2003) as cited in Nkolola-Wakumelo (2012), the choice of a language as a medium of instruction revolves around four main factors: the degree to which a language is spoken and readily understood by most of the people, level of the development of the language (the existence of an orthography, the availability of human and material resources necessary for the teaching of the language) and the political, cultural and social importance of the language. The Amharic language is able to fulfill all these criteria. That is why, urban populations from all language backgrounds demonstrate a marked tendency to shift to Amharic, often losing the language spoken by their parents (Cohen, 2005).

This happens because Amharic transcends tribal boundaries and is spoken by people of all tribes and is used in every walk of life. The strong position of the Amharic language in Ethiopia is uncontested. That is why Amharic has become the language of the Federal Government of Ethiopia. This was made due to the historical fact that Amharic has been used as an official and national language. Some Oromo political elites expect Amharic to recede gradually as Afan Oromo takes its position as the national language (Bekalu, 2025). This, perhaps, is a naïve take of the genesis of a language to become an official language; it needs centuries and has to get the willingness of stakeholders, but by no means does it need coercion and military force. Languages do not evolve overnight; they take ages to take root.

Despite this Education Policy that fractures national unity, people continue to use Amharic since they need to uphold their unity. Due to the historical legacy of the language that has been used as an official language by previous regimes, Amharic has been spoken mainly for instrumental and pragmatic reasons. Furthering the discussion, Cohen (2005) stated that the Amharic language was the only vehicle for accessing wider economic and educational opportunities in the Ethiopian State. To some extent, this is still true as the

hegemonic societal position of Amharic remains unassailable, even though, since 1991, other Ethiopian languages have been employed for official purposes, including primary education.

After the introduction of ethnic federalism, the political struggles over ethnic dominance have hindered Ethiopians from having a common linguistic basis which is indispensable for national unity. Criticizing this situation, Cohen (2005) further stated that the potential positive impact of strengthening one national language for communication has not been recognized. The contradictory policy documents exacerbate the situation which is against public expectation and we need to refute such an anomalous policy from taking roots in the system.

Conclusion

The article was intended to show an inconsistency existing in the document of the Education Policy and the Constitution. Since 2020, the Council of Ministers embraced five federal working languages, namely Amharic, Afan Oromo, Tigrigna, Somali, and Afar; a move that is contrary to the Constitution and without the approval of the House of Peoples' Representatives (HoPR). Subsequently, the Ministry of Education [MoE] (2023), in the 2023 Education and Training Policy, approved the Council's suggestion that, besides the mother language, students will be given another one of the above stated federal working languages from grade 3 to grade 10 on the basis of students' and parents' needs as ascertained by the education system at each level (New Education Policy, 2023, Article 4:3). This amendment is a clear contradiction to the Constitution and the Education Roadmap, and poses a serious threat to national unity.

With the exception of a second language, each regional state uses its own first or mother language as a language of instruction for elementary education. Secondly, each regional state is given a mandate to choose one additional language from the five federal languages. For instance, if region 'X' decides to use language 'A' as a second language in its education system, it is completely within its right to make such a decision. In the same way, if region 'Y' decides to use language 'B' as a second language in its education system, it is equally within its right to make such a decision. In this way, the regional states are able to choose from the five working languages recommended by the Council of Ministers. However, how do regional states communicate with one another as a nation? How can cross-regional communication effectively be maintained without a common national lingua franca such as Amharic?

Recommendation

Adopting a common language—such as Amharic—as a unifying language would be beneficial not only for the masses but also for the ruling political party, if the purpose and function of languages are grasped sincerely. Language itself is not anything that is detrimental to any given community; rather, it is a potent tool to bring bonding, communication, and unity among communities of different linguistic backgrounds.

All educational, economic, social, and political policies and announcements must be subservient to the Constitution and harmonious with its provisions. Therefore, any education policy contrary to constitutional principles must be critically assessed and questioned before institutionalization.

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ICT integration practices and challenges among biology teacher educators in selected Southern Ethiopian colleges of teacher education

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Abstract

The integration of information and communication technologies (ICTs) in education is widely acknowledged, but research on its use by teacher educators, particularly in Biology, remains limited. This study investigated how teacher educators (TEs) in Ethiopian colleges of teacher education utilized ICT in the teaching-learning process, alongside the challenges they encountered. Employing a mixed-methods approach, data were collected through questionnaires with 50 purposively selected TEs and semi-structured interviews were conducted with 18 teacher educators from three colleges. The findings revealed that 83% of the participants believed that certain complex biological concepts could not be adequately taught without the help of ICT. However, 14% to 42% of the participants admitted that they rarely or never used key tools such as LCD projectors and advanced software in their teaching. Significant differences in ICT usage were associated with age, $F(2, 49) = 3.44, p = .040, \eta^2 = .12$, and with teaching experience, $F(2, 49) = 4.19, p = .021, \eta^2 = .16$. Major challenges included insufficient pedagogical support, inadequate training, and limited access to devices. The study advocates for targeted interventions to empower TEs; enhancing technology integration is vital for advancing education in developing countries like Ethiopia.

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Introduction

Rapid technological breakthroughs have brought about a number of changes in the social and economic lives of many individuals worldwide. It is increasingly important for nations to not only adapt to these changes more readily but also to create and develop equipment, systems, structures, policies, and resources that will allow them to stay relevant (Reno & Sari, 2020). Moreover, these advancements presented increased pressure on universities, businesses, governments, and students and which forced them to turn to ICT to

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provide modern solutions to modern challenges (Akah et al., 2022). Using ICT in the processes of teaching and learning within educational institutions empowers both educators and learners. Notably, it helps students get ready to live in a culture that values information. It also acts as a catalyst for improvements in teaching methods, student outcomes, and educational quality (Alemu, 2015; Lawrence, 2018). Higher education is crucial for enhancing lifelong learning and reflecting modern learning environments. As a result, they have to use ICT to equip students with the knowledge and skills needed for success in the digital age.

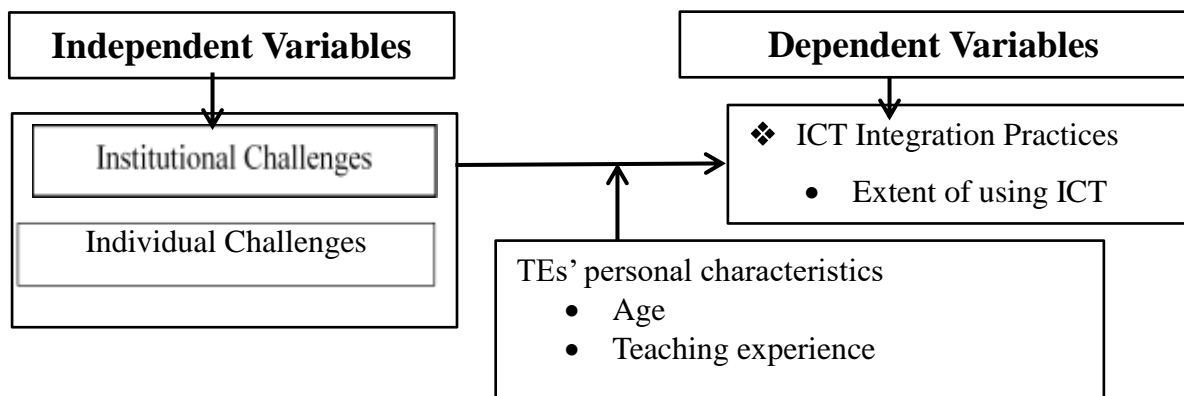
Studies across many African countries indicate that ICT resources in higher education are underutilized, with instructors often hesitant to integrate them into their teaching (Salam et al., 2018; Sutter & Kihara, 2019; Tekleselase, 2019). In Ethiopia, while ICT is seen as vital for national development and educational progress, research shows that schools fail to effectively use it to enhance instruction. Technical and administrative challenges have hindered ICT adoption, reducing its potential benefits. A lack of commitment from school administrations and poor ICT policy implementation further exacerbate the ICT underutilization issue (Ministry of Education [MoE], 2022; Yizengaw & Nigussie, 2023).

Moreover, teachers' perceptions of ICT's role in the classroom and their self-assessed ICT competencies significantly influence their willingness and ability to integrate technology into teaching in these nations (Arkorful et al., 2021; Rubach & Lazarides, 2021). Understanding these psychological and cognitive barriers is crucial for improving ICT utilization in education and shaping its effective use to facilitate instruction. In Ethiopia's teacher education programs, there's a recognized need for prospective teachers to develop 21st-century skills, including digital literacy and the integration of indigenous knowledge. Despite improvements in curriculum and ICT infrastructure, ICT utilization by teacher educators and prospective teachers remains limited, partly due to persistent challenges (MoE, 2022). Studying ICT integration in Biology education is crucial to optimize technology use and meet curriculum goals, which emphasize science and ICT as tools for fostering creativity and problem-solving skills in prospective teachers.

Indeed, studies on the use of ICT in Ethiopian education have been intense in primary and secondary schools and universities. However, little attention is paid to investigate colleges' educational perspectives and TEs. Furthermore, these studies concentrate on non-biological fields that contain complex and abstract concepts. Since teacher education has faced an urgent need to boost the new teachers' capacity to implement new teaching methods and use ICTs for the teaching-learning process, a more thorough study is needed to analyze TEs' ICT utilization and related challenges.

This study therefore examines the extent and nature of ICT use among Biology TEs in selected Ethiopian colleges of teacher education and identifies the individual and institutional challenges influencing integration. This is particularly relevant, as no research has specifically addressed the barriers to utilizing ICTs in the selected colleges of teacher education in Ethiopia, despite the country's renewed emphasis on ICT to enhance science education. Additionally, considering the study's primary focus on TEs, assumptions were made about how their personal characteristics (such as age and teaching experience) would affect their ICT integration practices, based on the ongoing literature debate on the subject (Hong, 2016; Kollia et al., 2020; Murithi & Yoo, 2021). The specific research questions that this study intended to address were the following:

- To what extent do teacher educators (TEs) use ICTs in the teaching-learning process of Biology?
- Is there a statistically significant difference in ICT integration practices among Biology TEs based on their age and teaching experience?
- What are the challenges faced by Biology TEs in the integration of ICT into teaching and learning practices?

Figure 1*Conceptual Framework of the Study*

The conceptual framework of the study illustrates the relationships among institutional challenges, individual-level challenges, and ICT integration practices, while considering moderating factors such as age and teaching experience. In this framework, ICT integration practices represent the dependent variable, reflecting the extent to which TEs effectively utilize ICT tools in teaching and learning. This includes both hardware and software components aimed at facilitating and improving student learning. Overall, it encompasses searching for supplementary materials online, using email and managing student information, and utilizing technology as a method of demonstration and an interactive teaching approach in the classroom. This definition aligns with the framework presented by Mama and Hennessy (2013).

The institutional challenges, such as inadequate infrastructure, limited access to digital resources, poor technical support, and insufficient administrative encouragement, serve as independent variables that can either hinder or facilitate ICT integration. Likewise, individual-level challenges, including limited digital competence, negative attitudes toward technology, and resistance to change, also act as independent variables influencing how teachers adopt and implement ICT in their instructional practices.

According to Ali et al. (2018), institutional characteristic challenges are characteristics that have a systematic impact on ICT adoption within an institution but are not directly related to individual users. For example, the institutional ICT plan describes the institution's basic philosophy and aims at ICT integration processes. It comprises precise technical and infrastructure specifications, as well as methodologies for program implementation, monitoring, and evaluation.

Teachers require professional development to acquire ICT skills and a positive mindset when new technology tools and pedagogies emerge. As a result, ICT integration

requires institutional technical and pedagogical support from specialized persons with expertise in technology instruction. Timely support is essential for overcoming technological problems and inspiring instructors to implement ICT. According to Rizana et al. (2020), without sufficient support, instructors may be unwilling to deploy technology due to the risk of failure. This emphasizes the need of having a productive and successful ICT support infrastructure in higher education. However, inadequate assistance is frequently highlighted as a barrier to ICT adoption. In addition, the accessibility of the ICT infrastructure of the institutions is among the major challenges of ICT usage in the teaching-learning process in developing nations (Tekleselase, 2019).

The individual-level challenges refer to TEs' qualities in our framework, taking into account their digital mindset and digital proficiency. Attitude indicates an instructor's inclination to employ ICT in the classroom. Teachers with a good attitude about technology are more inclined to include it in their instruction. Several studies back this up, suggesting that instructors' views regarding ICT pose substantial barriers to its usage in instruction (Sutter & Kihara, 2019; Ngao et al., 2022). Similarly, ICT proficiency, the knowledge and abilities of teachers in integrating ICT into the process of teaching and learning, is an important component. Many educators have little exposure to technology tools in the classroom, which can lead to a lack of ICT competency.

Furthermore, moderating variables—particularly age and teaching experience—are anticipated to shape both the magnitude and direction of these relationships. Prior empirical research indicates that individual characteristics such as age, gender, teaching experience, and ICT competence significantly affect technology integration by shaping teachers' attitudes, self-confidence, and preparedness to use digital tools (Gebhardt et al., 2019). Evidence suggests that younger teachers tend to be more flexible and open to adopting ICT, whereas more experienced educators demonstrate more effective technology integration when sufficient training and institutional support are available (Almerich et al., 2024). In line with these findings, Basargekar and Singhavi (2017) identified significant variations in teachers' perceptions of ICT across age and experience groups, while Kollia et al. (2020) reported that older and more experienced teachers were generally less willing to adopt ICT, often due to negative perceptions and resistance to change.

Methods

A mixed research approach with concurrent embedded design was used in this study for its suitability to examine ICT integration practices of TEs and challenges they faced (Creswell, 2014). The embedded method typically focuses on a secondary research question or a specific subtopic related to the broader study. In this case, the dominant method was quantitative, with qualitative data embedded to provide deeper insights. Key qualitative questions were incorporated and analyzed to complement and support the primary quantitative findings. Using this design, the study aimed to investigate TEs' practice and challenges for incorporating ICT into the instructional practices of Biology education in selected colleges of teacher education in Ethiopia. Doing this helps to gain insight into generalizing a situation and investigate significant variations among the respondents in their ICT integration practices based on their age and teaching experience.

The study was conducted in three Colleges of Teacher Education located in two regional states in Ethiopia: Arba Minch and Dilla in the South Ethiopia Regional State and Hosanna in the Central Ethiopia Regional State, which were purposefully selected to ensure the inclusion of diverse institutional contexts and representative experiences in ICT integration within biology education. These colleges differ in terms of infrastructure development, ICT resource availability, and institutional support systems, providing a range of environments that help capture variations in the challenges and practices of ICT integration. Selecting these institutions was therefore guided not by convenience, but by the need to obtain contextually rich and comparable data that reflect the broader realities of teacher education settings in these regions. This purposive selection enhances the relevance, depth, and representativeness of the findings, enabling a more nuanced understanding of how institutional and individual factors influence ICT integration across different teacher education contexts.

These colleges collectively host a total of 50 Biology TEs. Since the total number of participants in the target group was small and manageable, the study included the entire accessible population rather than selecting a sample. This approach ensured comprehensive data collection and eliminated sampling error that might arise from excluding potential participants. This approach focuses on the complex practices and challenges of ICT integration in teacher education across three selected colleges, allowing for a thorough exploration of individual experiences and the nuanced variances influenced by factors such as age and teaching experience. This method offers a richer understanding than larger, randomized samples might provide, all while maintaining a practical and focused scope for rigorous analysis.

The demographic data shows a significant gender disparity, with 84% of participants being male and 16% female. Age distribution reveals that 24% are aged 20-30, 48% are 31-40, and 28% are 41-50 years old. These age categories were used to represent distinct career stages commonly recognized in educational research—early-career, mid-career, and late-career TEs. These categories also align with generational differences in digital exposure and are therefore analytically appropriate for examining variations in ICT usage. The majority have substantial teaching experience: 36% with 11-20 years and 34% with 21-30 years, indicating that nearly 70% have over a decade in the field. In terms of academic qualifications, 24% hold a first degree, while the remaining participants have master's degrees. The study also includes insights from six TEs, six college vice deans, and six department heads from the ICT and biology departments across three colleges purposefully, providing valuable perspectives for the research. They were three females and fifteen males, aged 28 to 55 years, with teaching experience ranging from 10 to 30 years.

Data collection involved semi-structured interviews and a two-section questionnaire. The first section of the questionnaire captured demographic information, while the second used five-point Likert scale questions to assess TEs' ICT usage in teaching and the challenges they faced. The questionnaire included a mix of closed and open-ended questions, with most items carefully adapted from previous studies (Baguma & Vandeyar, 2018; Nzika, 2019) to reflect the specific context of this study. The questionnaire was pilot-tested to ensure reliability and validity. Internal consistency, measured by Cronbach's alpha, was assessed twice: during the pilot and after final data collection. According to Taber (2018), a

Cronbach's alpha of 0.7 to 0.8 is considered adequate. The results showed strong internal consistency, with reliability coefficients for all constructs (extent of ICT use (EICTU), institutional challenges of ICT (ICICT), and individual-level challenges (ILCs)) exceeding 0.7. For the qualitative aspects of the study, several strategies were used to ensure trustworthiness. Member checking was conducted by sharing interview summaries with participants to verify accuracy. Peer debriefing sessions were held with a colleague experienced in qualitative methods to review coding and emerging themes. Although the principal investigator was the sole coder, a clear coding framework and iterative coding process were applied to enhance inter-coder consistency. An audit trail documenting coding decisions, analytic memos, and theme development was maintained to support reliability.

The survey was pilot tested on eighteen biology TEs at Hawassa College of Teacher Education, which resulted in the rewording and elimination of some items from the survey. In this study, both content and face validity were evaluated through peer review. Two experts from the Department of Curriculum and Instructional Supervision from Hawassa University and Bahir Dar University reviewed the survey instruments based on the extent to which the instrument effectively captures the concept under study and how well the questionnaire items are understood and accepted, respectively. Once the face validity and content of the instruments were assessed, the exploratory factor analysis (EFA) statistical method was used to examine the construct validity (Tondeur et al., 2018). A specific type of construct validity determined through factor analysis is factorial validity, which examines how questionnaire items group together based on correlations in responses and can be assessed by evaluating the logical coherence of items within each factor. Hence, EFA using Principal Axis Factoring (PAF) with Varimax rotation was conducted to examine the structure of the scales, and the EFA of all the scales confirmed the factorial validity, and the results are discussed under the result section.

A questionnaire was administered after obtaining approval from Hawassa University, Ethiopia, and based on permission granted by the respective sampled colleges. Following this, all subjects provided unambiguous verbal and written consent. The investigators provided participants with orientation regarding the purpose of the instruments to ensure they felt comfortable. Afterwards, the researchers physically collected the completed questionnaires from each respondent.

Subsequently, the principal investigator conducted eighteen in-depth interviews, using a blend of general and specific questions primarily derived from the subscales of the survey questionnaire to gather comprehensive insights. Each session began with a general interview to collect background information about the participants. This was followed by targeted questions exploring their experiences with ICT use in biology education, specifically examining the instructional practices they adopt and the individual and institutional challenges they face. Six TEs were interviewed for their direct experiences integrating ICT in teaching were the main focuses. We also interviewed college vice deans and department heads from biology and ICT departments to understand broader, institution-wide challenges that impact the integration of ICT. This approach allowed us to capture a holistic view of ICT usage in biology education, from the classroom to the institutional level. To ensure confidentiality, each participant was assigned an anonymous code. The codes used were TE

for teacher educators, VD for vice deans, DHB for department heads of Biology, and DHI for department heads of ICT.

During the data collection process, a number of measures were taken to reduce interviewer bias. Initially, we employed a semi-structured interview guide to guarantee uniformity in the questions posed to each participant. Second, in order to avoid influencing participants' answers, we kept a neutral tone and refrained from sharing personal thoughts or feelings during interviews. Third, in order to improve familiarity with the questions and minimize unintentional cues, we rehearsed the interview protocol before data collection. To guarantee accuracy and prevent subjective interpretation, every interview was audio recorded and verbatim transcribed. Lastly, in order to recognize and control any potential biases that might emerge during the interviews, reflexive notes were maintained throughout the process.

Here are a few samples of the questions we asked: Would you like to share your experience with the extent of integrating ICT in biology education? What individual and institutional challenges do you face in integrating ICT into your teaching and learning process? Do you have a personal ICT integration plan that you follow? And why do you do so? Interviews were conducted at participants' selected location and time, lasting 25–45 minutes each. All interviews were audio recorded.

The data collected were used to establish the instrument's psychometric properties (factor structure, internal consistency reliability, and discriminant validity) first. To examine TEs' ICT usage and the challenges they face, descriptive statistics such as frequencies (F), percentages (%), means (M), and standard deviations (SD) were computed. A one-sample t-test was performed to determine whether TEs' ICT integration exceeded the neutral midpoint of the scale. One-way analysis of variance (ANOVA) was used with SPSS version 24 software to assess statistically significant differences in TEs' extent of ICT utilization in the teaching-learning process based on personal factors. Moreover, to ascertain the extent of differences, effect sizes were calculated using eta squared (η^2).

The assumptions for ANOVA were checked using tests of normality and homogeneity of variance. The Shapiro–Wilk results for all age groups and ICT experience categories showed p-values greater than .05, indicating that the distribution of ICT practice scores did not significantly deviate from normality. In addition, Levene's Test for homogeneity of variances produced a non-significant result ($p = .151 > .05$), showing that the variances across groups were equal. Therefore, both the normality and homogeneity assumptions were satisfied, and it was appropriate to proceed with the standard one-way ANOVA.

Thematic analysis of the interview data was conducted to explore TEs' ICT integration practices and challenges. To ensure confidentiality, each participant was assigned an anonymous code. The codes 'TE1' to 'TE6' were used for the six TEs, 'VD' for the vice deans, and 'DHI' and 'DHB' for the department heads of ICT and Biology, respectively. Following Braun and Clarke (2012) six-step process, the analysis involved immersing in the data, generating initial codes, identifying and reviewing themes, and naming them, culminating in a comprehensive report. Although various qualitative data analysis software's are available, the textual data was manually coded using Microsoft Word's "comments" feature for a meticulous and hands-on approach. Verbatim transcriptions of the text data from the individual interviews were made, and a preliminary examination provided an overview.

Codes were then determined based on research questions, leading to the creation of predefined core topics and subthemes.

To streamline the coding process, subthemes and code categories were distinguished using color-coding. For instance, within the broader category of challenges in ICT integration, institutional and individual-level challenges faced by TEs were identified as subthemes. Following these, thematic analysis was conducted to present the findings comprehensively. During this process, the authors reviewed the generated codes, identified areas of likeness, and combined them. Finally, the data is narrated, forming the basis for discussions, conclusions, and recommendations. The following are examples of the specific actions we took during this process.

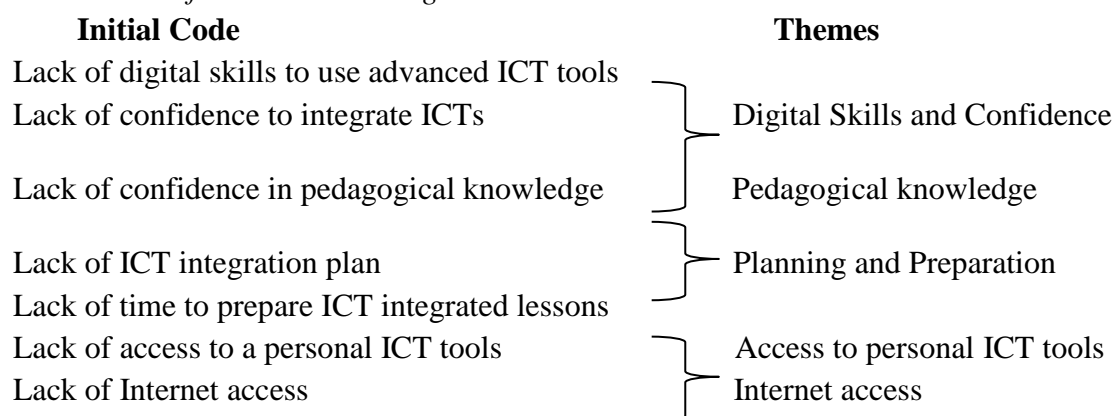
Table 1

A Thematic Organization of the Individual Level Challenges of ICT Integration

Interviewer's Questions	Participants' Response	Initial Code
Would you like to share your experience with the extent of integrating ICT in biology education?	I realize that many advanced ICT tools are available, but I feel the need to build my skills gradually. Starting with simpler tools helps me integrate technology into my teaching without feeling overwhelmed.	Lack of digital skills to use advanced ICT tools
What individual and institutional challenges do you face in integrating ICT into your teaching and learning process?	Many of us focus more on the technology itself rather on how it supports specific learning objectives and teaching strategies. I find it challenging to create lesson plans that fully leverage ICT to accommodate different learning styles; it costs me time, making me less confident in effectively integrating it.	Lack of confidence in pedagogical knowledge Lack of time to prepare ICT integrated lessons Lack of confidence to integrate ICTs
	I don't have a personal computer and rely on the library's institutional computers, and I always prepare my teaching notes using office desktops, which are often in high demand... Besides, unreliable internet access has also affected my teaching practices negatively.	Lack of access to a personal ICT tools Lack of Internet access
	Although I'm skilled with my preferred software, I rely on printed materials because I'm not confident in integrating advanced ICT tools like digital videos, graphics, and simulations into my teaching.	Lack of digital skills to use advanced ICT tools
Do you have a personal ICT integration plan that you follow? And why do you do so?	While I don't have a formal ICT integration plan that I follow, I believe that technology should enhance the learning experience without being rigidly structured, so I use it flexibly, incorporating it when it adds real value to my teaching, allowing me to stay responsive and adapt technology to fit naturally into each lesson.	Lack of ICT integration plan

Figure 2

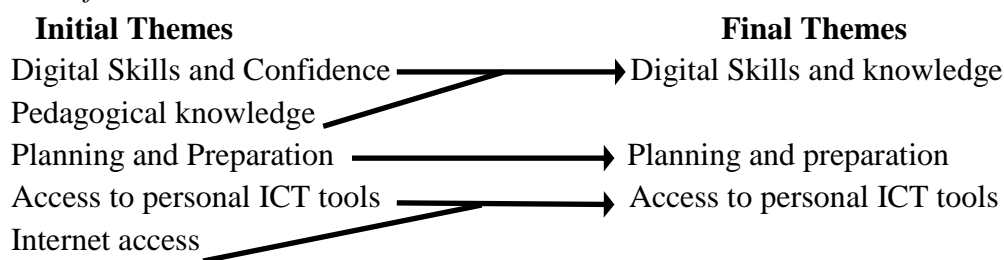
Themes Generated from Initial Coding



Following the creation of the themes, we moved on to the stage of theme assessment and naming. In this stage, we went over every subject that had been developed in the earlier stage and came up with a precise, clear final name for each one (Figure 3).

Figure 3

Final Names for Generated Themes



To enhance the credibility of the findings, quantitative and qualitative data were triangulated during the interpretation stage. The quantitative results from the survey were compared with themes emerging from the interviews to identify convergence, complementarity, or divergence.

Findings

Demographic Characteristics of the Respondents

The demographic data shows a significant gender disparity, with 84% of participants being male and 16% female. Age distribution reveals that 24% are aged 20-30, 48% are 31-40, and 28% are 41-50 years old. These age categories were used to represent distinct career stages commonly recognized in educational research—early-career, mid-career, and late-career TEs. These categories also align with generational differences in digital exposure and are therefore analytically appropriate for examining variations in ICT usage. The majority have substantial teaching experience: 36% with 11-20 years and 34% with 21-30 years, indicating that nearly 70% have over a decade in the field. In terms of academic qualifications, 24% hold a first degree, while the remaining participants have master’s degrees. The study also includes insights from six TEs, six college vice deans, and six department heads from the ICT and biology departments across three colleges purposefully,

providing valuable perspectives for the research. They were three females and fifteen males, aged 28 to 55 years, with teaching experience ranging from 10 to 30 years.

EFA Results for the Scales Measuring TEs' Extent of ICT Use, Institutional ICT Challenges, and Individual-Level Challenges

The exploratory factor analyses of the EICTU, ICICT, and ILCs scales confirmed their factorial validity. The factorability of the seven EICTU items was assessed. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was .748, and Bartlett's Test of Sphericity (BTS) ($\chi^2(21) = 100.61, p < .001$) was significant, indicating that the data were suitable for factor analysis. Two factors with eigenvalues greater than 1 emerged. The first factor, with four items loading strongly (.528–.827), reflects Instructional ICT Integration, capturing the use of presentation tools (e.g., PowerPoint, LCD projectors), data-processing applications (e.g., Excel), and advanced instructional software (e.g., animations and simulations). The second factor, with three items loading between .515 and .845, represents ICT Use for Information Access and Communication, covering internet use for sourcing information, the use of social media to communicate with pupils, and the use of personal devices for lesson preparation. Together, these two factors suggest that TEs' ICT integration behaviors can be understood in terms of both instructional uses and communication/information-access uses.

The KMO measure of sampling adequacy of the eight ICICT items was 0.76, and the BTS was significant ($\chi^2(28) = 134.5, p = 0.000$), confirming the suitability of the data for factor analysis. The scale had two factors with eigenvalues of 4.62 and 1.86, with four items loading onto one factor and two items onto another, explaining 81.1% of the total variance. The ILCs scale had a single factor with an eigenvalue of 4.35, representing 72.6% of the total variance. The KMO measures of sampling adequacy were above 0.70, and BTS were significant ($\chi^2(15) = 68.23, p = 0.000$), indicating that the data met the assumptions for factor analysis. All the communalities were also above 0.5, further supporting the factorial validity of this scale, and no items were eliminated.

ICT Integration Practices of TEs' in Biology

Our findings on the use of ICT in instruction fall into two categories, encompassing both hardware and software tools that aided in boosting student engagement and streamlining information management. For instance, TEs' use web browsers to source supplementary materials, email for effective communication, and tools like LCD multimedia projectors and Microsoft Word, Excel, and PowerPoint to deliver dynamic classroom demonstrations and interactive teaching sessions.

We used a questionnaire that invites participants to evaluate how frequently they incorporate various ICT tools into their favorite instructional activities. Responses were measured on a Likert scale, where Never (N) = 1, Rarely (R) = 2, Sometimes (S) = 3, Often (O) = 4, and Always (A) = 5. The results were then converted into percentages, reflecting the extent of ICT usage in teaching and learning (Table 2).

Table 2
Descriptive Statistics of TEs' Extent of ICT Use

Items	%					M	SD
	N	R	S	O	A		
Internet/web browsers for sourcing information	0	14	36	32	18	3.54	0.95
Ms. excels/spreadsheet for analyzing	0	22	38	22	18	3.36	1.02
MS PowerPoint to prepare lessons	0	36	32	24	8	3.04	0.96
LCD multimedia projector for giving lectures	8	42	24	24	2	2.70	0.99
Advanced software (Animations/simulations)	26	34	20	16	4	2.38	1.15
Social media for sharing information (to communicate with pupils and others)	2	22	20	30	26	3.56	1.16
Personal devices; laptops, etc. to prepare lessons	2	16	22	32	28	3.68	1.11
Grand Mean						3.17	

According to Table 2, the predominant ICT tools TEs integrated into their instruction ('Often' and 'Always') included preparing lessons using personal devices (60%), sharing information with pupils and others via social media (56%), and sourcing information from the internet and web browsers (50%). Other notable ICT tools included analyzing scores and conducting various activities with MS Office Excel or Spreadsheet (40%), presenting lessons using MS PowerPoint software (32%), delivering lectures with an LCD multimedia projector (26%), and creating presentations with advanced software featuring animations or simulations (2%).

The analysis has shown key insights into Biology TEs' use of advanced software. Notably, 26% of TEs never use tools like animations or simulations, and 34% use them rarely, indicating limited adoption of these technologies. Similarly, the use of LCD multimedia projectors is low, with 8% never using them and 42% using them rarely. Additionally, 36% of TEs rarely use MS PowerPoint for lesson preparation and presentations. Overall, while a small number of TEs frequently use these ICT tools, the majority rely on basic ICT tools only occasionally, highlighting significant potential for improving technology integration.

Besides, a one-sample t-test was conducted to determine whether TEs' ICT usage (EICTU) differed significantly from the neutral midpoint of 3 ("Sometimes"). The mean EICTU score ($M = 3.17$, $SD = 0.71$) was higher than the test value, but the difference was not statistically significant, $t(49) = 1.69$, $p = .098$. These results indicate that TEs' ICT usage is not significantly above average, suggesting only a moderate level of ICT integration.

TEs' ICT Integration Practices Based on Age

The difference of TEs' age on their ICT integration practices was investigated using a one-way ANOVA, with participants divided into three age groups (20-30 years, 31-40 years, and 41-50 years). The ANOVA revealed a statistically significant difference ($F(2, 49) = 3.44$, $p = 0.04$), and the effect size ($\eta^2 = 0.12$) was moderate (Cohen, 2016). A subsequent post hoc (Tukey's HSD) analysis identified a significant difference in mean scores of ICT integration practices between TEs aged 31-40 years ($M = 3.41$, $SD = 0.67$) and those aged 41-50 years ($M = 2.81$, $SD = 0.5$). However, no significant difference was found between TEs aged 31-40 years and those aged 20-30 years ($M = 3.13$, $SD = 0.87$).

TEs' ICT Integration Practices Based on Experience

A one-way ANOVA was performed to examine the effect of teachers' years of experience (1-10 years, 11-20 years, and 21-30 years) on their use of ICT in biology teaching. The results revealed a statistically significant difference in mean ICT integration scores among the groups ($F(2, 49) = 4.19, p = .021$), with a large effect size ($\eta^2 = 0.16$) indicating considerable variation in ICT use. Post-hoc analysis further highlighted a significant difference between teachers with 11-20 years of experience ($M = 3.53$) and those with 21-30 years ($M = 2.95$). This advocates that TEs with less experience are more inclined to integrate ICT into their teaching than their more experienced colleagues.

Overall, the quantitative results showed that only a small number of TEs frequently use specific, mostly basic ICT tools, while the majority use them only occasionally. Our in-depth qualitative exploration aimed to provide a comprehensive understanding and robust support for the quantitative findings. The participants' responses to their ICT integration practices are given narratively as follows.

Preferred ICT Tools and Teaching approach

The study identified two main issues related to TEs' preferred ICT tools and their preferred approach to the teaching process when discussing their experience with ICT use, specifically, a reliance on basic tools and dependency on traditional methods. Notably, the findings indicated that 67% of TEs who participated in the interviews reported relying primarily on basic tools such as MS Word, Excel, and PowerPoint in their teaching-learning process. Although they expressed frustration about not utilizing more dynamic features, they continued to depend heavily on printed materials, underscoring a hesitation to fully adopt ICT. Several TEs highlighted their reliance on basic ICT tools and their limited confidence in using advanced features. For instance, one participant noted, "I efficiently source information using web browsers, Microsoft Excel, and Microsoft Word but want to improve my skills in using social media for sharing information and communicating with students" (TE4). Similarly, another TE explained, "I always prepare PPT before the session, but I can't insert animations or simulations to capture learners' attention" (TE3). This limited competence led some participants to depend on traditional materials, as reflected by one respondent who stated, "I primarily rely on printed materials for my lessons, as I am not yet confident in utilizing many advanced features of ICT tools in my classroom" (TE1).

In addition, the qualitative findings also show 33% of participants expressed doubts about ICT, questioning its superiority over traditional lectures and its effectiveness in teaching biology. Similarly, when the participants were asked about their beliefs on whether some challenging concepts in biology can be effectively taught without ICT, 17% responded affirmatively, stating they believed it was possible. However, 83% of participants confidently affirmed their belief that these could not be effectively taught without relying on ICT. Their arguments are stated as follows:

In addition, the qualitative findings also show 33% of participants expressed doubts about ICT, questioning its superiority over traditional lectures and its effectiveness in teaching biology. Similarly, when the participants were asked about their beliefs on whether some challenging concepts in biology can be effectively taught without ICT, 17% responded affirmatively, stating they believed it was possible. However, 83% of participants confidently affirmed their belief that these could not be effectively taught without relying on ICT. Some TEs raised concerns about the potential negative effects of ICT on students' learning

behaviors. For example, one participant cautioned that while ICT can support teaching, it may also encourage student passivity and reduce critical thinking if overused, noting that “easy online answers discourage deep thought” and emphasizing that “effective instruction fostering critical thinking is vital regardless of ICT use” (TE1). This participant further expressed a preference for traditional teaching methods, stating, “I believe ICT can distract students if you simply display PowerPoint... I prefer using a chalkboard mostly for teaching,” and added that preparing ICT-based lessons “costs me a lot of time” (TE1).

In contrast, another TE emphasized the hands-on nature of biology and the value of experiential learning over technology-mediated instruction. As one TE explained, “Biology is inherently a hands-on subject. Experiments, dissections, and fieldwork allow students to engage directly with the material,” arguing that activities such as observing and dissecting real specimens provide “a concrete understanding that screens cannot replicate” (TE6). This participant also highlighted the importance of inquiry-based and independent investigations that promote deeper understanding without heavy reliance on ICT.

Conversely, other participants viewed ICT as a powerful instructional tool, particularly for explaining abstract biological processes. One TE noted that “many biological processes, such as cellular respiration or photosynthesis, involve complex interactions that are difficult to visualize,” and argued that ICT tools such as animations and simulations offer “dynamic representations that help students grasp these concepts more effectively than static images or text alone” (TE4).

Generally, both the quantitative and qualitative results indicate room for improvement in integrating advanced technology into teaching practices at these colleges of teacher education.

Challenges faced by TEs in integrating ICT

Institutional Level Challenges Table 3 presents responses to the survey that biology TEs completed on institutional-level problems they run across when utilizing technology in the classroom. The Likert scale responses allow for the measurement of the degree to which each challenge is perceived by the participants.

As it is shown in Table 3, the vast majority of TEs (more than 60%) believe that inadequate ICT tools in the library and laboratory, along with insufficient pedagogical support, are the primary obstacles to effectively integrating ICT in their instruction. Additionally, more than 55% of TEs highlight several other significant barriers: the absence of a clear institutional ICT plan, slow internet connections, lack of classroom with the necessary facilities, and insufficient in-service training opportunities. Similarly, the absence of classrooms equipped with the necessary facilities (52%, $M = 3.42$) presents a significant challenge. In comparison, a slightly smaller proportion of respondents (48%, $M = 3.32$) indicated that inadequate maintenance of unused computers hampers ICT utilization in the classroom. Conversely, only a small percentage of respondents disagree with the notion that inadequate in-service training (18%), slow internet connections (18%), and a lack of a clear institutional ICT plan (20%) are key challenges faced by TEs.

Table 3
Institutional-level Challenges

Items	%					M	SD
	SD	DA	U	A	SA		
Lack of a clear institutional ICT plan	8	12	22	38	20	3.50	1.18
Slow Internet connection for accessing resources	2	16	24	50	8	3.46	0.93
Inadequate ICT tools in the library and laboratory	4	22	14	50	10	3.40	1.06
Lack of classroom with the necessary facilities	0	28	16	26	30	3.58	1.19
Insufficient pedagogical support for TEs	0	24	14	32	30	3.68	1.15
Lack of maintenance for non-used computers	10	20	22	24	24	3.32	1.31
Frequent power failures or blackouts	12	18	18	20	32	3.42	1.41
Inadequate in-service training opportunities	2	16	26	28	28	3.64	1.12
Grand Mean						3.49	1.13

Note. SD=Strongly Disagree; DA=Disagree; U= Undecided; A=Agree; SA=Strongly Agree

Individual-Level Challenges

The grand mean score on the individual challenge scale is 3.08 with a standard deviation of 1.25 (Table 4). This suggests that respondents have a strong impression of their own individual characteristics and how these affect their ICT integration practices, in addition to the institutional challenges.

Upon detailed analysis, it was found that the majority of TEs expressed a lack of confidence in their pedagogical knowledge for integrating ICT into their instructional activities. This sentiment is reflected in the mean score of 3.48, and 58% of the TEs agree that they feel not confident in their pedagogical knowledge. Furthermore, many respondents cited the lack of personal devices as the second most important challenge; with a mean score of 3.38, 54% of TEs agree that they don't have adequate personal devices. Similarly, a considerable number of respondents (42%) agreed with insufficient confidence to integrate ICTs into their teaching practices (M = 3.06) and lack of digital skills to use ICT effectively 42% of TEs (M = 2.94).

Table 4

Individual Level Challenges of ICT Integration

Statements	%					M	SD
	SD	DA	U	A	SA		
I don't have necessary digital skills to use ICT in my teaching effectively	10	36	12	34	8	2.94	1.20
I don't have ICT integration plan	16	32	14	24	14	2.88	1.33
I don't feel confident in my ability to integrate ICT into my teaching practices	20	12	26	26	16	3.06	1.36
I don't have sufficient time to prepare ICT integrated lessons	16	22	30	26	6	2.84	1.16
I am not confident in my pedagogical knowledge	10	14	18	34	24	3.48	1.28
I don't have sufficient personal devices to integrate ICT	4	26	16	36	18	3.38	1.17
Grand Mean						3.08	1.25

In contrast, a notable portion of respondents did not firmly agree that lack of ICT integration plan and lack of time to prepare ICT-integrated lessons are major obstacles to using ICT in their teaching-learning activities, with cumulative percentages of agreement of respondents for these statements being 38% and 32%, respectively.

The quantitative results show that most TEs do not incorporate a variety of ICT tools, including basic ones, into their instructional practices. The findings also highlight various individual and institutional challenges that TEs perceive as obstacles to effective ICT integration.

Similar to the quantitative result, the qualitative data from individual interviews revealed critical institutional and individual-level challenges that TEs face when integrating ICT into their instructional practices. The qualitative findings of this study reveal two main themes underlying institutional-level challenges: infrastructure and resources, and institutional ICT planning and support. From these themes, three critical challenges emerged, consistently highlighted by all interviewees (100%) across the colleges involved in this study: insufficient pedagogical support for teacher educators (TEs), inadequate in-service training opportunities, and lack of adequately equipped classrooms. Colleges lack structured guidance and adequate resources to support TEs in delivering quality education, and limited access to professional development constrains their ability to keep pace with contemporary educational demands. Several participants emphasized that effective ICT integration requires both pedagogical knowledge and technical competence; however, they reported insufficient institutional support to develop these skills. For instance, one TE explained that although efforts are made to incorporate ICT into classroom practice, the absence of formal training creates uncertainty about whether ICT is being used appropriately, noting that “official training has never been conducted for TEs in our college” (TE1).

Institutional support for ICT integration was widely perceived as inadequate across all participant groups. Similar to TE1, DHI3 acknowledged a lack of pedagogical guidance and formal institutional training for incorporating ICT into teaching and learning. As the ICT department head, DHI3 admitted that although ICT training sessions are planned annually, none have been implemented to date. However, ICT support is generally provided informally when staff experience challenges, suggesting the absence of organized and sustained professional development initiatives.

This lack of institutional direction was consistently echoed by all participants, including college deans, who unanimously reported the absence of a clearly defined and operational ICT plan. While institutions reportedly possess ICT plans and allocated budgets, participants emphasized that these plans lack concrete technical details, infrastructural specifications, and clear mechanisms for implementation, monitoring, and evaluation. As a result, progress in ICT integration remains limited and fragmented.

In addition to planning and training gaps, participants frequently cited infrastructural constraints as a major institutional challenge. Issues such as limited access to ICT equipment, slow internet connectivity, frequent power interruptions, and insufficient maintenance services were repeatedly mentioned. Half of the TE interviewees indicated that the scarcity of essential resources discourages them from integrating ICT into their teaching. For example, several participants reported preparing digital instructional materials but being unable to use

them in classrooms due to the limited availability of LCD projectors, forcing them to rely on printed handouts instead.

Beyond institutional factors, the findings also revealed substantial individual-level challenges that further hinder ICT integration. These challenges were grouped into three major themes: digital skills and knowledge, access to personal ICT tools, and planning and preparation. A large proportion of participants (83%) reported limitations in pedagogical knowledge, confidence, and ICT integration skills, which affected their ability to align technology use with instructional objectives. Many participants noted that they focused more on operating technology than on designing ICT-supported pedagogical strategies, often finding ICT-based lesson planning time-consuming and confidence-reducing.

Access to personal ICT tools also emerged as a significant barrier, with 83% of participants reporting inadequate access to personal computers and reliable internet connectivity. Some TEs relied heavily on shared institutional computers, which were often unavailable due to high demand, further constraining lesson preparation and ICT use.

Finally, all participants acknowledged the absence of a structured personal ICT integration plan, which they believed negatively influenced their teaching practices. While some TEs reported using ICT flexibly and selectively based on perceived instructional value, the lack of deliberate plans limited systematic and effective integration. Overall, participants' responses underscore the combined impact of institutional and individual barriers and highlight the urgent need for structured training, clear planning, and improved resource provision to support meaningful ICT integration in teaching and learning.

Discussion

This study aimed to explore how TEs utilize ICT in their Biology teaching and how their personal characteristics influence these practices. It also explored the challenges that TEs face in integrating ICT in colleges of teacher education. The overall findings from the quantitative and qualitative data revealed that TEs predominantly use specific ICT tools such as web browsers, email, Microsoft Office, and social media in their teaching. The study revealed an intriguing paradox: while the majority of TEs (83%) confidently believed that ICT is essential for teaching challenging biology concepts, a significant number did not translate this belief into practice. Between 14% and 42% of TEs reported that they use ICT tools like LCD projectors and advanced software only occasionally, and 8% to 26% admitted to never using them at all. Besides, one-sample t-test results indicate that TEs' ICT usage is not significantly above average, suggesting only a moderate level of ICT integration. This gap underscores disconnects between their beliefs and classroom practices, pointing to potential barriers to ICT adoption in teaching.

Studies show that positive ICT beliefs often enhance its use in education (Halim & Sulaiman, 2020; Ngao et al., 2022). However, our findings align with Taimalu and Luik (2019), revealing no significant link between TEs' ICT beliefs and their actual usage. In addition, the limited use of advanced tools like animations, simulations, and specialized software among many TEs aligns with findings from studies by Scherer et al. (2019), where a significant portion of educators rarely or never engage with these resources. This suggests a

missed opportunity to enhance lesson delivery and engagement through the use of more dynamic presentation tools, which could potentially improve the learning experience.

Studies have shown that teachers tend to adopt technologies that are easy to use, readily available, and perceived as beneficial for their instructional needs (Tondeur et al., 2017). However, research suggests that the effective integration of ICTs, beyond just basic tools, can enhance student engagement, improve learning outcomes, and promote higher-order thinking skills (Dini et al., 2024). Therefore, the result of this study highlights the importance of providing TEs with the necessary support, training, and resources to integrate a wider range of ICT tools into their instructional activities in order to maximize the potential benefits for student learning.

A one-way ANOVA shows a significant difference in ICT integration between TEs aged 31-40 and those aged 41-50, with the younger group demonstrating higher integration levels. The observed effect size ($\eta^2 = 0.12$) represents a moderate practical significance, indicating that the difference between these age groups is educationally meaningful. This suggests that age contributes appreciably to variations in ICT integration practices, with early-career teachers being more open to new technologies while more experienced teachers may be resistant or lack confidence and skills. Additionally, TEs with 11-20 years of experience show higher ICT integration than those with 21-30 years with a large effect size ($\eta^2 = 0.16$), indicating considerable variation in ICT use, aligning with Tondeur et al. (2017) on the complex relationship between experience and technology use. Moreover, the study's findings indicate that older, more experienced teachers generally have less ICT usage. This aligns with research by Bingimlas (2018), which identified age and experience as significant factors in technology adoption and integration. Similarly, Basargekar and Singhavi (2017) found notable differences in perceptions based on teachers' age and years of experience. Kollia et al. (2020) also reported that older, more experienced instructors are less likely to incorporate ICT due to negative perceptions and reluctance to change. However, Abidoye and Adeyemi (2020) found that in Nigeria, Biology teachers' perceived ICT usage for instructional activities did not significantly differ based on their teaching experience.

Unlike the finding of this study, Peng et al. (2023) suggests that experienced teachers can be more effective at integrating ICT due to their deeper understanding of pedagogical practices and their ability to leverage technology effectively. These variations in ICT utilization by age and teaching experience underscore the importance of tailored professional development programs that address the unique needs and contexts of TEs.

The findings of this study identified insufficient pedagogical support, inadequate in-service training opportunities, lack of classrooms with the necessary facilities, and a lack of a clear institutional ICT plan as key institutional-level challenges of TEs in confidently integrating both basic and advanced ICT tools into their teaching process. These findings are consistent with Ghavifekr and Rosdy's (2015) emphasis on the importance of professional development programs for teachers to enhance their pedagogical skills in using ICT. Studies by Bingimlas (2018) and Yizengaw and Nigussie (2023) identified lack of access to resources as a major barrier to ICT integration. As Tondeur et al. (2017) note, the absence of a well-defined institutional ICT plan is a great challenge. He highlighted the need for a clear, shared vision and strategic planning for successful ICT integration in educational institutions.

Whereas, lack of confidence in pedagogical knowledge, limited access to personal devices, and insufficient digital skills and confidence are key individual level challenges. Furthermore, the time-consuming nature of creating lessons and experimental tasks using ICT and a preference for traditional teaching methods are found as barriers. This finding is in line with a study by Taimalu and Luik (2019), who found that teachers' self-efficacy beliefs are significant predictors of their ICT integration in teaching. This finding is also consistent with Joshi and Khatiwada (2024), who identified lack of personal access to computers as a significant barrier to ICT integration. Moreover, this result is consistent with Nzika (2019), who observed that those lecturers' insufficient perceived ICT abilities hinder them from effectively using educational technologies in teaching. Overall, the findings of this study emphasize the need for tailoring professional development programs to the individual requirements and settings of TEs at various career stages in order to achieve education goals in developing countries such as Ethiopia in science courses like Biology.

Conclusion

The study concluded that most TEs primarily use basic ICT tools when teaching biology, underutilizing more sophisticated ones which could help them to improve instruction and student participation. The study discovered that, in comparison to their older and more experienced peers, younger and less experienced TEs exhibit higher degrees of ICT integration. Offering professional development programs specifically designed to meet the requirements and circumstances of TEs at various career phases is crucial.

According to this study, main institutional-level challenges include insufficient pedagogical support, inadequate in-service training, a lack of well-equipped classrooms, and the absence of a clear institutional ICT plan. At the individual level, TEs struggle with limited confidence in their pedagogical knowledge, access to personal devices, and digital skills, as well as a preference for traditional teaching methods.

Given these conclusions, we recommend that teacher education colleges devote more attention to the use of ICT for teaching and learning. They should provide comprehensive support, training, and resources to enable TEs to effectively integrate a wider range of ICT tools into their teaching, thereby maximizing the potential benefits for student learning and engagement. TEs should also make excellent use of technology in their lessons in a way that their prospective teachers can embrace the benefits of ICT in educational practices.

Limitations of the study

The study was limited to Biology TEs in three colleges of teacher education in Ethiopia; this restricts the results' generalizability beyond these specific institutions. Therefore, future studies in this area should encompass a more diverse range of colleges and TEs in other fields of study to gain broader insights into TEs ICT integration practices and the challenges they encounter. Furthermore, TEs' age and teaching experience were the only demographic characteristics involved in this study. Future research should take into account additional parameters.

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The role of teachers' core instructional practices in predicting Amharic reading achievement among early grade students

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Abstract

This study examined the influence of teachers' core instructional practices—planning, classroom management, and assessment—on early grade students' reading achievement. Using correlational design, the study involved 160 Grade 2 and Grade 3 students and 8 Amharic language teachers from Ewket Fana, Dilchibo, Shimbit, and Teyima elementary schools in Bahir Dar during the 2025 school year. Data were collected through reading tests, classroom observations, and document analysis. The data were analyzed using bivariate linear regression. The results showed a significant positive association between teachers' instructional practices and students' performance in letter-name identification, reading of familiar and nonsense words, oral reading fluency, and reading comprehension. Planning practice ($\beta = .721-.946$, $R^2 = .519-.896$, $p < .05$), classroom management ($\beta = .718-.794$, $R^2 = .515-.630$, $p < .05$), and assessment practice ($\beta = .714-.828$, $R^2 = .510-.685$, $p < .05$) emerged as significant predictors of reading achievement. However, teachers' planning and assessment practices were not significantly associated with students' phonemic awareness ($\beta = .304-.608$, $R^2 = .093-.370$, $p > .05$). Overall, the findings indicate that, except for phonemic awareness, teachers' core instructional practices substantially predict early grade reading achievement in the Amharic context.

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ቋንቋን በመማር ሂደት ትኩረት ተሰጥቷቸው ሊዳብሩ ከሚገባቸው ክሂሎች መካከል የማንበብ ችሎታ በዋናነት ይጠቀሳል። ጥናቶች እንደሚያሳዩት በማንበብ ችሎታና በአካዳሚያዊ ስኬት መካከል ጠንካራ አዎንታዊ ዝምድና አለ። Zebbron (2022) እና Cardenas (2024) እንዳመለከቱት የማይቋረጥ የማንበብ ተግባር የቃላት ዕውቀትን ያሻሽላል፣ የማስታወስ ችሎታን ያሳድጋል፣ ለነገሮች ትኩረት የመስጠትና በጥልቀት የማሰብ ችሎታን በማሳደግ ሐሳቦችን ከተለያዩ አቅጣጫ የመመልከትና

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የመተንተን፣ ከዳህራዊ ግንዛቤ ጋራ የማዋላድ ችሎታን ያሳድጋል፤ እነዚህ የዳበሩ ችሎታዎች በሁሉም የትምህርት ዓይነቶች ስኬት እንዲገኝ ያስችላሉ። Cox (2024, p.3) በበኩላቸው “የማንበብ ክህሎት የመማሪያ መንገድን የሚወስን ነው” በማለት ማንበብ የአካዳሚያዊ ስኬት መግቢያ በር መሆኑን ገልጾታል። Cardenas (2024) እንዲሁ፣ አሁን ካለው የዲጂታል ዓለም በቀላሉ ከሚገኙ ዓይነተ-ብዙ የጽሑፍ ዘውጎች መካከል የሚጠቅመውን ብቻ በጥልቀት ገምግሞ በመውሰድ ለስኬት መብቃት የሚቻለው አንብቦ በመረዳት ችሎታ እንደሆነ ያስረዳሉ።

የማንበብ አካዳሚያዊና የእድሜ ልክ መማር ስኬቶች እውን እንዲሆኑ በዋናነት መሠረት በሚጣልበት ደረጃ ለክህሎት ትኩረት መስጠት ያስፈልጋል። ይህንን በተመለከተ Hogenboom (2022, p.11) “የልጆች ቀደምት የቋንቋ ልምዶች ለቀጣይ ስኬቶቻቸው መሠረት ነው።” ሲሉ፣ Kern and Friedman (2009) ደግሞ ቀደምት ስኬት፣ ወደጥሩ አካዳሚያዊና ሥነልቦናዊ አቅጣጫ የሚያመራ አዎንታዊ የሕይወት ዘመን ስኬት ይወስዳል፤ በማለት ይገልጻሉ። ይህን ሐሳብ Li (2015, p. 2) “ልጅነት በቀላሉ ማንበብ የሚለመድበት ነው” (“Earlier is Easier”) ይሉታል። በአጠቃላይ በመጀመሪያዎቹ የክፍል ደረጃዎች ለማንበብ ትኩረት መስጠት የሚከተሉት አምስት ጥቅሞች አሉት፤ (ሀ) ኒዩሮሎጂካል፣ ልጆች ሲያነቡ የአንጎል ሴሎች ድር ይጠነክራል፤ አዳዲስ ድሮች ይፈጠራሉ፤ ይህም አንጎልን በፍጥነት ያዳብራል። በዚህም በመጀመሪያዎቹ የክፍል ደረጃዎች (ልጆችን ከቀጣዮቹ እድሜዎች ይልቅ) በቀላሉ በጣም ፈጣን አንባቢዎች ማድረግ ይቻላል፤ (ለ) አካዳሚያዊ፣ ኒዩሮሎጂካል መዳበሩ ከመነሻው አካዳሚያዊ ስኬት እንዲፈጠር ያደርጋል፤ (ሐ) ሥነልቦናዊ፣ ቀደም ብሎ ማንበብና አካዳሚያዊ ስኬት ያገኙ ልጆች በራስ መተማመን (ግለ-ብቃት እምነት) ይኖራቸዋል፤ (መ) ማህበራዊ፣ ማህበራዊ ግንዛቤያቸው ያድጋል፤ ከቢጤዎቻቸው መካከል ያላቸው ማህበራዊ ደረጃ ከፍ ይላል፤ (ሠ) ቋንቋ ነክ፣ ከጅምሩ የበለጸገ የቃላት፣ የሰዎች፣ የጽሕፈትና የተግባር ሰው-ቀትና ክህሎት ለእድሜ ልክ መማር ወሳኝ ይሆናል (EAES, 2022; Hogenboom, 2022; Kern & Friedman, 2009; Li, 2015)። NRP (2000)፣ Read M&E (2018) እና RTI International (2016) የማንበብን በልጅነት የመማር ጠቀሜታ በተመለከተ ከላይ የቀረቡ ሐሳቦችን ሲያጠናክሩ፣ እድሜ ሲጨምር ማንበብ መማር ከባድ ይሆናል፤ በአንደኛ ደረጃ ትምህርት በመጀመሪያዎቹ የክፍል ደረጃዎች ማንበብ በበቂ ሁኔታ የተማሩ ልጆች ደረጃውን በስኬት የማጠናቀቅ እድላቸው ከፍ ያለ ሲሆን ይህንን ዕድል ያላገኙ ግን ክፍል የመድገምና ትምህርት የማቋረጥ እድላቸው ይጨምራል።

በመጀመሪያዎቹ የክፍል ደረጃዎች ትኩረት ሊደረግባቸው የሚገቡ የማንበብ አላባዎች፣ የንግግር ድምፆች ግንዛቤ (phonemic awareness)፣ ትዕምርተ-ድምጻዊ ግንዛቤ (graphophonemic awareness)፣ አቀላጥፎ ማንበብ (reading fluency)፣ የቃላት ዕውቀት (vocabulary knowledge) እና አንብቦ መረዳት (reading comprehension) ናቸው (NRP, 2000)። Lin (2001) እነዚህ አላባዎች በጀማሪ ክፍሎች፣ መምህራን የሚያተኩሩባቸውና የሚመዘኗቸው፣ ወላጆች የልጆቻቸውን የቋንቋ ችሎታ በተመለከተ የሚጠይቋቸው እንደሆኑ ሲገልጹ፣ RAES (2018, p. 8) በበኩላቸው “አምስት መሠረታዊ የማንበብ አላባዎች” (“the big five of reading”) ይሏቸዋል። እነዚህ አላባዎች ለስኬታማ የማንበብ ሂደት ወሳኝ ናቸው፤ ለእድሜ ልክ መማር ስኬትም ጠንካራ መሠረት ይጥላሉ (Bower, 2017)። አላባዎቹ ጥራት ላለው የመሠረታዊ ማንበብ-መጻፍ ክህሎት (literacy) ትምህርት ወሳኝ ስለሆኑ በመጀመሪያ ደረጃ ትምህርት (በልጅነት ዘመን) ልዩ ትኩረት ሊሰጣቸው ይገባል (NRP, 2000)።

የንግግር ድምፆች ግንዛቤ፤ ቃላት በሚነበቡበት/በሚጠሩበት ጊዜ በውስጣቸው ያሉ አነስተኛ ቅንጣቶችን (ድምፆችን) ማዳመጥ፤ ነጥሎ ማመልከትና በድምፆቹ መገልገል (ድምፆችን መነጠል፤ ማጣመር፤ ተመሳሳዮችን ማመልከት፤ መነሻውን፤ መካከለኛውንና መድረሻውን ድምፅ መለየት/መጥራት ወዘተ) መቻል ነው (EAES, 2022; Cox, 2024; George, 2023; Gump, 2024; Read M&E, 2018; RTI International, 2016):: NRP (2000) በ52 የጥናት ውጤቶች ላይ ልዕላ-ትንተና አካሂደው፤ ሕጻናትን የንግግር ድምፅ ግንዛቤ በማስተማር $d = 0.53 - 0.86$ የተጽዕኖ መጠን (effect size) ያለው ውጤት እንደተገኘና ክሂሉ የማንበብ ችሎታቸው ዝቅተኛ ለሆኑ ሕጻናት ወሳኝ ትምህርት እንደሆነ አመለካከተዋል:: ትዕምርተ-ድምጻዊ ግንዛቤ የፊደል-ድምፅ ግንኙነት ነው:: የንግግር ድምፆችን ከጽሑፋዊ ምልክቶቻቸው ወይም ፊደሎች ጋራ አዋህዶ ማንበብ/መጥራት (decoding) ነው (Cox, 2024; George, 2023; RAES, 2018):: NRP (2000) በ38 ጥናቶች ላይ ልዕላ-ትንተና አድርገው 76% መምህራን ይህንን ክሂል በማስተማራቸው (ክሂሉን ከማይጠቀሙት ይልቅ) ውጤት/ለውጥ እንዳገኙና የተጽዕኖ መጠኑም በጀማሪ ክፍል ደረጃ ተማሪዎች ላይ ከፍ ያለ መሆኑን (effect size $d = 0.44$) አመለካከተዋል::

አቀላጥፎ ማንበብ፤ አንድን ጽሑፍ በተገቢ ፍጥነት (rate)፤ በትክክል (accuracy) እና በተገቢ አገላለጽ (prosody) ማንበብ መቻል ነው:: አቀላጥፎ የማንበብ የመጨረሻ ግብ አንብቦ መረዳትን እውን ማድረግ ሲሆን፤ ይህ ግብ እንዲሳካ ደግሞ በተደጋጋሚ ልምምድ የተማሪዎች በፍጥነት የማንበብ፤ በትክክልና በተገቢ አገላለጽ ቃላትን የመጥራት ችሎታ እንዲዳብር ማድረግ ያስፈልጋል (EAES, 2022; Read M&E, 2018; RTI International, 2016):: ክሂሉ ተማሪዎች በአንድ ደቂቃ ምን ያህል ቃላትን በፍጥነት፤ በትክክልና በተገቢ አገላለጽ ማንበብ ቻሉ? የሚለውን ይመለከታል (RAES, 2018):: በኢትዮጵያዊያን ተማሪዎች ላይ በተካሄደ ሀገርአቀፍ ጥናት፤ ተማሪዎች በአንድ ደቂቃ በፍጥነት፤ በትክክልና በተገቢ አገላለጽ የሚያነቧቸው ቃላት ቁጥር ሲጨምር አንብቦ የመረዳት ችሎታቸውም እያደገ እንደሚሄድ ተመለክቷል (Piper, 2010)::

የቃላት ዕውቀት፤ ሐሳብን በመግለጽና ሐሳብን በመቀበል ሂደት ጥቅም ላይ የሚውሉ ቃላትን በትክክል ማንበብና ፍቻቸውን በትክክል መለየት መቻል ነው (EAES, 2022; RAES, 2018; Read M&E, 2018; RTI International, 2016):: Cox (2024) እንደሚሉትም ማንኛውንም አሁኖ ለመረዳት የቃል ንብትና ፍቺ ዕውቀት ወሳኝ ነው:: የሕጻናት የቃላት ዕውቀት ከፍ ያለ ከሆነ (የአሁኑን 90% ቃላት የሚያውቁ ከሆነ) ንብታቸው ንግግርአክል ይሆናል፤ የቃላቱን ፍቺ በቀላሉ መለየት ይችላሉ፤ የተለያዩ የጽሑፍ ዘውጎችን አንብቦ የመረዳት ችሎታቸው ያድጋል (George, 2023; Goldberg, 2025)::

አንብቦ መረዳት፤ በቃል፤ በዓረፍተነገር፤ በአንቀጽና በሙሉ ጽሑፍ ደረጃ በግልጽና በአመስጥሮ የቀረቡ ጽሑፋዊ ሐሳቦችን መተርጎምና መጠቀምን ይመለከታል (EAES, 2022; RAES, 2018; Read M&E, 2018; RTI International, 2016):: Cox (2024) እንደሚሉት ክሂሉ ቀደም ብለው የተገለጹ ክሂሎች ድምር ውጤትና የማንበብ ትምህርት የመጨረሻ ግብ ነው:: ዕውቀትና መረጃዎችን በመለየት፤ በመተንተን፤ በማብላላትና ከዳራዊ ዕውቀት ጋራ አዋህዶ መረዳትን እውን ለማድረግ ደግሞ አንድምታ የመመሥረት፤ በጥልቀት የማሰብ፤ ጥያቄ የመጠየቅ፤ ዳራን ከጽሑፋዊ አሁኖ መረጃዎች ጋራ የማዛመድና የመሳሰሉ በርካታ ንኡሳን ክሂሎችን ማዳበር ያስፈልጋል (George, 2023)::

A'yunin (2020) እና Untailawan (2020) እንደሚሉት አንብቦ የመረዳት ክሂል ላይ ተፅዕኖ አድራሽ ተላውጦዎች በርካታ ሲሆኑ፤ ከእነዚህ መካከል ከተማሪዎች ሁኔታ፤ ለትምህርት ከቀረበው

ውሕድ-አሐድ ባሕርይና ከአካባቢያዊ ሁኔታዎች ጋራ የተያያዙ ተላውሎዎች ይጠቀሳሉ። Francisco and Celon (2020) እና Karngebae and Kennedy (2022) ደግሞ የመምህራን የትምህርት ዝግጅትና አቀራረብ (teachers' instructional practices) ጠንካራ ተፅዕኖ አድራሽ ተላውሎ እንደሆነ ይከራከራሉ። ዳሕፍቱ አያይዘውም፣ የመምህራን የቅድመ-ዝግጅት፣ የማስተማር ሂደትና፣ ሂደቱንና ውጤቱን የመገምገም ተግባራት በተማሪዎች የማንበብ ችሎታ ላይ ወሳኝ ጉዳዮች እንደሆኑ ያስረዳሉ። የተማሪዎች የማንበብ ችሎታ እንዲሻሻል ቊልፍ ተግባራትን (ማቀድ፣ የክፍል አመራር፣ መመዘን) በቅንጅት ማከናወን የግድ እንደሆነ ደግሞ Bibon (2022)፣ Calonia et al. (2023) እና Ullah et al. (2021) ይገልጻሉ።

ቀዳሚው ቊልፍ ተላውሎ ማቀድ ነው፤ ማቀድ ታሳቢ የሚደረገውን ግብ ዒላማ ያደርጋል፤ ግቡ በትምህርቱ ዓላማ ውስጥ በግልጽ ይመለከታል፤ ለዓላማው መሳካት አስፈላጊ ግብዓቶች (የትምህርት ይዘቶች) ይቀርባሉ፤ ግብዓቶችን ለመጠቀም የሚያስችሉ ስልቶች (የመማር ዘዴዎች) እና መርጃ መሣሪያዎች ይለያሉ፤ በሂደቱ ዓላማዎች እየተሳኩ መሆኑን፣ በማጠናቀቂያው ላይ ደግሞ ዓላማዎች መሳካታቸውን መመርመር የሚያስችሉ ምዘናዎች ይሰፍራሉ (Calonia et al., 2023; Saad et al., 2010)። እነዚህን ቅድመ-ዝግጅቶች በትክክል ማከናወን የመማር ማስተማር ሂደቱ በአግባቡ እንዲከናወን ያስችላል (Bibon, 2022)። Farhang et al. (2023) እንደሚያስረዱትም፣ በትክክል የታቀደ ትምህርት ግማሽ እንደተፈጸመ ይቆጠራል፤ ለዚህም ተፈላጊ ተግባራት መካተትና አፈጻጸማቸው መመለከት ይኖርበታል (König et al., 2021)። Enow and Goodwyn (2018) እንዲሁም Lai and Lam (2011) ይህንን ሐሳብ ሲያጠናክሩ፣ የተማሪዎች የማንበብ ችሎታ እንዲዳብር ከተፈለገ እርምጃው ትምህርትን ከማቀድ መጀመር ያስፈልጋል፤ ተግባሩም በዕውቀት መመራትና መፈጸም ይኖርበታል። እቅድ መማር ማስተማርን ይመራል፤ ማንኛውም የማስተማርም ሆነ የመማር እንቅስቃሴ ትኩረት ውጤት ላይ እንዲሆን ያስችላል (Chizhik & Chizhik, 2018; Janssen et al., 2019)።

ትምህርትን በውጥ ማቀድ ብቻውን የግብ ስኬትን አያስገኝም፤ እቅዱ በውጥ በክፍል ውስጥ መተግበር ይኖርበታል፤ በቅድመ-ትምህርት፣ በትምህርቱ ሂደትና ማጠቃለያ ሊከውኑ የሚገባቸው የመማርና የማስተማር ተግባራት በእቅዱ መሠረት መፈጸም ይኖርባቸዋል (Osborne, 2021; Zhu & Kaiser, 2022)። ለዚህ ደግሞ የመማሪያ ክፍሉን በሚገባ ማደራጀትና መምራት ይጠበቃል (Wenglinsky, 2001)። ይህ ሁለተኛ ቊልፍ ተላውሎ (ማደራጀትና መምራት) የመማሪያ ክፍልን በዕውቀት መምራት ተማሪዎች የትምህርቱን ዓላማና ይዘቶች በግልጽ እንዲለዩ፣ ቅድመ-ትምህርት፣ የትምህርት ሂደትና ድጎረትምህርት ተግባራትን በነቃ ተሳትፎ እንዲያከናውኑ፣ ለተግባራቱ የተመደበውን ሰዓት በተገቢው ሁኔታ እንዲጠቀሙ፣ የመምህራን ክትትልና ድጋፍ ተጠቅመው የትምህርቱን ዓላማ እንዲያሳኩ ይረዳል (Adeleke & Akere, 2023; Bas, 2025; Olayvar, 2021; Ozdemir, 2020)። Beaulieu (2023) እንደሚያብራሩት፣ ክፍልን መምራት የታቀደው ይዘት ወደተማሪዎች ግልጽና ሳቢ ሆኖ እንዲደርስና የትምህርቱ ዓላማ እንዲሳካ ምቹ የመማር አካባቢን መፍጠር ነው፤ ይህ ደግሞ የዕለት ተዕለት ትምህርትን የሚፈለግና የሚወደድ ያደርጋል። Chibsa (2024)፣ Farook and Ahmed (2021)፣ Terada (2019) እና Thomas et al. (2010) እንደሚገልጹትም ክፍልን መምራት፣ የትምህርት ግብዓቶችን በሥርዓት በማደራጀት ለመማር ማስተማር ሂደቱ ጥቅም ላይ እንዲውሉ በማድረግ፣ የተማሪዎችን ተሳትፎ በማረጋገጥና አላስፈላጊ ባሕርያትን በመቆጣጠር እውን የሚሆን ቊልፍ የማስተማር ተግባር ነው።

ሠስተኛው ቊልፍ ተላውጦ ምዘና ነው። ምዘና የመማር ማስተማር አካል ነው፤ በትምህርቱ ሂደት ሲተገበር ክፍተቶችን እየለዩ ማስተካከያ ማድረግ ያስችላል፤ በትምህርቱ ማጠናቀቂያ ላይ ሲመጣ ደግሞ የዓላማውን መሳካት/አለመሳካት ያረጋግጣል፤ ቀጣይ የመማር ሂደቶች የበለጠ ውጤታማ እንዲሆኑ መነሻ ይሆናል (Calonia et al., 2023)። Li (2012) እና Ullah et al. (2021) እንደሚገልጹትም፣ ውጤታማ የመማር ሂደት በምዘና ይደገፋል፤ ከምዘና ትምህርት ይገኛል፤ ክፍተት ይለያል፤ ማስተካከያ ብልቃቶች ይመለከታሉ፤ ቀጣይ የተሻለ ይሆናል። ምዘና እያንዳንዱን የትምህርት ሂደት (መግቢያ፣ ዋና የትምህርት ክፍል፣ ማጠቃለያ) ይመለከታል፤ በእያንዳንዱ ደረጃ የተማሪዎች ክፍተት እየተለየ ድጋፍ ይሰጣል፤ ማስተካከያ ይደረጋል፤ ይህም የዕለቱን ትምህርት ዓላማ በታቀደው ልክ ውጤታማ የመሆን እድል ያሰፋል። ከዚህ በተጨማሪ ምዘና ለስኬትም ሆነ ለውድቀት ተጠያቂነትን ለማስፈንና በተለይም ድክመቶች እንዲስተካከሉ አቅጣጫ ለማመላከት ወሳኝ ጉዳይ ነው (Cai et al., 2022; Xuan et al., 2022)። ከተጠያቂነት ባሻገር ምዘና ውጤታማ ፈጻሚዎችን በማበረታታት ለሌሎች አርአያ እንዲሆኑ የሚያስችል ዐቢይ የመማር ማስተማር ሂደት አካልም ነው (Yan & Chiu, 2022)።

ውጤታማነቱ በማቀድ፣ በማደራጀትና በመምራት፣ እንዲሁም በመመዘን ተግባራት ጥራት ላይ በሚመሠረተው የማንበብ ችሎታ ላይ ትኩረት ማድረግ፣ እንዲሁም በጀማሪ የክፍል ደረጃዎችና በማንበብ አላባዎች ትምህርትና ምዘና ላይ ማተኮር፣ በምርምርና በተግባር የተፈተኑ ንድፈ-ሐሳባዊና ብልቃታዊ መሠረቶች አሉት። ከመሠረቶች መካከል በዋናነት ማንበረ-አእምሯዊ ንድፈ-ሐሳብ (social-cognitive theory) እና ሁሉ-አቀፍ መሠረታዊ ማንበብ-መጻፍ ክህሎች ትምህርት (comprehensive or Holistic literacy instruction) በመምህራን ቊልፍ የማስተማር ተግባራትና በተማሪዎች አንብቦ የመረዳት ችሎታ ላይ ለሚያተኩረው ለዚህ ጥናቱ መሠረቶች ናቸው። ትምህርት በግለሰባዊ ባሕርይና ክህሎች እድገት ላይ ያተኩራል፤ የባሕርይና የክህሎች እድገት ደግሞ በትምህርት ታሪክ ቀዳሚ ተጠቃሽ በሆነው የአልበርት ባንዱራ ማንበረ-አእምሯዊ የመማር ንድፈ-ሐሳብ ላይ ይመሠረታል (Bandura, 1977)። በመማር ሂደት ለአእምሯዊ ግንዛቤ ትኩረት የሚሰጠው ማንበረ-አእምሯዊ ንድፈ-ሐሳብ በዋናነት በምልክታዊ ሚና (ሌሎች የሚሠሩትን በመመልከት/በመኮረጅ መማር)፣ አርአያ ሆኖ በማሳየት (አርአያተኮር ትምህርት፣ የሚና ጨዋታና አስመስሎ ማቅረብ) እና የመማር ሂደትን በማጠናከር ላይ ትኩረት ያደርጋል (Widodo & Astti, 2024)። ብቃት ያላቸው አርአያዎች፣ በመማር ስኬት ላይ አዎንታዊ ተፅዕኖ ይኖራቸዋል፤ አርአያዎችን ምሳሌ ማድረግና እነሱን በመመልከት መማር “እኔም እችላለሁ!” የሚል ግለ-ብቃት እምነትን ይፈጥራል፤ ግለ-ብቃት እምነታቸው ከፍ ያለ ተማሪዎች ደግሞ ከፍተኛና ጥራት ያለው የትምህርት ውጤት ይሻሉ፤ ከፍተኛ ጥረት በማድረግም ውጤቱን እንደሚያሳኩ ያምናሉ (Yilmaz & Yilmaz, 2019)።

በምልክታና ከአርአያዎች በመማር ሂደት ልዩ ልዩ የማንበረሰብ ክፍሎች (ለምሳሌ፣ ወላጆች፣ መምህራን፣ ቢጤዎች) የተማሪዎችን የማንበብ ተግባር በተመለከተ የሚሰጧቸው አዎንታዊ ምጋቤምላሾች መማርን በማጠናከር ተማሪዎች ለውጤት እንዲበቁ ያስችላሉ (Lim, 2015)። ማንበረዊ መስተጋብሩ የተማሪዎችን የመማር ተሳትፎ ይጨምራል፤ በትብብራዊ ተራክቦ አማካኝነት የመማር ትጋትን ይፈጥራል፤ ማንበረዊ ተግባራትን ያሳድጋል፤ በጋራ የመሥራት፣ ግጭቶችን በራስ የመፍታትና ማንበረዊ ክህሎችን የማሳደግ አቅምን ይፈጥራል (Widodo & Astti, 2024)። Yilmaz and Yilmaz (2019) ማንበረዊና አእምሯዊ ችሎታን በማሳደግ ላይ የሚያተኩረው ማንበረ-አእምሯዊ ንድፈ-ሐሳብ የጀማሪ የክፍል ደረጃ ተማሪዎችን ማንበረዊና ሞራላዊ ስሜት በማሻሻል ረገድ አዎንታዊ ሚና እንዳለው ሲገልጹ፣

Eekhof et al. (2021) ደግሞ የንድፈሐሳቡን ብልሃቶች (በምልከታ መመዘኛ፣ አርአያነትና ትምህርትን ማጠናከር) በመጠቀም የጀማሪ ክፍል ደረጃ ተማሪዎችን የማንበብ ችሎታ ማዳበር እንደሚቻል ያስረዳሉ፤ በትክክል ማንበብ፣ በፍጥነት ማንበብ፣ በተገቢ ቅጻዬ ማንበብ በብዛት አርአያዎችን በመመልከት (በማዳመጥ) የሚለመዱ፣ በተደጋጋሚ ጥረት የሚዳብሩ ናቸው።

የማንበብ ችሎታ እንዲዳብር ደግሞ የማንበብ አላባዎችን (የንግግር ድምፅ ግንዛቤን፣ የድምፅ የፊደል ግንኙነት ግንዛቤን፣ አቀላጥፎ ማንበብን፣ የቃላት ዕውቀትንና አንብቦ መረዳትን) በተናጠል ሳይሆን በቅንጅት ማስተማር (Holistic approach) አስፈላጊ ነው (NRP, 2000):: Castles et al. (2018) እንደሚያስረዱትም ክህሎቶችን በተፈጥሮ ቅደምተከተላቸው ከማስተማር ይልቅ አቀናጅቶ ማስተማር ውህድ ዕውቀትና ክህሌት እንዲኖር ያስችላል፤ አንብቦ በመረዳት ጊዜ ድምጽን የመለየት፣ ፊደሎችን ከትዕምርቶቻቸው ጋር የማዛመድ፣ ቃላትን የመለየትና አቀላጥፎ የማንበብ ሂደቶች ይኖራሉ፤ በአቀላጥፎ ማንበብም ጊዜ እንዲሁ ሌሎች አላባዎች ይካተታሉ። ይህ ቅንጅታዊ ሂደት ተማሪዎች የማንበብ አላባዎችን በማዋሃድ ከፍተኛ አንብቦ የመረዳት ችሎታ እንዲኖራቸው ከማድረጉም በተጨማሪ የተለያዩ ዘውግ ያላቸው፣ አዳዲስ ቃሎችን፣ አገላለጾችንና ጽንሰሐሳቦችን ያካተቱ ውሕድአሐዶችን በቀላሉ አንብበው እንዲረዱ ያስችላቸዋል (Rayner et al., 2001)::

ባጠቃላይ ከላይ የተቃኙትን ጠንካራ የንድፈሐሳብ ማህበራዊ ሰፊ የምርምር ግኝቶች መሠረት የሚያደርገው ማንበብ፣ መምህራን በሚያከናውኑት የትምህርት ዝግጅትና አቀራረብ ላይ ይመሠረታል፡ ማንበብ ውጤታማ እንዲሆን (የተማሪዎች የማንበብ ችሎታ እንዲሻሻል) ደግሞ የትምህርቱ ዝግጅቶችና አቀራረቦች ውጤታማ በሆነ መልኩ መከናወን ይኖርባቸዋል። ይህ ጥናትም በአማርኛ ቋንቋ ትምህርት የመምህራን ትምህርትን የማቀድ፣ ክፍልን የመምራትና የመመዘን ተግባራት በጀማሪ ክፍል ተማሪዎች የማንበብ ችሎታ መዳበር ላይ ያለውን አስተዋፆ መርምሯል።

የጥናቱ አነሳሽ ምክንያት

ቀደም ሲል እንደተገለጸው፣ በማኅበረሰብ አጠቃላይ ንድፈሐሳብና ሁሉአቀፍ መሠረታዊ የማንበብ-መጻፍ ብልሃት፣ መማር የሚከናወነው በዋናነት በምልከታ፣ ከአርአያዎች ዕውቀትና ክህሌት በመቅሰምና የመማር ሂደቱን በማኅበራዊ መስተጋብር በማጠናከር ነው። በዚህ ሂደት የሚቀርቡ አርአያዎችና የማኅበራዊ መስተጋብር እድሎች የተማሪዎችን ግለብቃት እምነትና ተነሳሽነት በማሳደግ ራስመርና ከፍተኛ ውጤት የሚሹ እንዲሆኑ ያስችላል፤ ይህ እንዲሆን ደግሞ የመማር ማስተማር ሂደቱ ከእቅድ እስከግምገማ ድረስ መስተጋብሮችን በሚያሳልጥና ከአርአያዎች የመማር እድልን ሊያሰፋ በሚችል መልኩ መቃኘት ይኖርበታል (NRP, 2000; Usher & Schunk, 2018):: እነዚህ መሠረታዊ ሐሳቦች፣ የትምህርት እቅድ፣ የክፍል ውስጥ ተግባራትና የግብ ስኬት ማረጋገጫ ምዘናዎችን ውጤታማነት በየጊዜው የመፈተሽና ማስተካከያ የማድረግ አስፈላጊነትን ያመለክታሉ፤ ይህም ለዚህ ጥናት መነሻ ሆኗል።

በኢትዮጵያ በ2010 ሁለት የከተማ አስተዳደሮችን ጨምሮ በስምንት ክልሎች በስድስት የአፍ መፍቻ ቋንቋዎች፣ እንዲሁም በ2014 በሁለት ተጨማሪ ቋንቋዎች (ሀዲይሳና ወላይታቶ) የጀማሪ ተማሪዎች የማንበብ ምዘና (EGRA) ጥናት ተካሂዷል (Piper, 2010; RTI International, 2016):: በጥናቱ የተገኘው ውጤት የልጆች የማንበብ ችሎታ እጅግ በጣም ዝቅተኛ መሆኑን አመለክቷል። በ2ኛና በ3ኛ ክፍሎች ደረጃ የማንበብ ምዘናው ያተኮረባቸው የጀማሪ ተማሪዎች ቊልፍ የማንበብ አላባዎች፤

የንግግር ድምፆች ግንዛቤ (የቃላትን ድምፆች መለየት)፣ የፊደል ስያሜ ዕውቀት፣ ተዘውታሪ ቃላትንና ትርጉምየለሽ ቃላትን ማንበብ፣ አቀላጥፎ ማንበብ (ቃላዊ)፣ አንብቦ መረዳትና አዳምጦ መረዳት ናቸው (Piper, 2010; RTI International, 2016)። ከእነዚህ ምዘናዎች የተገኙ ውጤቶች እንዳመለከቱት የ2ኛ ክፍል ትምህርታቸውን ካጠናቀቁት ተማሪዎች መካከል 34% አንድ ቃል እንኳ ማንበብ አልቻሉም፤ 48% አንብቦ በመረዳት ምዘና ምንም ውጤት አላስመዘገቡም። የ3ኛ ክፍል ትምህርታቸውን ካጠናቀቁ ተማሪዎች መካከልም እንዲሁ 20% የሚሆኑት ምንም ቃል ማንበብ አልቻሉም፤ 30% ያህሉ አንብቦ በመረዳት ምንም ውጤት አላስመዘገቡም። ይህም ውጤት በሁለቱም የክፍል ደረጃዎች በትምህርት ሚኒስቴር ከተቀመጡት ዝቅተኛ ተፈላጊ ችሎታዎች (≥ 50) በከፍተኛ ደረጃ ያነሰ ነው። በብዙዎቹ ክልሎች ከ50% በላይ የሚሆኑት ተማሪዎች አንድም አንብቦ የመረዳት ጥያቄ አልመለሱም (Piper, 2010; RTI International, 2016)። ይህ ውጤትም በኢትዮጵያ በብሔራዊ ደረጃ የማንበብ ትምህርትን ብሎም የተማሪዎችን የማንበብ ክህል እንደገና መመርመርና ለአፍ መፍቻ ቋንቋ የማንበብ ትምህርት የቅድሚያ ቅድሚያ ትኩረት እንዲሰጥ ገፊ ምክንያት ነበር።

ማንበብን ጨምሮ በቀላል የትምህርት ዓይነቶች በተካሄደው ዐራተኛው ብሔራዊ የመማር ምዘና ጥናት (NEAEA, 2013)፣ የ4ኛ ክፍል ተማሪዎች የማንበብ ውጤት ከጀማሪ ክፍል ደረጃ ተማሪዎች የማንበብ ምዘና ውጤት ጋራ የሚደጋገፍ ሆኗል። ከመሠረታዊ በታች (<50 ውጤት ያስመዘገቡ)፣ መሠረታዊ (50 – 70 ውጤት ያስመዘገቡ) እና ውጤታማ (>70 ውጤት ያስመዘገቡ) በሚሉ ሦስት የማንበብ ችሎታ ርክዎች በተካሄደው በዚህ ምዘና ከግማሽ በላይ የሚሆኑት (54.20%) የ4ኛ ክፍል ተማሪዎች የማንበብ ችሎታ ከመሠረታዊ በታች መሆኑ ተመላክቷል። በምዘናው መሠረት በውጤታማ የማንበብ ችሎታ ርክን መካተት የቻሉት ተማሪዎች 19.50% ሲሆኑ፣ በመሠረታዊ የማንበብ ችሎታ ርክን ደግሞ 26.30% ተማሪዎች ናቸው።

በ2010 በተካሄደው የጀማሪ ክፍል ተማሪዎች ምዘና (EGRA) የተገኙ የአማርኛ ቋንቋ የማንበብ ችሎታ ውጤቶችም ከላይ ከቀረቡ ውጤቶች ጋራ ተደጋጋፊነት አላቸው (Piper, 2010)። በ2010 በተደረገው የአማርኛ ቋንቋ የማንበብ ችሎታ ምዘናዎች የ2ኛና የ3ኛ ክፍሎች ተማሪዎች ውጤት አጥጋቢ አልሆነም። በምዘናው የተሳተፉ ተማሪዎች ፊደላትን የመለየት ችሎታ በ2ኛ ክፍል በደቂቃ 41.4፣ በ3ኛ ክፍል ደግሞ በደቂቃ 54.2 ሆኗል፤ ይህም ከሚጠበቀው ውጤት (≥ 60) በእጅግ ያነሰ ነው። ተዘውታሪ ቃላትን በትክክል በማንበብ ረገድ ደግሞ የሚጠበቀው ዝቅተኛ ውጤት ≥ 50 ሲሆን የተገኘው ውጤት ግን ከዚህ ያነሰ ሆኗል (የ2ኛ ክፍል ተማሪዎች አማካይ ውጤት በደቂቃ 20 ቃላት፣ የ3ኛ ክፍል በደቂቃ 29.4 ቃላት ነው)። ትርጉምአልባ ቃላትን በትክክል ማንበብ የቻሉት የ2ኛ ክፍል ተማሪዎች በአማካይ 12.8 ሲሆኑ፣ በ3ኛ ክፍል በአማካይ 18.3 ብቻ ናቸው። አቀላጥፎ ማንበብን በተመለከተም የ2ኛ ክፍል ተማሪዎች በአንድ ደቂቃ በትክክል ማንበብ የቻሉት 19.1 ቃላትን ብቻ ነው፤ የ3ኛ ክፍል ተማሪዎች ደግሞ 27.9 ቃላትን በደቂቃ በትክክል ማንበብ ችለዋል። አንብቦ ከመረዳት አንጻርም የተገኘው ውጤት በመቶኛ ሲገለጽ የ2ኛ ክፍል ተማሪዎች 22.0% ሲሆን፣ የ3ኛ ክፍል 35.3% ነው፤ ውጤቱ በክፍል ደረጃው ከሚጠበቀው (≥ 50) ያነሰ ነው። በዚህ ምዘና ከተሳተፉ ተማሪዎች መካከል ከ2ኛ ክፍል 25%፣ ከ3ኛ ክፍል ደግሞ 20% ያህሉ በቀረበላቸው አሐድ (ታሪክ) ውስጥ ያሉ ቃላትን (ትርጉምአልባ ቃላትን ጨምሮ) በትክክል ለይተው ማንበብ አልቻሉም። አንብቦ ከመረዳት አንጻርም ግማሽ ያህሉ (49.0%) የ2ኛ ክፍል ተማሪዎችና 30.4% የሦስተኛ ክፍል ተማሪዎች ምንም ውጤት አላስመዘገቡም (Piper, 2010)።

በጀማሪ ክፍል ተማሪዎች ላይ በተካሄደው በዚህ የማንበብ ችሎታ ምዘና ጥናት የተመዘገቡ ዝቅተኛ የማንበብ ችሎታ ውጤቶች በእነዚህ ደረጃዎች (በጀማሪ ክፍሎች) ለማንበብ ክህል ልዩ ትኩረት መስጠት እንደሚገባ ያመለክቱ ናቸው። በዚህ የ2010 ጥናት መነሻነትም በኢትዮጵያ በብሔራዊ ደረጃ ለአፍሪካ ቋንቋ የማንበብ ትምህርት መሻሻል ቀዳሚ ትኩረት እንዲሰጥ ተደርጓል። ይህንንም ተከትሎ የችግሮቹን ምክንያቶችና መፍትሔዎች በጥልቀት ለመመርመር በርካታ ሀገርአቀፍ ምክክሮች ተደርገዋል። ምክክሮችንም መሠረት በማድረግ የኢትዮጵያ የማንበብ እድገት ቴክኒካል ድጋፍ ሰጭ ድርጅት (READ TA) እና የአሜሪካ የልማት ተራድኦ ድርጅት (USAID) ከትምህርት ሚኒስቴር ጋራ በመተባበር፣ በሀገርአቀፍ ደረጃ በጥናት ላይ የተመሠረቱ የአፍሪካ ቋንቋ የማንበብ መርሐትምህርቶች፣ እንዲሁም የመምህርና የተማሪ መጻሕፍት ተዘጋጅተው ከ2006 ዓ.ም. ጀምሮ ሥራ ላይ ውለዋል (NEAEA, 2013)።

ይሁን እንጂ የሥርዓተትምህርት ቀረጻና ትግበራ ከተከናወነ በኋላ የተገኙ ውጤቶችን ለመፈተሽ በተካሄዱ ተከታታይ የጀማሪ ክፍል ተማሪዎች የማንበብ ችሎታ ምዘናዎች የተገኙ ውጤቶች መሻሻሎች እንዳልታዩ አመለክተዋል። ለምሳሌ፣ በ2018 በተካሄደው የማንበብ ችሎታ ምዘና በቃላዊ አቀላጥፎ ማንበብ 15.2% የ2ኛ ክፍልና 7.3% የ3ኛ ክፍል ተማሪዎች ዜሮ አንባቢዎች ሆነዋል። ባጠቃላይ በክፍል ደረጃዎቹ የሚጠበቀውን የብቁ አንባቢነት ደረጃ አሟልተው የተገኙት 4% የ2ኛ ክፍልና 8% የ3ኛ ክፍል ተማሪዎች ብቻ ናቸው (READ M&E, 2018)። በ2021 በተካሄደው ምዘና ደግሞ ከቀደሙት የማንበብ ምዘናዎች ያነሰ ውጤት ተመዝግቧል። 59.1% ያህል ተማሪዎች አቀላጥፎ በማንበብ ምዘና ዜሮ አንባቢ ሆነዋል። ፊደላትን ለይቶ በማንበብ 2ኛ ክፍል 23%፣ 3ኛ ክፍል 23%፣ ተዘውታሪ ቃላትን በማንበብ ከ2ኛ ክፍል 65%፣ ከ3ኛ ክፍል 49%፣ ትርጉምአልባ ቃላትን በማንበብ ከ2ኛ ክፍል 70%፣ ከ3ኛ ክፍል 54%፣ እንዲሁም አቀላጥፎ በማንበብ ከ2ኛ ክፍል 68%፣ ከ3ኛ ክፍል 51%፣ ያህል ተማሪዎች ዜሮ አንባቢዎች ሆነዋል ወይም ምንም ውጤት አለስመዘገቡም (EAES, 2022)።

ከ2010 – 2021 የተካሄዱ ምዘናዎች የጀማሪ ክፍል ደረጃ ተማሪዎች የማንበብ ችሎታ ዝቅተኛ መሆኑንና ችግሩን ለመቅረፍ የተደረጉ የሥርዓተትምህርት ቀረጻና ትግበራ ጥረቶች ውጤት አለመስገኘታቸውን፣ የተማሪዎች የማንበብ ችሎታ ውጤትም እያሸቆለቆለ መምጣቱን ያመለክቱ ናቸው። ይህም ዋና ዋና ተጽእኖ አድራሽ መንስኤዎችን በምርመራ በመለየት የመፍትሔ ሐሳቦችን የማመለከት አስፈላጊነትን የሚያረጋግጥ ነው።

ይህ ጥናትም የመምህራን ቅሬታ የማስተማር ተግባራት (ማቀድ፣ የክፍል አመራርና መመዘን) በተማሪዎች የማንበብ ችሎታ ላይ ያላቸውን አስተዋፆ መርምሯል። የጥናቱ መሠረታዊ ጥያቄዎችም የሚከተሉት ናቸው፤

1. የመምህራን ትምህርትን የማቀድ ተግባር ከጀማሪ ክፍል ተማሪዎች የአማርኛ የማንበብ ችሎታ ጋራ ግንኙነት አለውን?
2. የመምህራን የክፍል አመራር ከጀማሪ ክፍል ተማሪዎች የአማርኛ የማንበብ ችሎታ ጋራ ተዛምዶ አለውን?
3. የመምህራን የክፍል ውስጥ የምዘና ተግባር ከጀማሪ ክፍል ተማሪዎች የአማርኛ የማንበብ ችሎታ ጋራ ግንኙነት አለውን?

የአጠናን ዘዴ

የጥናቱ ዓላማ የመምህራን ቅሬታ የማስተማር ተግባራት (ማቀድ፣ የክፍል አመራር፣ መመዘን) የጀማሪ ክፍል ተማሪዎችን በአማርኛ ቋንቋ የማንበብ ችሎታ ለማሻሻል ያላቸውን አስተዋፆ መመርመር ነው። ለዚህም ተዘምዶ የጥናት ንድፍና ተግባራዊ ተደርጓል። የተማሪዎችን ወቅታዊ ችሎታ መግለጽ የሚያስችል በመሆኑ፤ በተለውጦዎች መካከል ያለውን ዝምድና ማመላከትና ተንባብሮ ተለውጦ ተተንባብሮን ተለውጦ (output variable) በምን ያህል ደረጃ መግለጽ/መተንባብሮ እንደቻለ መፈተሽ የሚያስችል በመሆኑ ንድፍ ተመርጧል (Ma & Zhao, 2025)።

ጥናቱ በባሕር ዳር ከተማ በሚገኙና በዓላማተኮር ንጥናት በተመረጡ አራት ትምህርትቤቶች (ዕውቀት ፋና፣ ድል ችቦ፣ ጠይማና ሽምብጥ) ተካሂዷል። መረጃዎችን በበቂ መጠን ማግኘት የሚያስችሉና ከመገኛ በታ አንጻር ወካይ ሊሆኑ እንደሚችሉ በመታመኑ ትምህርትቤቶቹ ተመርጠዋል። ከእያንዳንዱ ትምህርትቤት ከ2ኛና ከ3ኛ የክፍል ደረጃዎች አንዳንድ ክፍሎች (ከ2ኛ 1፣ ከ3ኛ 1) በዕጣ ከተለዩ በኋላ ከጠቃላይ 560 ተማሪዎች መካከል ከየክፍሎቹ 20 ተማሪዎች፣ በድምሩ 160 (ከ2ኛ ክፍል 80፣ ከ3ኛ ክፍል 80) ተማሪዎች በሥርዓት በተዘጋጀ ናሙና (Systematic Sampling) ከተማሪዎች የስም ዝርዝር ከአራት አንድ በመውሰድ በምዘና ተሳትፈዋል። ከእነዚህም መካከል የወንዶች ቁጥር 77 (2ኛ ክፍል 36፣ 3ኛ ክፍል 41) የሴቶች ደግሞ 83 (2ኛ ክፍል 44፣ 3ኛ ክፍል 39) ነው። ከተማሪዎች በተጨማሪ ወንድ 1፣ ሴት 7፣ ባጠቃላይ 8 የጀማሪ ክፍል የአማርኛ ቋንቋ መምህራን (ከእያንዳንዱ ትምህርትቤት 2) በጠቅላይ ንጥናት ተመርጠው በሚያስተምሩበት ክፍል 116 ክፍላገዜ በክፍል አደረጃጀትና አመራር እንዲሁም በምዘና አፈጻጸማቸው ላይ ያተኮረ በማመሳከሪያ ቅፅ የታገዘ ምልከታ ተደርጓል።

የ2ኛና የ3ኛ ክፍል ተማሪዎች የአማርኛ ቋንቋ መሠረታዊ የማንበብ ችሎታ መረጃዎች በሰዓት ገደብ (timed) ምዘናዎች (የፊደል ስያሜ ዕውቀት፣ የተዘውታሪና የትርጉምአልባ/የፈጠራ ቃላት ቃላዊ ንባብና አቀላጥፎ የማንበብ ምዘናዎች) እንዲሁም የሰዓት ገደብ በሌለባቸው (untimed) ምዘናዎች (የንግግር ድምፆች ግንዛቤና አንብቦ የመረዳት ምዘናዎች) ተሰብስበዋል።

የፊደል ስያሜ ዕውቀት መመዘኛው ከ2010 የጀማሪ ክፍሎች የማንበብ ምዘና በቀጥታ የተወሰደ ነው። መመዘኛው 100 የአማርኛ ቋንቋ ፊደሎችን ይዟል። ይህ መመዘኛ ተማሪዎች በአንድ ደቂቃ ምን ያህል ፊደላትን በፍጥነት፣ በትክክልና በተገቢ አገላለጽ ማንበብ እንደሚችሉ (Letters Correct Per Minute/LCPM) መረጃ መሰብሰብ የሚያስችል ሲሆን ባጠቃላይ 100 ነጥቦች አሉት (እያንዳንዱ ፊደል አንድ ውጤት አለው)። የተዘውታሪና ትርጉም የሌላቸው/የፈጠራ ቃላት የማንበብ ምዘናዎች በሰዓት የተገደቡ (WCMP) ሲሆኑ፣ ከEGRA የ2010 ጥናት በቀጥታ የተወሰዱ ናቸው (Piper, 2010)። ምዘናው ተመዘኝ ተማሪዎች በአንድ ደቂቃ ምን ያህል ቃላትን በፍጥነት፣ በትክክልና በተገቢ አገላለጽ ማንበብ እንደሚችሉ መረጃ የመሰብሰብ ዓላማ ያለው ሲሆን፣ በተዘውታሪና በፈጠራ ቃላት ምዘና በእያንዳንዳቸው 50 ቃላት ያሉት ሲሆን እያንዳንዱ ቃል አንድ ነጥብ አለው።

አቀላጥፎ የማንበብ ምዘና ተማሪዎች በአንድ ውሕድአሐድ ካሉ ቃላት በአንድ ደቂቃ ምን ያህልን በትክክል፣ በፍጥነትና በተገቢ አገላለጽ ማንበብ እንደሚችሉ መረጃ የሚሰበሰብበት ሲሆን፣ ይህም ከEGRA የ2010 ጥናት በቀጥታ የተወሰደ ነው (Piper, 2010)። ምዘናው በትረካዊ አሐድ ላይ የተመሠረተ ሲሆን፣ አሐዱ በውስጡ 60 ቃላት አሉት። በምዘናው ለተመዘኞች ከ60 ነጥብ ይመዘገባል (ለእያንዳንዱ ቃል 1)። ሌላው ከEGRA የ2010 የምዘና ጥናት በቀጥታ የተወሰደ ተግባራዊ የተደረገው የማንበብ ችሎታ መለኪያ (አንብቦ የመረዳት) ምዘና ነው (Piper, 2010)። አንብቦ የመረዳት ምዘናው

የሰዓት ገደብ ምዘና አይደለም (በሰዓት ገደብ አይለካም)። ይህ ምዘና አቀላጥፎ ለማንበብ ምዘና በቀረበው ባለ60 ቃላት አጭር ትረካዊ ውሕድአሐድ ላይ የተመሠረተ ሲሆን፣ 5 ጥያቄዎች (5 ነጥብ ያለው) አሉት። ተማሪዎች አቀላጥፈው ካነበቡ በኋላ ባነበቡት ታሪክ መሠረት ለጥያቄዎቹ ምላሽ ይሰጣሉ። የሰዓት ገደብ ከሌለባቸው የማንበብ ምዘናዎች ሌላው፣ የንግግር ድምፅ ግንዛቤ (phonemic awareness) ምዘና ነው። የዚህ ምዘና ዓላማ የተማሪዎችን የንግግር ድምፅ ግንዛቤ/ችሎታ ለመለካት ነው። በምዘናው ከEGRA የ2010 ጥናት በቀጥታ የተወሰዱ 10 ቃላት አሉ (Piper, 2010)፤ ተማሪዎች ቃሎቹ በመዛኝ ሲነበቡላቸው በቃሎቹ ውስጥ ያሉ ድምፅን ነጥለው ወይም ለይተው ይናገራሉ። ለእያንዳንዱ ቃል 1 ነጥብ ይመዘገባል (ምዘናው በጠቅላላ 10 ነጥብ አለው)።

ሌላው የመረጃ መሰብሰቢያ የሰነድ ፍተሻ ነው። ዓላማውም መምህራን ያዘጋጁቸው ዕለታዊ የትምህርት እቅዶች ሥነትምህርታዊ የእቅድ ዝግጅት መርሶዎችን ማሟላታቸውንና አስፈላጊ ነጥቦችን ማካተታቸውን በተመለከተ መረጃዎችን ለመሰብሰብ ነው። ፍተሻው 30 ነጥቦች ባሉት የማመሳከሪያ ቅፅ የተከናወነ ሲሆን፣ የ30ዎቹን ነጥቦች አፈጻጸም በሚገልጹ አራት የደረጃ መወሰኛ ስኬሎች (በጣም አጥጋቢ [4]፣ አጥጋቢ [3]፣ አጥጋቢ ያልሆነ [2]፣ በጣም አጥጋቢ ያልሆነ [1]) አማካኝነት ውጤት በመስጠት መረጃዎች ተሰብስበዋል። የፍተሻ ዝርዝር ነጥቦች ከAhmed (2022)፣ ከEchevarría et al. (2017) እና ከPalad (2025) ሥራዎች በማስማማት የተወሰዱ ናቸው። በማመሳከሪያ ቅጹም ባጠቃላይ 16 ዕለታዊ የትምህርት እቅዶች (ከእያንዳንዱ/ዲ መምህር 2) ላይ ፍተሻ ተካሂዷል።

በምልከታዎች የመምህራንን የክፍል አመራር ሂደትና የክፍል ውስጥ የተማሪ ምዘና አፈጻጸምን የተመለከቱ መረጃዎች ተሰብስበዋል። የክፍል አመራርና አደረጃጀት አፈጻጸምን የተመለከቱ መረጃዎች ከBeaulieu (2023) እና Terada (2019) ሥራዎች ተስማምተው የተወሰዱ 20 የትኩረት ነጥቦችና አራት የመወሰኛ ደረጃዎች/ስኬሎች (በጣም አጥጋቢ [4]፣ አጥጋቢ [3]፣ አጥጋቢ ያልሆነ [2]፣ በጣም አጥጋቢ ያልሆነ [1]) ባሉት የምልከታ ማመሳከሪያ ቅፅ በመታገዝ ተሰብስበዋል። የተማሪ ምዘና አፈጻጸምን የተመለከቱ መረጃዎች ደግሞ ከAhmed (2022)፣ ከEchevarría et al. (2017) እና ከPalad (2025) ሥራዎች ተስማምተው በተወሰዱ 25 ነጥቦችን በያዘ ማመሳከሪያ ቅፅ ተሰብስበዋል። ማመሳከሪያ ቅጹ 4 የደረጃ መወሰኛ ስኬሎች (በጣም አጥጋቢ [4]፣ አጥጋቢ [3]፣ አጥጋቢ ያልሆነ [2]፣ በጣም አጥጋቢ ያልሆነ [1]) አሉት። በዚህም ባጠቃላይ ለ16 ክፍላጊዜ ያህል ምልከታ ተከናውኖ የክፍል አመራርና የምዘና አፈጻጸሞችን የተመለከቱ መረጃዎች ተሰብስበዋል።

የመረጃ መሰብሰቢያ መሣሪያዎች ከተዘጋጁ በኋላ በሦስት የሥነትምህርትና በሦስት የቋንቋ የዩኒቨርሲቲ ተመራማሪዎችንና መምህራንን ባሳተፈ ፓናልና ለመዛኝ ባለሙያዎች በተዘጋጀ ዐውደጥናት እንዲገመገሙ ተደርገው በዋናነት በምዘናዎች አቀራረብ ላይ ማሻሻያዎች ተደርገዋል። ዋናዎቹ መረጃዎች ከመሰብሰባቸው በፊትም ከጥናቱ ተሳታፊ ተማሪዎች ውጭ የሆኑ የዕውቀት ፋና ትምህርትቤት 10 ተማሪዎችን (ከ2ኛ ክፍል 5፣ ከ3ኛ ክፍል 5) መሠረታዊ የማንበብ ችሎታዎችን በቀጥታ በመመዘን በተገኙ ተመክሮዎችና ግብዓቶች መሠረት በተለይም በሰዓት ገደብ ምዘናዎች የደቂቃ አመዘጋገብና ውጤት አሰጣጥ ላይ ማሻሻያዎች ተደርገዋል።

የትክክለኛነት ፍተሻዎች ከተከናወኑ በኋላ 160ዎቹ የጥናቱ ተሳታፊ ተማሪዎች እንዲመዘኑ ተደርገው የተገኙ የምዘና መረጃዎች አስተማማኝነት (reliability) በክሮንባክ አልፋ (KR20) ተሰልቶ በሁሉም ምዘናዎች ተቀባይነት ያለው ውጤት ($\alpha > .7$) ተገኝቷል። የፈተናዎቹ፣ የምልከታውና የቃለመጠይቁ የጥያቄ-ውጤት ተዛምዶ (Inter-Item Correlation) በተጨማሪነት ተሰልቶ በእያንዳንዱ

መረጃ መሰብሰቢያ ውስጥ ያለ የእያንዳንዱ ጥያቄ/ነጥብ ውጤት ከሌሎች ጥያቄዎች (ከጠቅላላው ውጤት) ጋራ የጠበቀ ትስስር እንዳለውና በቅንጅት ታላሚውን ችሎታ/ተግባር መመዘን እንደቻለ የሚያረጋግጥ ውጤት ($r= 0.2 - 0.5$) ተገኝቷል።

የዚህ ጥናት ትግበራ የተጀመረው የጥናት መሪ እቅድ (proposal) በማዘጋጀት ነው። በመቀጠል የመረጃ መሰብሰቢያ መሣሪያዎችን በማዘጋጀት ከባሕር ዳር ከተማ አስተዳደር ትምህርት ጽሕፈትቤት ታላላቆችና ኤክስፐርቶች ጋራ ውይይት ተደርጓል፤ ጥናቱን ለማከናወንም ይሁንታ ተገኝቷል። ከዚያም የምክክር ዐውደጥናት በማሰናዳት የትምህርት ጽሕፈትቤት ባለሙያዎች፣ ርዕሰመምህራንና ምክትሎች፣ የጉድጓት ሱፐርቫይደሮችና ተመራማሪዎች በተሳተፉበት ስለጥናቱ ዓላማዎችና ከእነሱ ስለሚጠበቁ ታላላቆች በማስረዳት ሊደረግ በሚገባው ትብብር ላይ መግባባት ላይ ተደርሷል። ከዐውደጥናቱ በኋላ ለመረጃ ሰብሰቢያዎች ሥልጠና ተሰጥቷል፤ ከሥልጠናው በኋላ በዕውቀት ፋና ትምህርትቤት 10 ያህል የ2ኛና የ3ኛ ክፍል ተማሪዎችን መዝነዋል። በምዘናው ሂደት ላይ በተደረገው ምልከታና በተመዘገቡት የምዘና ውጤቶች ትንተናም በመዛኞች መካከል የአተገባበር ልዩነት አለመኖሩን ለማረጋገጥ ተችሏል።

በዚህ መልኩ ሁኔታዎች ከተመቻቹ በኋላ በዐራቱ ትምህርትቤቶች በአካል በመገኘት ከመጋቢት 18-24 ፣ 2017 ዓ.ም. በማንበብ ችሎታ ምዘናዎች መረጃዎች ተሰብስበዋል። ተማሪዎች በጀማሪ ክፍሎች ምዘና መተግበሪያ መርሆዎችና መመሪያዎች መሠረት፣ ስለምዘናው ዓላማና የትኩረት ነጥቦች ከተገለጸላቸውና በምዘናው ለመሳተፍ ይሁንታ መስጠታቸው ከተረጋገጠ በኋላ በተናጠል ተመዝነዋል። በመቀጠልም አስቀድሞ በተዘጋጀ የክፍል አመራርና የምዘና አፈጻጸም የማመሳከሪያ ቅፅ በመመራት ከመጋቢት 25-30፣ 2017 ዓ.ም. በእያንዳንዱ ትምህርትቤት የ4 ክፍለ ጊዜ ምልከታ ተደርጓል። ምልከታው ከ1- 3ኛ ክፍሎች የተከናወነ ሲሆን ምልከታ በተከናወነበት ክፍለጊዜ መምህራኑ ያዘጋጁቸውንና የተገበጁቸውን ዕለታዊ የትምህርት እቅዶች ፎቶግራፍ በማንሳት በሰነድ ፍተሻ ማመሳከሪያ ቅፁ አማካኝነት ምርመራ ተከናውኖባቸዋል።

በሰዓት በሚለኩና የሰዓት ገደብ በሌለባቸው ምዘናዎች የተገኙ መረጃዎች በጥንድ ተላውጦ ድኅረት ትንተና ስልት (Bivariate Linear Regression) ተተንትነዋል። የሰዓት ገደብ ምዘናዎች በአንድ ደቂቃ፣ በፍጥነት፣ በትክክልና በተገቢ አገላለጽ የተነበቡ ፊደሎች/ቃላት በሚል ተሰልተዋል። የሰዓት ገደብ የሌለባቸው ምዘናዎች ደግሞ ከቀረቡ ጥያቄዎች በትክክል የተመለሱ ጥያቄዎችን ብዛት በመውሰድ ትንተና ተካሂዶባቸዋል።

በዚህም የመምህራን የማስተማር ዝግጅትና አቀራረብ (ማቀድ፣ የክፍል አመራር፣ መመዘን) ለተማሪዎች የፊደል ስያሜ ዕውቀት፣ የተዘውታሪና ትርጉምአልባ/የፈጠራ ቃላት ንባብ፣ አቀላጥፎ የማንበብ፣ የንግግር ድምፆች ግንዛቤና አንብቦ የመረዳት ችሎታ ያለው ሚና በተመረጠው የመተንተኛ ስልት (በድኅረት ትንተና ስልት) ተመርምሯል። በምርመራው የመምህራን የማቀድ፣ የክፍል አመራርና የመመዘን ተግባራት አፈጻጸም እያንዳንዱን የማንበብ አላባ ለማሳደግ ያለው አስተዋፆ ሲሰላ የተተነተኑት ቊልፍ ጉዳዮች የሚከተሉት ናቸው። (ሀ) የመምህራን የማቀድ፣ የክፍል አመራርና የመመዘን ተግባራት ከተማሪዎች የማንበብ ችሎታ ጋራ ያላቸው ተዛምዶ (r) ተሰልቷል፤ (ለ) ተንባዩ ተላውጦ ተተንባይ ተላውጦውን በምን ያህል ደረጃ መግለጽ/መተንባይ እንደቻለ ምርመራ ተከናውኗል። ይህም ተንባዩ ተላውጦ (ማቀድ፣ የክፍል አመራር ወይም መመዘን) በአንድ መደበኛ ልዩይት (standard deviation) ሲያድግ ተተንባዩ ተላውጦ (የተማሪዎች ስድስቱ የማንበብ ችሎታዎች በተናጠል) ምን ያህል የመደበኛ ልዩይት ለውጥ አሳዩ? በሚለው የመደበኛ ድኅረታዊ መጣኝ (β) ተተንትኗል። በተጨማሪም በተጋርቶ

መጠን “R²” ስሌት የተተንባዩ ተላውጦ ምን ያህል ልዩይት (variation) በተተንባዩ ተላውጦ ተገለጸ የሚለው በመቶኛ ተሰልቷል። የተዛምደው ትክክል የመሆን/የጉልህነት ደረጃም (sig.) በትንተናው ተካትቷል።

ቀደም ሲል እንደተገለጸው በጥናቱ የተሰበሰቡ መረጃዎች የተተነተኑት በድግረት ትንተና ስልት ነው። የትንተና ስልቱ ተግባራዊ የተደረገው ደግሞ በቅድሚያ ዋና ዋና እሴቶች (assumptions) መሟላታቸው ከተረጋገጠ በኋላ ነው። በመጀመሪያ የተፈተኛው የስርጭት ወጥነት (normality) ሲሆን የተሰበሰቡ መረጃዎች በአምድ ግራፍ (histogram) ተሰልተው እሴት መሟላቱ ተረጋግጧል። ቀጥሎ መረጃዎች ፈርጅብዙ ተዛምዶ (Multicollinearity) ያላቸው መሆኑ በልዩይት ግሽበት ፋክተር (variance inflation factor/VIF)፣ የ“tolerance value” ደግሞ በንጥል ድግረት ትንተና ስልት (linear regression analysis) ተሰልቶ የተገኘው ውጤት (VIF < 10; toleranc \geq 1) እሴት መሟላቱን አመለክቷል፤ የ“condition index value” < 15 መሆኑም ለእሴት መሟላት ተጨማሪ ማስረጃ ሆኗል። ከስርጭት ወጥነትና ከፈርጅብዙ ተዛምዶ ምርመራ በኋላ በመረጃዎቹ ተናጠላዊ አፈንጋጭ ነጥቦች (univariate outliers) አለመኖራቸው በክፋይ ሳጥን (boxplot)፣ የፈርጅብዙ ተላውጦ አፈንጋጭ ነጥቦች (Multivariate outilers) የሌሎ መሆኑ በማሀላኖቢስ የልዩነት መወሰኛ (Mahalanobis distance)፣ Autho-correlation አለመኖሩ ደግሞ በንጥል ድግረት ትንተና የ“Durbin-Watson” ስልት ተፈትሾ (Auto-correlation \approx 2) እሴቶቹ ተሟልተዋል። ከዚህ በተጨማሪም የመረጃዎቹ የልዩይት መጠን እኩልነት (Homogeneity of variances) በሌቪን የልዩይት ተመጣጣኝነት መፈተሻ (Levene’s Test of Equality of Variances) ተመርምሮ እሴት መሟላቱ የተረጋገጠ (P > .05) ሲሆን፣ የልዩይት-አበር ልዩይት ተመሳሳሪ (Homogeneity of variance-covariance matrices) በቦክስ ኤም የአበር ልዩይት ተመጣጣኝነት መፈተሻ ቴስት (Box’s M)፣ የመረጃዎች ቀጥተኛ ተዛምዶ (Linearity) ደግሞ በብትን ክፋይ (scatterplot matrix) ተፈትሾ እሴትን ያሟላ ሆኗል።

የውጤት ትንተና

ቀደም ብሎ በቀረበው የመረጃ አተናተን ክፍል እንደተገለጸው በማንበብ ምዘናዎች ከ160 የጥናቱ ተሳታፊ ተማሪዎች፣ እንዲሁም ከስምንት መምህራን ደግሞ በክፍል ውስጥ ምልክታና በሰነድ ፍተሻ የተገኙ መረጃዎችን መሠረት በማድረግ የመምህራን ቅሬታ የማስተማር ተግባራት (ማቀድ፣ የክፍል አመራር፣ መመዘን) የጀመረ ክፍል ተማሪዎችን የማንበብ ችሎታ ለማሻሻል ያለውን አስተዋፆ ለመለየት ትንተናዎች ተካሄደዋል። የመተንተኛ ስልቱ እሴቶች መሟላታቸው አስቀድሞ ከተረጋገጠ በኋላ፣ የተሰበሰቡ መረጃዎች ከጥናቱ መሠረታዊ ጥያቄዎች አንጻር በጥንድ ተላውጦ ድግረት የትንተና ስልት እየተሰሉ ቀርበዋል። ከዚያ በፊት ግን እያንዳንዱ ተንባይ ተላውጦ ከማንበብ አላባዎች ጋራ በተናጠል ያለው ተዛምዶ መሰላትና አስቀድሞ ተዛምዶ መኖሩ መረጋገጥ ስለሚኖርበት (Kiernan, 2014) ፍተሻው ተካሄዶ በሠንጠረዥ 1 የተመለከተው ውጤት ተገኝቷል።

ሠንጠረዥ 1

የመምህራን ቅጥር የማስተማር ተግባራትና የተማሪዎች የማንበብ ችሎታ ዝምድና የፈረሰን ተዛምዶ (Pearson correlation) ውጤት

	ተዛምዶ/Correlations								
	ማቀድ	የክፍል አመራር	መመዘን	1	2	3	4	5	6
የፈደል ስያሜ ዕውቀት (1)	.829*	.740*	.828*	1					
የንግግር ድምፅ ግንዛቤ (2)	.304	.794*	.608	.276**	1				
የተዘውታሪ ቃላት ንባብ (3)	.900**	.726*	.799*	.818**	.216**	1			
የፈጠራ ቃላት ንባብ (4)	.911**	.846	.715*	.861**	.241**	.853**	1		
አቀላጥፎ ማንበብ (5)	.946**	.737*	.826*	.761**	.235**	.869**	.836**	1	
አንብቦ መረዳት (6)	.721*	.718*	.714*	.277**	.130	.311**	.324**	.328**	1

Note. *. Indicates correlation is significant at the 0.05 level (2-tailed) while ** indicates correlation is significant at the 0.01 level (2-tailed).

በሠንጠረዥ 1 እንደተመለከተው ማቀድና መመዘን ከተማሪዎች የንግግር ድምፅ ግንዛቤ ጋራ ትክክል የመሆን ደረጃ/ጉልህ ዝምድና የሌላቸው ($r < .7, P > .05$) ሲሆን በሌሎች የዝምድና ፍተሻዎች ግን ተንባይ ተላውጦዎች ከሁሉም ተተንባይ የማንበብ ችሎታ ተላውጦዎች ጋራ ትክክል የመሆን ደረጃ/ጉልህ ተዛምዶ እንዳላቸው ($r > .7, P < .05$) ማረጋገጥ ተችሏል። ቀጥሎ የጥንድ ተላውጦ ድኅረት ትንተና ውጤቶች ቀርበዋል።

የጥናቱ የመጀመሪያ መሠረታዊ ጥያቄ “የመምህራን ትምህርትን የማቀድ ተግባር የጀመረ ክፍል ተማሪዎችን በአማርኛ የማንበብ ችሎታ ለማሻሻል አስተዋጾ አለውን?” የሚለው ነው። 30 ነጥቦች ባሉት የማመሳከሪያ ቅፅ በመታገዝ በመምህራን ዕለታዊ የትምህርት እቅዶች አፈጻጸም ላይ በተካሄደ የሰነድ ፍተሻ የተገኙ መረጃዎችንና በምዘና የተሰበሰቡ የተማሪዎች የማንበብ ችሎታ መረጃዎች በድኅረት ትንተና ስልት ተሰልተው የተገኙ ውጤቶች በሠንጠረዥ 2 ቀርበዋል።

በተጋርቶ መጠን “R2” ስሌት የተተንባይ ተላውጦ ምን ያህል ልዩይት በተንባይ ተላውጦ ተገለጸ? የሚለውን የሚያመለክት ሲሆን የተገኘው ውጤት ወደመቶኛ ተሰልቶ ይገለጻል። በዚህም ከንግግር ድምፅ ግንዛቤ ውጭ ባሉ የተማሪዎች የማንበብ ውጤት ላይ ከታየው ለውጥ ከ51.9% – 81.6% የሚሆነው በመምህራን ትምህርትን የማቀድ ተግባር ላይ የተገለጸ እንደሆነ የቀረበው መረጃ ያመለክታል። መረጃው የመምህራን የእቅድ ትግብራ አፈጻጸም ከተማሪዎች የተዘውታሪና የትርጉም አልባ ቃላት፣ አቀላጥፎ የማንበብና የንግግር ድምፅ ግንዛቤ ችሎታ ጋራ ከፍተኛ ($R^2 > .50$) ግንኙነት እንዳለውና በከፍተኛ ደረጃ ክሂሎቹን መተንባይ እንደቻለ ወይም የማቀድ ተግባር ቢሻሻል የተማሪዎች የማንበብ ውጤት እንዲሻሻል ሊያደረግ የሚችል መሆኑን ያረጋገጠ ሲሆን፣ ዕለታዊ የትምህርት እቅድ ማዘጋጀት የንግግር ድምፅ ግንዛቤን የመግለጽ/የመተንባይ አቅሙ አነስተኛ መሆኑን ($R^2 = 9.3\%$) አመለክቷል (Fernando, 2024)።

ሠንጠረዥ 2

የመምህራን ትምህርትን የማቀድ ተግባር (planning practice) የተማሪዎችን የማንበብ ችሎታ ለማሻሻል ያለው አስተዋፆ የጥንድ ተላውጦ ድጎረት ትንተና (bivariate regression analysis) ውጤት

የምዘና ዓይነት	የተጋርቶ መጠን (R^2)	መደበኛ ድጎረታዊ መጠኝ ($Beta (\beta)$)	F	ትክክል የመሆን/የጉልህነት ደረጃ (sig.)
የፊደል ስያሜ ዕውቀት	.687	.829	13.184	.011
የተዘውታሪ ቃላት ንባብ	.811	.900	25.662	.002
የትርጉም አልባ ቃላት ንባብ	.831	.911	29.463	.002
አቀላጥፎ ማንበብ	.896	.946	51.466	.000
የንግግር ድምፆች ግንዛቤ	.093	.304	.612	.464
አንብቦ መረዳት	.519	.721	6.487	.044

Note. Df= (1,114)

የመደበኛ ድጎረታዊ መጠኝ (β) ስሌት ደግሞ ነጻ ተላውጦው በአንድ መደበኛ ልይይት ሲጨምር/ሲሻሻል በእያንዳንዱ ጥገኛ ተላውጦ ላይ በአማካይ ምን ያህል ለውጥ/መሻሻል ተስተዋለ? የሚለውን የሚገልጽ ነው። በሠንጠረዥ 2 እንደተመለከተው የመምህራን ትምህርትን የማቀድ ተግባር በአንድ መደበኛ ልይይት ሲለወጥ፣ ከንግግር ድምፆች ግንዛቤ ውጭ ባሉ የተማሪዎች የማንበብ ውጤት ላይ ከ.721 – .946 መደበኛ ልይይት ለውጥ ታይቷል። ውጤቱ የመምህራን የማቀድ ተግባር አፈጻጸም ከተማሪዎች የፊደል ስያሜ፣ የተዘውታሪና የትርጉም አልባ ቃላት፣ አቀላጥፎ የማንበብና አንብቦ የመረዳት ውጤት ጋራ ከፍተኛ አዎንታዊ ተዛምዶ ያለው መሆኑንና ክሂሎቹን በከፍተኛ ደረጃ መተንበይ እንደቻለ፣ (የመምህራን የማቀድ ተግባራት ከተሻሻሉ የተማሪዎቹ የማንበብ ችሎታ ሊሻሻል የሚችል መሆኑን) ($\beta > .50$) ያመለክተ ሲሆን፣ ከንግግር ድምፆች ግንዛቤ ጋራ ያለው ተዛምዶ ግን አነስተኛ እንደሆነ ($\beta = .304$) እና ክሂሉን መተንበይ የቻለው በአነስተኛ ደረጃ እንደሆነ አሳይቷል (Nieminen, 2022)።

የተዛምዶ ደረጃውን አጠቃሎ የሚገልጸው ትክክል የመሆን/የጉልህነት ደረጃ ውጤቱም (significance level/P) የመምህራን ትምህርትን የማቀድ ተግባር በንግግር ድምፆች ግንዛቤ ላይ ትክክል የመሆን ደረጃ/ጉልህ ተዛምዶ እንደሌለውና ክሂሉን መተንበይ ያልቻለ መሆኑን ያመለክተ ሲሆን ($F(1,114) = .612, P = .464$)፣ የፊደል ስያሜ ዕውቀት፣ የተዘውታሪና የትርጉም አልባ ቃላት ንባብ፣ አቀላጥፎ የማንበብና አንብቦ የመረዳት ጋራ ያለው ተዛምዶ ግን ትክክል የመሆን ደረጃ/ጉልህ መሆኑንና ክሂሎቹን በከፍተኛ ደረጃ መተንበይ እንደቻለና የመምህራን ትምህርትን የማቀድ ተግባር ከተሻሻለ የተማሪዎች የማንበብ ችሎታ ሊሻሻል እንደሚችል ($P < .05$) አረጋግጧል (የፊደል ስያሜ ዕውቀት $F(1,114) = 13.184, P = .011$)፣ የተዘውታሪ ቃላት ንባብ $F(1,114) = 25.662, P = .002$)፣ የትርጉም አልባ ቃላት ንባብ $F(1,114) = 29.463, P = .002$)፣ አቀላጥፎ የማንበብ $F(1,114) = 51.466, P = .000$)፣ አንብቦ የመረዳት $F(1,114) = 6.487, P = .044$)።

“የመምህራን የክፍል አመራር የጀማሪ ክፍል ተማሪዎችን በአማርኛ የማንበብ ችሎታ ለማሻሻል አስተዋፆ አለውን?” የሚለው የጥናቱ ሁለተኛ መሠረታዊ ጥያቄ ነው። ለጥያቄው ምላሽ ለመስጠት የሚያስችሉ መረጃዎች 20 ነጥቦች ባሉት የማመሳከሪያ ቅፅ በመመራት በተካሄደ የክፍል ውስጥ

ምልከታና በማንበብ ምዘናዎች ተሰብስበዋል፤ መረጃዎቹ በጥንድ ተላውሮ ድጎረት ትንተና ተሰልተው የተገኙ ውጤቶች በሠንጠረዥ 3 ቀርበዋል።

ሠንጠረዥ 3

የመምህራን የክፍል አመራር (classroom management) የተማሪዎችን የማንበብ ችሎታ ለማሻሻል ያለው ሚና የጥንድ ተላውሮ ድጎረት ትንተና (bivariate regression analysis) ውጤት

የምዘናው ዓይነት	የተጋራቶ መጠን (R ²)	መደበኛ ድጎረታዊ መጠኝ Beta (β)	F	ትክክል የመሆን/የጉልህነት ደረጃ (sig.)
የፊደል ስያሜ ዕውቀት	.548	.740	7.269	.036
የተዘውታሪ ቃላት ንባብ	.527	.726	6.684	.041
የትርጉም አልባ ቃላት ንባብ	.517	.746	6.295	.034
አቀላጥፎ ማንበብ	.544	.737	7.146	.037
የንግግር ድምፆች ግንዛቤ	.630	.794	10.209	.019
አንብቦ መረዳት	.515	.718	6.375	.045

Note. Df= (1,114)

በሠንጠረዥ 3 እንደተመለከተው በተማሪዎች የማንበብ ውጤት ላይ ከታየው ለውጥ ከ51.5% – 63.3% የሚሆነው በመምህራን የክፍል አመራር ተግባር አፈጻጸም ላይ የተንጸባረቀ መሆኑን የቀረበው የተጋራቶ መጠን “R²” ውጤት ያስረዳል። የተገኘው ውጤት በክፍል አመራር ተግባራት አፈጻጸምና በተማሪዎች ውጤት መካከል ከፍተኛ ተዛምዶ መኖሩንና የክፍል አመራር ተግባሩ የተማሪዎችን ውጤት በከፍተኛ ደረጃ መተንበይ እንደቻለ (የክፍል አመራር ቢሻሻል የተማሪዎች ውጤት ሊሻሻል እንደሚችል) አመለካከቷል (R² > .50) (Fernando, 2024)። የመደበኛ ድጎረታዊ መጠኝ (β) ስሌት እንዳመለከተውም የመምህራን የክፍል አመራር ተግባር በአንድ መደበኛ ልይይት ሲጨምር/ሲሻሻል፣ በተማሪዎች የማንበብ ውጤት ላይ በአማካይ ከ.718 – .794 መደበኛ ልይይት ጭማሪ ታይቷል። ይህም የመምህራን የክፍል አመራር ተግባር አፈጻጸም ከተማሪዎች ከሁሉም በአማርኛ ቋንቋ የማንበብ ችሎታዎች ጋራ ያለው ተዛምዶ ከፍተኛ መሆኑንና ክሂሎቹን መተንበይ መቻሉን (የክፍል አመራር አፈጻጸም ከተሻሻለ የተማሪዎች የማንበብ ችሎታ ሊሻሻል የሚችል መሆኑን) (β > .50) ያመለክተ ሆኗል።

የድጎረት ትንተናው፣ የመምህራን የክፍል አመራር ከፊደል ስያሜ ዕውቀት ጋራ (F [1,114] = 7.269, P = .036)፣ ከተዘውታሪ ቃላት ንባብ ጋራ (F [1,114] = 6.684, P = .041)፣ ከትርጉም አልባ/የፈጠራ ቃላት ንባብ ጋራ (F (1,114) = 6.295, P = .034)፣ አቀላጥፎ ከማንበብ ጋራ (F [1,114] = 7.146, P = .037)፣ ከንግግር ድምፆች ግንዛቤ ጋራ (F [1,114] = 10.209, P = .019)፣ እንዲሁም አንብቦ መረዳት ጋራ (F [1,114] = 6.375, P = .045) ትክክል የመሆን ደረጃ/ጉልህ ግንኙነት እንዳለውና ክሂሎቹን መተንበይ እንደቻለ አመለካከቷል።

ሦስተኛው የጥናቱ መሠረታዊ ጥያቄ “የመምህራን የክፍል ውስጥ ምዘና ተግባር የጀማሪ ክፍል ተማሪዎችን በአማርኛ የማንበብ ችሎታ ለማሻሻል አስተዋፆ አለውን?” የሚለው ነው። 10 ነጥቦች ባሉት የማመሳከሪያ ቅፅ በተካሄደ ምልከታ የተገኙ የመምህራን የምዘና አፈጻጸምና በምዘና የተሰበሰቡ

የተማሪዎች የማንበብ ችሎታ/ውጤት መረጃዎች በጥንድ ተላውሮ ድኅረት ትንተና ተሰልተው የተገኙ ውጤቶች በሠንጠረዥ 4 ቀርበዋል።

ሠንጠረዥ 4

የመምህራን የምዘና ተግባር (classroom assessment practice) የተማሪዎችን የማንበብ ችሎታ ለማሳደግ ያለው ሚና የጥንድ ተላውሮ ድኅረት ትንተና (bivariate regression analysis) ውጤት

የምዘናው ዓይነት	የተጋራ ስምንት (R ²)	መደበኛ ድኅረታዊ መጠኝ Beta (β)	F	ትክክል የመሆን/የጉልህነት ደረጃ (sig.)
የፊደል ስያሜ ዕውቀት	.685	.828	13.053	.011
የተዘውታሪ ቃላት ንባብ	.638	.799	10.585	.017
የትርጉም አልባ ቃላት ንባብ	.512	.715	6.288	.046
አቀላጥፎ ማንበብ	.682	.826	12.865	.012
የንግግር ድምፆች ግንዛቤ	.370	.608	3.526	.109
አንብቦ መረዳት	.510	.714	6.251	.047

Note. Df= (1,114)

በሠንጠረዥ 4 እንደተመለከተው በተማሪዎች ውጤት ላይ ከታየው ለውጥ ከ51.0% – 68.5% የሚሆነው በመምህራን የክፍል ውስጥ ምዘና አፈጻጸም ላይ የታየ መሆኑን (ከንግግር ድምፆች ግንዛቤ በስተቀር) የቀረበው የተጋራ ስምንት “R²” ውጤት ያስረዳል። ውጤቱ በመምህራን የክፍል ውስጥ ምዘና ተግባራት አፈጻጸምና በተማሪዎች የማንበብ ውጤት መካከል ከፍተኛ ተዛምዶ መኖሩንና የምዘና ተግባሩ የተማሪዎችን ውጤት በከፍተኛ ደረጃ መተንበይ እንደቻለ (የምዘና አፈጻጸሙ ቢሻሻል የተማሪዎች ውጤት ሊሻሻል እንደሚችል) አመለካከቷል (R² > .50) (Fernando, 2024)። የመደበኛ ድኅረታዊ መጠኝ (β) ስሌቱም የመምህራን የክፍል ውስጥ ምዘና ተግባር በአንድ መደበኛ ልዩይት ሲጨምር/ሲሻሻል፣ በተማሪዎች የማንበብ ውጤት ላይ (ከንግግር ድምፆች ግንዛቤ በስተቀር) በአማካይ ከ51.0 – 68.5 መደበኛ ልዩይት ጭማሪ እንደታየ አረጋግጧል። ይህም የመምህራን የክፍል ውስጥ የምዘና ተግባር አፈጻጸም ከተማሪዎች ከሁሉም የማንበብ ችሎታዎች ጋር ያለው ተዛምዶ ከፍተኛ መሆኑንና ክሂሎቹን መተንበይ መቻሉን (የመምህራን የክፍል አመራር ተግባር አፈጻጸም ሲሻሻል የተማሪዎች የማንበብ ችሎታ ሊሻሻል የሚችል መሆኑን) (β > .50) አመለካከቷል።

ትክክል የመሆን/ጉልህነት ስሌቱም (significance level/P)፣ የመምህራን የክፍል ውስጥ የምዘና አፈጻጸም ከተማሪዎች የፊደል ስያሜ ዕውቀት (F (1,114) = 13.053, P = .011)፣ የተዘውታሪ ቃላት ንባብ (F (1,114) = 10.585, P = .017)፣ የትርጉም አልባ/የፈጠራ ቃላት ንባብ (F (1,114) = 6.288, P = .046)፣ አቀላጥፎ የማንበብ F (1,114) = 12.865, P = .012) እና አንብቦ የመረዳት F (1,114) = 6.251, P = .047) ችሎታ ጋር ትክክል የመሆን ደረጃ/ጉልህ ተዛምዶ እንዳለው (P < .05) የድኅረት ትንተናው አመለካከቷል። ይህም የመምህራን የክፍል ውስጥ ምዘና አፈጻጸም የተማሪዎችን የማንበብ ውጤት/ችሎታ በሚገባ መተንበይ እንደቻለ (የምዘና ተግባር ቢሻሻል የተማሪዎች የማንበብ ውጤት ሊሻሻል እንደሚችል ያመለክተ) ሆኗል። በአንጻሩ የመምህራን የክፍል ውስጥ የምዘና ተግባር ከንግግር ድምፆች ግንዛቤ ጋር

ያለው ተዛምዶ ግን ስታስቲካዊ ትክክል በመሆን ደረጃ/ጉልህ እንዳልሆነ የትንተናው ውጤት ($F(1,114) = 3.526, P = .109$) አሳይቷል።

የውጤት ማብራሪያ

በውጤት ትንተናው እንደተገለጸው የመምህራን ትምህርትን የማቀድ ተግባር አፈጻጸም ከተማሪዎች የማንበብ ችሎታ ጋራ አዎንታዊ ትክክል የመሆን ደረጃ/ጉልህ ተዛምዶ እንዳለውና ክሂሉን በከፍተኛ ደረጃ መተንበይ እንደቻለ የድግረት ትንተና ውጤቱ አመለካከቷል ($\beta = .721 - .946, R^2 = .519 - .896, P < .05$)። የተገኘው አዎንታዊ ውጤት ከChizhik and Chizhik (2018)፣ Janssen et al. (2019)፣ Karngbeae and Kennedy (2022) እና Lai and Lam (2011) ጋራ የተደጋገፈ ነው። እንደጸሐፊዎቹ፣ ትምህርትን ማቀድ ከመምህራን ቀዳሚ ኃላፊነቶች መካከል ሲሆን ተግባሩ በዕውቀት የሚከውን ዋና ዓላማውም የትምህርቱን ዓላማዎች በማሳካት በተማሪዎች ላይ የአሠራርና የአስተሳሰብ ለውጥ ማምጣት ነው። በዚህ የማቀድ ተግባር የግብ ጠቋሚ ዓላማዎች ይቀረጻሉ፤ ወደግብ አድራሽ ይዘቶችና ስልቶች (ሥነዘዴዎች) ይለያሉ፤ ማሳለፊያ ግብዓቶች (መርጃ መሣሪያዎች) ይወሰናሉ፤ የግብ ስኬት ማረጋገጫ የምዘና ስልቶች ይቀርባሉ። እነዚህ ዐበይት ጉዳዮች በውጥ ሲታቀዱ የእቅድ ዓላማ (የተማሪዎችን ውጤት ማሻሻል) እውን ይሆናል። በዚህ ጥናት በሁለቱ ተለውጦዎች መካከል (የመምህራን የትምህርት እቅድ ዝግጅትና የተማሪዎች የማንበብ ውጤት) የተመለከተው አዎንታዊ ትክክል የመሆን ደረጃ/ጉልህ ተዛምዶም፣ በጸሐፊዎቹ የተገለጹ ዝርዝር የእቅድ ጉዳዮች በውጥ ሲፈጸሙ እውን ሊሆን እንደሚችል የሚታመን ይሆናል። በአንጻሩ ከንግግር ድምፅ ግንዛቤ ጋራ ትክክል የመሆን ደረጃ/ጉልህ ተዛምዶ ያልተገኘው ($\beta = .304, R^2 = .093, P = .464$) የማቀድ ተግባራቱ በሚገባ ሳይከናወኑ በመቅረታቸው እንደሆነ ይታሰባል።

Farhang et al. (2023) እና Karngbeae and Kennedy (2022) ያካሄዷቸው ጥናቶችም የዚህን ጥናት አዎንታዊ ውጤት ደግፈዋል። እንደጥናቶቹ፣ በጥናቱ ከተሳተፉ መምህራን መካከል ውጤታማ የሆኑት ተግባራትን ሳያንጠባጥቡ በማካተታቸው፣ ተግባራቱ በተሻለ ዘዴ የሚቀርቡበትን አቅጣጫ በመጠቆማቸው፣ ሙሉ ጊዜው ለትምህርቱ እንዲውል ለተግባራቱ ተገቢ የሰዓት ምደባ በማድረጋቸው፣ ተጠያቂዎች የይዘት አቀራረብን በመፍጠር የመማር ዕድልን ሊያሰፋ የሚያስችል እቅድ በማዘጋጀታቸው፣ የእቅድ ተግባራቸው ከተማሪዎቻቸው ውጤት ጋራ ከፍተኛ ተዛምዶ ማሳየቱን ሲገልጹ፣ ትምህርትን ለማቀድ ዕውቀት የሚያንሳቸው መምህራን ግን የእቅድ አፈጻጸማቸው ከተማሪዎቻቸው ውጤት ጋራ ያለው ግንኙነት ከሚጠበቀው በእጅጉ ያነሰ ሆኗል። በተመሳሳይ Enow and Goodwyn (2018)፣ Farhang et al. (2023)፣ König et al. (2021) እና Saad et al. (2010) በርእሰ-ጉዳይ ላይ ካካሄዷቸው ጥናቶች በመነሳት ባቀረቡት ማብራሪያ፣ ትምህርትን በውጥ ማቀድና በታለመው አግባብ መተግበር በተማሪዎች የመማር ፍላጎትና ተነሳሽነት ላይ አዎንታዊ ተፅዕኖ ያሳድራል፣ በንቃትና በትጋት የመማር ዕድልን ያሰፋል፣ የትምህርቱ ጊዜ ለታለመለት ዓላማ ብቻ እንዲውል ያስችላል፤ ክፍተቶችን እየለዩ ድጋፍ ለመስጠትና ዓላማው ግብ መምታቱን ለማረጋገጥ ያስችላል፤ ሂደቱ የተማሪዎቹን ችሎታ በማሳደግ የሚያስመዘግቡትን ውጤት ከፍ ያደርጋል። በዚህ ጥናት እንደተገኘው ጉልህ የተዛምዶ ውጤት የመምህራን ትምህርትን የማቀድ ተግባር ከተማሪዎች ውጤት ጋራ እንዲገናኝ ጊዜ ሰጥቶ፣ በዕውቀት በተመራ ሁኔታ ተግባሩን ማከናወን እንደሚገባ መረዳት ይቻላል።

በሌላ በኩል ደግሞ የመምህራን የክፍል አመራር ከተማሪዎቹ ከሁሉም የማንበብ ውጤቶች ጋር አዎንታዊ ተዛምዶ እንዳለውና የማንበብ ችሎታን በከፍተኛ ደረጃ መተንበይ እንደቻለ ከድኅረት ትንተናው የተገኘው ውጤት አረጋግጧል ($\beta = .718 - .794, R^2 = .515 - .630, P < .05$):: ይህ አዎንታዊና ትክክል የመሆን ደረጃ/ጉልህነት ያለው ውጤት በተለያዩ ዐውድ በበርካታ አካባቢዎች በተካሄዱ ጥናቶች የተደገፈ ነው:: Chibsa (2024) ባካሄዱት ጥናት በወጉ የተዘጋጀን እቅድ በክፍል ውስጥ በትክክል በመተግበር ለተማሪዎቻቸው አሳታፊ የመማር እድል የሚፈጥሩ መምህራን የተማሪዎቻቸውን ውጤት ማሻሻል እንደሚችሉ 72% መረጃ ሰጪዎች እንደሚሆኑ ያሳዩ ውጤት አቅርበዋል:: Wenglinsky (2002) ደግሞ የNAEP ዓለም አቀፍ የ15 ዓመት ተማሪዎችን ምዘና መሠረት በማድረግ በ7146 የ8ኛ ክፍል አሜሪካዊዎችን ተማሪዎች ላይ ባካሄዱት ጥናት የመምህራን የክፍል አመራር ተግባር አፈጻጸም ከተማሪዎች የትምህርት ውጤት ጋር ከፍተኛ ግንኙነት እንዳለው አረጋግጠዋል:: Olayvar (2021) በበኩላቸው በመምህራን የክፍል አመራርና በተማሪዎች የእንግዝሊዝኛ ቋንቋ ውጤት መካከል ከፍተኛ ዝምድና እንዳለ ($r = .853$) በጥናታቸው በማረጋገጥ፣ አፈጻጸሙ እየተሻሻለና እየጠነከረ ቢሄድ የተማሪዎች ውጤትም አብሮ ሊሻሻል እንደሚችል በውጤት ማብራሪያው ላይ ገልጸዋል::

Thomas et al. (2010) እንዲሁ የተማሪዎች ውጤት በመምህራን የክፍል አመራር ተግባር ጥራት የሚወሰን ሲሆን የመምህራን ውጤት የሚለካው ደግሞ ተማሪዎች ባስመዘገቡት ውጤት እንደሆነ ገልጸዋል:: የመምህራን ዋና ኃላፊነት በክፍል ውስጥ ይፈጸማል፤ ኃላፊነቱ በታቀደው መሠረት የተማሪዎችን ዕውቀት፣ ክህሎትና አመለካከት የሚለውጥ ትምህርት ማቅረብ ነው፤ ከክፍል ውጭ ያሉ የመምህራን ተግባራት ለክፍል ውስጥ አፈጻጸሞች ደጋፊ እንጂ ዋና አይደሉም፤ በመሆኑም ልዩ ትኩረት ሊሰጥ የሚገባው ለክፍል አመራር ሂደት ነው፤ በማለት ከጥናት ውጤታቸው በመነሳት የገለጹት ደግሞ Zhu and Kaiser (2022) ናቸው:: ባጠቃላይ የክፍል ውስጥ የመምህራን የክፍል አመራር በትምህርት እቅድና በዓላማ ስኬት ምዘና መካከል ያለ ድልድይ ሲሆን በጠቅላላ የመማር ማስተማር ሂደቱና (የተማሪዎች ችሎታ/ውጤት) እና የትምህርት ሥርዓት ውጤታማነት መገለጫ ዐቢይ ተግባር እንደሆነ በዚህ ጥናትና ዋቢ ተደርገው የቀረቡ ጥናቶች አመለካከተዋል (Adeleke & Akere, 2023; Wenglinsky, 2001):: ከዚህ በተቃራኒ ግን ቀደም ሲል ከቀረቡና የክፍል አመራር በማንበብ ችሎታ ላይ አዎንታዊ ተጽእኖ እንዳለው ከገለጹ ጥናቶች የሚቃረን ጥናት በFarook and Ahmed (2021) ቀርቧል:: ተመራማሪዎቹ 255 የ2ኛ ደረጃ ተማሪዎችን በማሳተፍ ባካሄዱት ጥናት፣ በመጠይቅ የተገኙ መረጃዎችን በድኅረት ትንተና ስልት ተንትነው የክፍል አደረጃጀት ከተማሪዎች ውጤት ጋር ትክክል የመሆን ደረጃ/ጉልህ አዎንታዊ ዝምድና እንደሌለውና ውጤቱን መተንበይ እንዳልቻለ የሚያመለክት ውጤት ($R^2 = .041, P = .514$) አግኝተዋል:: ይህም ርእሰጉዳዩን በተጨማሪ ጥናቶች የመመርመር አስፈላጊነትን የሚጠቁም ነው::

የመምህራን የክፍል ውስጥ ምዘና ተግባር፣ የጀማሪ ክፍል ተማሪዎችን በአማርኛ የማንበብ ችሎታ የማሻሻል ትክክል የመሆን ደረጃ/ጉልህ ተዛምዶ በተመለከተም፣ በድኅረት ትንተናው የተገኘው ውጤት የመምህራን የክፍል ውስጥ ምዘና አፈጻጸም ከንግግር ድምፃች ግንዛቤ ውጭ ካሉ የማንበብ ውጤቶች ጋር ትክክል የመሆን ደረጃ/ጉልህ አዎንታዊ ተዛምዶ እንዳለውና ክህሎቱን መተንበይ እንደቻለ አረጋግጧል ($\beta = .714 - .828, R^2 = .510 - .685, P < .05$):: Calonia et al. (2023) እንደሚሉት ከመማር ማስተማር ተግባራት መካከል ዐቢይ ቦታ የሚይዘው ምዘና፣ እቅድን ከውጤት ጋር የሚያስተሳስር፣ የትምህርት ዓላማ እንዲሳካ ክፍተቶችን በማመለከት ማስተካከያ እንዲደረግ የሚያስችል፣ በምን ያህል

ደረጃ ውጤት እንደመጣ መረጃ የሚሰጥ እንደሆነ ሲገልጹ፣ Ullah et al. (2021) በበኩላቸው በተለይም ሂደታዊ የሆነው የክፍል ውስጥ ምዘና ለላቀ ውጤት ተነሳሽነትን የሚያሳደግ፣ መደጋገፍን የሚፈጥር ነው፤ ይላሉ። ከጻሕፍቱ ሐሳብ ጋር በተገናኘ በዚህ ጥናት የተገኘው አዎንታዊ የተዛምዶ ውጤትም፣ የእቅድና የክፍል አመራር ተግባራትን በማስተሳሰር፣ ክፍተቶችን ማመላከት በመቻል፣ የውጤት ደረጃን በማሳየት፣ መደጋገፍ እንዲኖር በማድረግ ሊመጣ እንደሚችል ይታመናል።

ከጻሕፍት ሐሳብ በተጨማሪ የጥናቱ ውጤት ከተለያዩ የጥናት ውጤቶች ጋራም እንዲሁ ተደጋግቷል። በጀርጂያ ስቴት ዩንቨርሲቲ መምህር የሆኑት Li (2012) ከዓለም አቀፉ የ15 ዓመት ተማሪዎች የ2009 ምዘና (PISA) ውጤት የአሜሪካን ተማሪዎች ነጥለው በመውሰድ ባካሄዱት ጥናት በሂደታዊ ምዘናዎች (formative assessment) እና በተማሪዎች የማንበብ ውጤት መካከል ከፍተኛ ተዛምዶ እንዳለና ምዘናው ከተማሪዎች የማንበብ ፍላጎት ጋር ዝምድና እንዳለው፣ የመምህር-ተማሪ ግንኙነቶችንም በአዎንታዊነት እንደሚያሻሽልም አሳይተዋል። በተመሳሳይ Xuan et al. (2022) ባጠቃላይ 116,051 ተማሪዎችን በማሳተፍ የተካሄዱ 48 መጠናዊ ጥናቶች ላይ ልዕላትንተና አድርገው ሂደታዊ የክፍል ውስጥ ምዘና ከተማሪዎች የማንበብ ውጤት ጋር አዎንታዊ መካከለኛ ግንኙነት (ES = +0.19) እንዳለው አመለክተዋል። Yan and Chiu (2021) በበኩላቸው የ19 ሀገሮች 151,969 የ15 ዓመት ዕድሜ ተማሪዎችን ባካተተው የPISA 2018 ጥናት ላይ በመመሥረት ባካሄዱት ጥናት፣ ግቦችን ግልጽ በማድረግና መሻሻሎችን በመመዘን በሚገኘው ውጤት ላይ በመመሥረት የሚደረግ የመማር ማስተማር ሂደት ከተማሪዎች የማንበብ ውጤት ጋር አዎንታዊ ተዛምዶ እንዳለው አረጋግጠዋል። በዚህ ጥናትም፣ የምዘና ሂደት የመምህር-ተማሪ ግንኙነቶችን ሲያሻሽል፣ ግቦችን ግልጽ ሲያደርግና መሻሻሎችን በመከታተል ክፍተቶችን መሙላት ሲያስችል የመምህራን የክፍል ውስጥ ምዘና ከተማሪዎች የማንበብ ውጤት ጋር አዎንታዊ ትክክል የመሆን ደረጃ/ጉልህ ተዛምዶ እንደሚኖረው መረዳት ይቻላል። የCai et al. (2022) ጥናት ውጤት ግን እስካሁን ከቀረበው ተቃራኒ ሆኗል። አጥኝው 4837 የሆንግኮንግ ተማሪዎችን በማሳተፍ ባካሄዱት ጥናት ያሰባሰቧቸውን መረጃዎች በመዋቅራዊ ስሌት ሞዴል ተንትነው፣ ሂደታዊ ምዘና በዝቅተኛና በመካከለኛ ደረጃ ተማሪዎች የማንበብ ችሎታ ላይ ትክክል የመሆን ደረጃ/ጉልህ አዎንታዊ ተጽእኖ እንዳለው፣ በከፍተኛ ደረጃ ተማሪዎች የማንበብ ችሎታ ላይ ግን ያሳደረው ተጽእኖ ስታቲስቲካዊ አለመሆኑን የሚያመለክት የጥናት ውጤት አቅርቦታል። ይህም ምዘና ከፍ ያለ ችሎታ ባላቸው ተማሪዎች የማንበብ ችሎታ ላይ አወንታዊ አስተዋጾ ያላሳደረው ለምን እንደሆነ በተጨማሪ ጥናቶች የመመርመር አስፈላጊነትን ይጠቁማል።

ባጠቃላይ በዚህ ጥናት በምዘና፣ በምልከታና በሰነድ ፍተሻ የተሰበሰቡ መረጃዎች በድኅረት ትንተና ስልት ተተንትነው የመምህራን ቅጥር የማስተማር ተግባራት (ማቀድ፣ የክፍል አመራርና ምዘና) የቀዳማዊ ክፍል ደረጃ ተማሪዎችን የማንበብ ችሎታ ለማሻሻል አዎንታዊ አስተዋጾ ያላቸው መሆኑንና ክሂሉን መተንበይ እንደቻሉ የሚያረጋግጡ ውጤቶች ተገኝተዋል። ውጤቶቹም በተለያዩ ጊዜያትና ዐውዶች ከተሠሩ በርካታ ጥናቶች ውጤቶች ጋር ተደጋጋፊ ሆነዋል። ከዚህም የተማሪዎችን የማንበብ ችሎታ ለማሻሻል የመምህራንን የዕውቀትና የአፈጻጸም ክሂል በማሳደግ የማቀድ፣ የአመራርና የምዘና ተግባራት በተሻለ ሁኔታ እንዲከናወኑ ማድረግ እንደሚገባ መገንዘብ ይቻላል። በማቀድ፣ በክፍል አመራርና በመመዘን አስተዋጾ ላይ ተቃራኒ የጥናት ውጤቶች መታየታቸው ደግሞ ተጨማሪ ምርምሮችን በማካሄድ የተለውጡዎቹን አስተዋጾ በበለጠ ማረጋገጥ አስፈላጊ መሆኑን ያስገነዘበ ሆኗል።

ማጠቃለያ

የመምህራን ቅሬታዎች የማስተማር ተግባራት የቀዳማዊ ክፍል ደረጃ ተማሪዎችን የማንበብ ችሎታ ለማሻሻል ያላቸውን አስተዋፆ መመርመር የጥናቱ ዋና ዓላማ ነበር። የዚህን ገለጫ-ተዛምዶ ጥናት ሦስት መሠረታዊ ጥያቄዎች ለመመለስ ከ160 የ2ኛና የ3ኛ ክፍል ተማሪዎች በምዘና፣ ከ8 የአማርኛ ቋንቋ መምህራን በክፍል ውስጥ ምልከታ፣ እንዲሁም በሰነድ ፍተሻ የተሰበሰቡ መረጃዎች በጥንድ ተላውጦ ድኅረት የትንተና ስልት ተፈትሸዋል። ከትንተናው በፊት ስልቱ የሚጠይቃቸው እሙኖች መሟላታቸው ተረጋግጧል። ከድኅረት ትንተናው የተገኙ ውጤቶችም የመምህራን ቅሬታዎች የማስተማር ተግባራት (ማቀድ፣ የክፍል አመራር፣ መመዘን) ከተማሪዎች የማንበብ ችሎታ ጋር (ከፊደል ስያሜ ዕውቀት፣ ከተዘውታሪና ትርጉምአልባ ቃላት ንባብ፣ አቀላጥፎ ከማንበብና አንብቦ ከመረዳት ጋር) አዎንታዊ ትክክል የመሆን ደረጃ/ጉልህ ተዛምዶ እንዳላቸውና እነዚህ ቅሬታዎች የማስተማር ተግባራት ቢሻሻሉ የተማሪዎች የማንበብ ችሎታ ሊሻሻል እንደሚችል መተንበይ እንደቻሉ አረጋግጠዋል።

የተገኙ አወንታዊ ውጤቶች በአማርኛ ቋንቋ ትምህርት የታየውን የጀማሪ ክፍል ተማሪዎች የማንበብ ውጤት ማሻሻል ለመግታትና ለማሻሻል፣ መምህራን የትምህርት እቅዶችን ሲያዘጋጁ፣ ክፍል ሲመሩና ምዘና ሲያከናውኑ የሚታዩባቸውን የዕውቀትና የክህሎት ውስንነቶችን በመለየት፣ በተከታታይ ሥልጠናዎች (ለምሳሌ፣ በትምህርት ጥናት፣ በተከታታይ የሙያ ማሻሻያ፣ በጉድገት ወዘተ) ውስንነቶችን በመሙላት፣ ተግባሮቹ (ማቀድ፣ መምራትና መመዘን) በማንበብ ችሎታ መዳበር ላይ አወንታዊ አስተዋፆ እንዲያበረክቱ ማድረግ የሚገባ መሆኑን የጠቆሙ ናቸው። ይህ እንዲሆን ደግሞ በተለይም መምህራንን የመደገፍና የማብቃት ኃላፊነት ያለባቸው የጉድገት ሱፐርቫይዘሮችና ርእሰ/ሰነድ መምህራን ድርሻቸው የጎላ ይሆናል። ከዚህ ሌላ ጥናቱ በ4 ትምህርትቤቶች፣ 160 ተማሪዎችንና 8 መምህራንን በማሳተፍ የተካሄደ መሆኑ የተገኙ ውጤቶችን የማጠቃለል አቅም ውስን እንደሚያደርገው ይታመናል። ይህም ሰፊ ባለ አካላዊና የፍጡና መጠን ተጨማሪ ጥናት የማካሄድ አስፈላጊነትን የሚጠቁም ነው።

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Evaluating the new grade eight general science textbook vis-a-vis the key criteria of problem-solving skills development

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Abstract

This study aimed to evaluate the extent to which the Grade Eight General Science textbook satisfies the key criteria for the development of students' problem-solving skills. To achieve this objective, content analysis was employed to examine the entire unit of the textbook. Data collected through quantitative content analysis were analyzed using frequencies and percentages, while qualitative data were analyzed using content analysis and the findings were presented thematically through textual descriptions. The findings revealed that 66.5% of the textbook content was not related to real-life situations. Although students were made aware of the intended learning outcomes, 71 (78.8%) of the objectives were confined to factual, lower-level cognitive domains. The textbook made substantial use of graphic organizers and collaborative learning strategies (84.8%) as mechanisms for promoting students' problem-solving skills. However, the use of metacognitive strategies, process-oriented tasks, and higher-order thinking—provoking activities—essential for enhancing students' problem-solving skills—was found to be limited. To strengthen students' problem-solving skills, the Grade Eight General Science textbook should be revised to incorporate situated problem-based tasks, open-ended questions that foster higher-order thinking, and explicit metacognitive strategies.

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Introduction

Education is the process of learning the knowledge, skills, attitudes, interests, abilities, competence, and cultural practices of society and passing them on to future generations in order to foster long-term growth (Lawal, 2013). It is critical to the evolution of the human mind and underpins all development successes, from medical breakthroughs and agricultural innovations to effective government administration and private-sector growth. To completely secure these benefits, a country must cultivate the human mind's potential (Bruner, 2020; Ozdem-Yilmaz & Bilican, 2020).

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Education cannot solve problems on its own, but educated people endowed with problem-solving abilities can bring about essential development in the social, cultural and ecological environment. Education increases output by providing people with up-to-date scientific and technological information (Becker et al., 2017; Freeman et al., 2015). To be successful, learners should be equipped with problem-solving skills. It is widely acknowledged that textbooks serve as major instructional inputs in developing this skill among learners (Hunegnaw & Melesse, 2023). Textbooks may determine the content of instruction and teaching procedures in thousands of classrooms (Gak, 2011). Learning materials based on Problem-Based Learning (PBL) meet effective criteria of higher order thinking development and can improve problem-solving ability and student self-efficacy (Peranginangin et al., 2019). In this case, textbooks are extremely important for teaching and learning (Rashid & Sandaran, 2022). They are widely accepted as common features of classrooms worldwide and serve as important vehicles for curriculum promotion (O'Keeffe, 2013). According to recent research, the quality of instructional materials can significantly affect student learning (Bugler et al., 2017).

In some countries (e.g., Ethiopia, and Nigeria), textbooks are the primary teaching materials, offering a structured knowledge base that teachers adapt to fit their instructional goals. Textbooks should be part of the students' activities, and the teacher can include them into all stages of the teaching-learning process, as well as those learning approaches that need working with textbooks (Devetak & Vogrinc, 2013). Textbooks also explain the relationships between real-world occurrences and scientific theories, as well as the content to be taught and the basic rules for teaching techniques. However, it is important to recognize that insufficient and inconsistent scientific knowledge offered in science textbooks harms students' ideas, and some concern has been expressed that textbook notions may not always be accurate (Irez, 2016).

The Ethiopian educational curriculum predominantly emphasizes knowledge acquisition, with limited attention to learners' active construction of knowledge (Melesse, 2014). It focused on the transfer of bulky lower cognitive domain content to students. This one-way transfer of lower cognitive domain content to the students and the loading of students' minds with a massive amount of information made them simply an information collector rather than constructing knowledge by themselves (Dessie, 2015). Scholars have long criticized transmission-oriented pedagogy for reducing learners to passive recipients of information. Freire (1970) conceptualized this practice as the banking model of education, where students merely store deposited knowledge rather than construct meaning. Similarly, Dewey (1938) argued that learning based on information transmission suppresses reflective thinking and authentic understanding. Constructivist theorists such as Piaget (1970), and Bruner (1961) emphasize that knowledge is actively constructed through interaction, experience, and inquiry, not passively received. When instruction focuses predominantly on lower-order cognitive domains, as Bloom (1956) warned, students become information collectors rather than critical thinkers and knowledge producers.

Even if the Ethiopian educational policy recommended a concise and student-centered curriculum, studies such as Mebrahtu and Ejigu (2019), and Tesfamariam et al. (2014) have indicated that the Ethiopian science curricula were too theoretical and overloaded, and used

teacher-centered (commonly called “chalk and talk”) teaching methods that expect students for mere recalling large amounts of factual information to pass examinations.

Problem solving entails analyzing the possible causes of a non-routine problem and formulating an action plan to tackle this problem (Mogari & Chirove, 2017). People utilize their problem-solving abilities at all times, both in their personal and professional lives. Practical problem solving in the workplace typically demands following a step-by-step procedure and using a set of specified problem-solving skills. The ability to solve problems is a basic life skill essential to our daily lives. People utilize their problem-solving abilities continuously in both their personal and professional lives (Jonassen, 2000; OECD, 2018). Practical problem solving in workplace contexts typically requires following step-by-step procedures and applying a set of specific cognitive and metacognitive skills (Pólya, 1957; Sternberg, 2012). The ability to solve problems is widely recognized as a fundamental life skill essential for effective functioning in everyday situations (Trilling & Fadel, 2009).

Problem-solving skills used in daily life can be taught, practiced, and transferred from classroom learning experiences to real-life contexts (Bransford et al., 2000). The problem-solving skills used in our day-to-day lives can be taught or adapted from classroom situations. Students who successfully solve real life related problems in the classroom can have self-confidence in solving problems outside the classroom situation as well. That is, teaching students using a problem-solving approach makes learners have a better understanding, enjoyable learning experience, and better academic performance, and makes them critical thinkers. In other words, students who successfully solve real-life-related problems in classroom settings are more likely to develop confidence in solving problems beyond the classroom environment (Bandura, 1997). Put differently, teaching through a problem-solving approach promotes deeper understanding, more enjoyable learning experiences, improved academic performance, and the development of critical thinking skills (Hmelo-Silver, 2004; Prince & Felder, 2006). Therefore, to effectively enhance students’ problem-solving skills, curricular materials need to be redesigned and constructed to support problem-based, inquiry-oriented, and learner-centered instructional approaches (Jonassen, 2011; Darling-Hammond et al., 2020).

To advance national development and equip students for success in the twenty-first century, the curriculum should undergo a paradigm shift in emphasis from an immutable view of knowledge transmission to a view of dynamic knowledge construction (Kassaye, 2024). This can be attained only if the curriculum and curricular materials are designed according to the criteria of problem-solving skills development charted out by renowned scholars in the area (e.g., Melesse, 2014; Jonassen, 2011; Bransford et al., 2000).

This goal can be achieved only when the curriculum and its associated instructional materials are designed in accordance with well-established criteria for the development of problem-solving skills articulated by leading scholars in the field (e.g., Jonassen, 2000; Hmelo-Silver, 2004). Such curricular materials should position students as active agents in solving problems and constructing new knowledge, rather than passive recipients of ready-made information imposed upon them (e.g., Jonassen, 2011; Bransford et al., 2000).

To effectively enhance learners’ problem-solving abilities, the criteria guiding textbook development should incorporate problem-based learning, clearly defined learning phases, task recursiveness, the use of graphic organizers, metacognitive engagement, and

collaborative learning opportunities (e.g., Melesse, 2014; Jonassen, 2011; Pólya, 1957; Bransford et al., 2000). Textbooks developed based on these principles encourage students to actively engage with content, apply what they have learned, and thereby develop stronger problem-solving skills as well as higher-order thinking capacities.

As previously highlighted, textbooks play a central role in supporting students' problem-solving skill development. Hence, it should be prepared by incorporating key criteria of student problem-solving skill development disclosed earlier. To ensure that textbooks are prepared with the key criteria of student problem-solving skills development in mind, textbook evaluation should be conducted regularly (Hunegnaw & Melesse, 2023; Bishaw, & Ayalew, 2013). It aids in identifying what is missing as well as the curriculum's inherent strengths and weaknesses. It provides data for continuous textbook modification and determines whether the curriculum's intended goals have been met. As a result, it is crucial to evaluate whether textbooks are prepared using key criteria for problem-solving skills development.

In any curriculum, teachers, students, and textbooks are the main components of classroom instruction (Guerrettaz & Johnston, 2013). Science textbooks, as a reflection of the objectives and outcomes of teaching/learning, have always played a vital role in influencing what science is taught, and more importantly, how science should be taught in a classroom. In many countries (e.g., Ethiopia, Nigeria, Turkey), textbooks are regarded as the principal reference tools for classroom instruction. This is especially true in schools in developing countries, where both teachers and students rely significantly on textbooks for instruction. For instance, according to Upahi et al. (2020), Nigerian science teachers rely on textbooks to choose acceptable information to teach their students. Ethiopian researchers (e.g., Hunegnaw & Melesse, 2023) confirmed that Ethiopian science/chemistry teachers rely primarily on textbooks for various reasons. As a result, curriculum developers should design a textbook with an exceedingly critical approach that develops higher order thinking and problem-solving skills, thus improving student achievement and curriculum success.

A good textbook, as emphasized by more recent scholars, should be learner-centered, support self-directed learning, allow students to progress at their own pace, provide meaningful exercises to deepen conceptual understanding, and clearly state learning objectives prior to instruction (Pingel, 2010; UNESCO, 2016). Accordingly, it is advisable to evaluate grade eight general science textbook to determine whether they have been prepared in alignment with these contemporary textbook quality criteria.

The grade eight general science students' textbook which is prepared by the Amhara National Regional State Education Bureau is first published in 2023. Experts in the Amhara National Regional State Education Bureau and the scholars' council participated collaboratively as writers and editors during this textbook preparation. All governmental, public, and private schools have used this textbook throughout the region. As far as the researchers' knowledge is concerned, there is no study conducted on the evaluation of grade eight general science textbook status concerning students' problem-solving skill development. Hence, the researchers were initiated to evaluate grade eight general science textbook vis-à-vis the key criteria of problem-solving skills development. With this in mind, the following research questions were raised:

1. Does the grade eight general science textbook incorporate content related to real-life problems?
2. Does the grade eight general science textbook provide information about learning objectives?
3. Does the grade eight general science textbook provide students with a chance to predict and summarize information by posing process-type questions?
4. To what extent does the grade eight general science textbook promote students' use of graphics?
5. To what extent do the grade eight general science textbook support meta-cognitive strategies?
6. To what extent does the grade eight general science textbook support cooperative learning?

Methods

A mixed-methods research approach was used in this study to collect relevant data, and the integration of both quantitative and qualitative approaches was intended to explicate the researchers' investigation with the intention that one does not fault or diminish the strength of another but rather complements each other to make sound interpretation and conclusion.

Content analysis (quantitative and qualitative) was employed to describe the status of the textbook regarding problem-solving skills criteria. Content analysis is a research method in which a researcher obtains data from recorded information or information that has been recorded in texts, media, or physical items. As a qualitative approach, content analysis is based on the assumption that texts are rich data sources with the potential to reveal valuable information about specific phenomena, and as a quantitative approach, content analysis is a method based on the systematic coding and quantification of content concerning the stated criteria.

The instruments and units of analysis vary with the nature and purpose of the research that researchers undertake (Selvi, 2019). Hence, the unit of analysis may be a single word/phrase, letter, symbol, sentence, paragraph, whole text, theme, or entire textbook. In this study, to answer the basic research questions, illustrations, tables, flowcharts, graphics, topics and sub-topics, questions (in-text questions, activities, exercises), and instructions (directions) included in the textbook were used as unit of analysis (Melesse, 2014). The findings from these units of analysis served as a basis for assessing the degree to which the eighth-grade general science textbook facilitates the development of problem-solving skills. To collect data from these data sources, checklists were prepared and carefully used by the researchers throughout the analysis.

As the research follows a mixed-methods approach, both quantitative and qualitative data analysis techniques were employed. Qualitative data were analyzed using data driven thematic narrative analysis method, and quantitative data were analyzed using frequency, and percentage distributions. After expressing the quantitative data in terms of frequency, and percentage, the calculated data were expressed using graphic and tabulation representations.

Findings

Evaluating the Textbook against Situated Problem Learning Criterion

The extent of problem-solving skill development in grade eight general sciences textbook was assessed in relation to situated problem learning criterion. Contents and sub-contents were classified into those that provide life situated and non-life situated learning.

Table 1 indicates that out of 161 contents in the grade eight general science textbook, 54(33.5%) of the topics are presented in relation to real-life context, while the remaining 107(66.5%) of the topics are not presented based on real-life contextualized approach. To promote students' problem-solving skills, textbooks should incorporate more life-situated learning than un-contextualized learning. More specifically, from Table 1 in Unit One, 2(33.3%) were real life related presentations and the remaining 4(66.7%) were non-real life related presentations.

In Unit Two, 1(14.28%) is real life related presentation, and the remaining 6(85.7%) are un-contextualized presentations. In Unit Three, 2(8%) are real life related presentations, and the remaining 23(92%) are un-contextualized presentations. Similarly, in Unit Four, 21(52.5%) are real-life related, and the remaining 19(47.5%) are un-contextualized presentations. In Unit Five, 17(53.12%) are context-based, while 15(46.87%) are un-contextualized ones. In Unit Six, 2(11.76%) are context-based, while the remaining 15(88.23%) are un-contextualized presentations. Lastly, in Unit Seven, 9(36%) are context-based, but the remaining 15(64%) are un-contextualized. As can be seen in Table 1, four units have very low contextualized presentations (Units, 1, 2, 3, and 6) while two units (Units 4 and 5) have a relatively higher number of contextualized presentations.

Table 1

Contents of the Textbook Related to Real Life Problems and Students' Experiences

Unit	Topic presented related to real life situations	Topic presented not related to real life situation	Total
1	2	4	6
2	1	6	7
3	2	23	25
4	21	19	40
5	17	15	32
6	2	15	17
7	9	25	34
Total	54 (33.5%)	107(66.5%)	161

In situated learning, students are faced with the problem that they know in their real life and they can easily solve the problem that they faced. For example, in grade eight general science textbook (Page, 44); to teach students about indicators, local indicators prepared by extracting from different parts of plants such as roots, leaves, flowers or fruits were used. The inclusion of Petunia flowers and Beetroot as natural indicators leverages students' prior knowledge of their surroundings. This approach facilitates a deeper understanding of chemical indicators by grounding abstract concepts using real-world examples. There is also an impressive way of relating content to real-life problems; to teach about chemical change,

students were asked to do activity (Page 53) which says “In everyday life, souring of “Tella” and “Milk” is a common problem. What do you suggest to extend the age of “Tella” and “Milk” without souring? And what is the common indigenous knowledge used by the people in your locality? Ask your parents, why they tightly pack the containers of the crude mixture (Difidif) of Tella or Teji?” Similarly on Page 53, to teach students about action of acids and soap on metals (Gold or Silver with lemon juice) the text use questions like “Your Mom often washes her jewellery made from Gold or Silver with lemon juice. Why did she use lemon juice to clean her jewellery instead of soap?” The incorporation of these types of questions best illustrates a situational learning approach. However, because science exists within learners’ daily lives, textbook developers have ample opportunity to include more life-situated learning activities than are currently provided.

Evaluating the Textbook against Phases of Learning Criterion

To enhance problem-solving skills of students, besides the inclusion of problem-situated content in the textbook, students should also be informed about the learning objectives before the teaching learning process. Following the learning objectives, questions (process type) should be forwarded to raise awareness of what is expected from them. The learning objectives stated in the textbook were counted and related to the contents presented to analyze the extent of grade eight general science textbook problem-solving skill development (whether or not the textbook motivates students’ problem-solving skills through informing them of the learning objective). As problem-solving skill development is closely related to the cognitive level of learning objectives, the objectives were analyzed based on Bloom’s taxonomy.

As seen from Table 2, there are no general objectives designed in each unit of grade eight general science textbook. There are 90 specific objectives designed and stated next to the main topic, and each specific objective is designed for the sub-topic found in the textbook. From the analysis, there are 153 topics and sub-topics in the textbook. Despite scholarly recommendations emphasizing constructive alignment between learning objectives and content (Tyler, 1949; Taba, 1962; Biggs & Tang, 2011), the results reveal a clear imbalance, with contents and sub-contents far outnumbering the specific objectives. The textbook writers should have incorporated general objectives to inform students about the main goal of their learning. Thus, the textbook was poor in enhancing students’ problem-solving skill development for it fails to incorporate learning objectives at the beginning of their learning.

Table 2

General, Specific Objectives and Sub-Contents Incorporated in the Textbook

Unit	General Objectives	Specific Objectives	Content
1	-	4	6
2	-	6	8
3	-	8	27
4	-	24	36
5	-	27	25
6	-	7	17
7	-	14	34
Total	-	90	153

As seen from Table 2, most of the specific objectives reflect knowledge level thinking or allow students to recall facts and theory that are learned in the class. The objectives expected from grade eight general science syllabus are 59(65.5%) recalling knowledge level, 12(13.3%) comprehension, 7(7.8%) application, 6(6.6%) analysis, 4(4.4%) synthesis, and 1(1.1%) are evaluation levels.

Table 3
Process and Factual Type Objectives

Unit	Recalling and factual objectives			Processing type questions			Total
	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	
1	2	1	1	-	-	-	4
2	4	1	-	1	-	-	6
3	5	2	-	-	-	1	8
4	16	2	3	1	1	-	24
5	20	3	1	1	2	-	27
6	4	1	1	1	-	-	7
7	8	2	1	2	1	-	14
Total	59(65.5%)	12(13.3%)	7(7.8%)	6(6.6%)	4(4.4%)	1(1.1%)	90

Even if science is more of experimental, students are expected to recall facts and theories rather than encourage them to perform tasks through different processes. The textbook does not promote problem-solving skills by incorporating processes and higher-order thinking objectives.

In the textbook, almost all the designed objectives (factual and process type learning outcomes) are clearly presented. Hence, students do not need to discuss with others, refer to other materials, think more by themselves, and relate the objectives with life situations to accommodate the designed objectives; instead, students can obtain all detailed notes in the textbook. This can make students textbook-dependent rather than solving problems by thinking in a multidimensional way.

Evaluating the Textbook against Recursiveness Criterion

The inclusion of activities (problems) that motivate students to summarize, analyze, apply, and evaluate ideas can enhance their problem-solving skills. In doing so, textbooks should incorporate process-type questions than simple (factual) content types. To evaluate whether activities and problems incorporated in grade eight general science textbooks were designed to enhance students' problem-solving skills, questions in the textbook were counted and categorized into process and content (factual) questions. Table 4 shows that a total of 1136 activities were forwarded to students to engage them with thinking more about the topic and to answer those activities. Most of the activities incorporated in the textbook (685(60.3%)) were process type questions.

Table 4*Types of Questions Incorporated in the Activities of the Textbook*

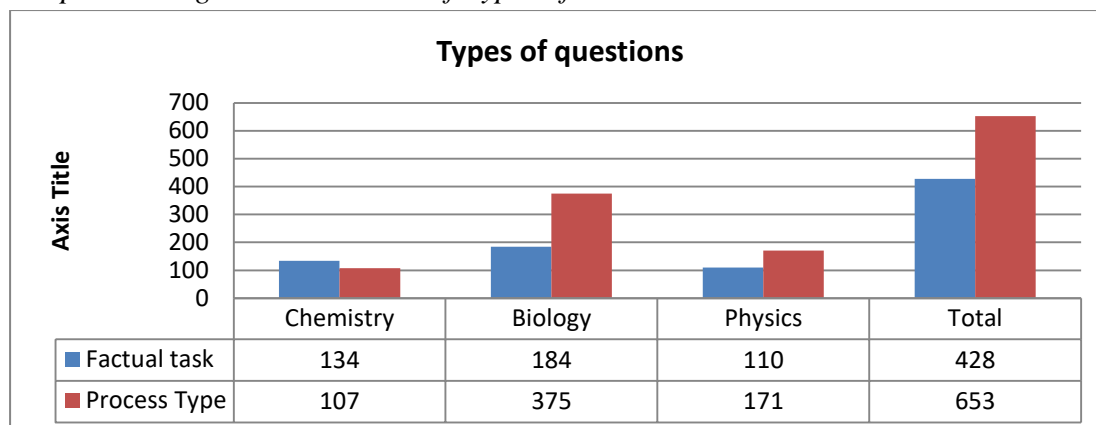
Unit	Types of questions incorporated in the activities of the textbook		
	Factual/content based	Process	Total
1	23	32	55
2	43	28	71
3	91	79	170
4	143	255	398
5	41	120	161
6	50	54	104
7	60	117	177
Total	451(39.7%)	685(60.3%)	1136

For example, in the grade 8 general science textbook (Page 33), the following process-oriented activity While the remaining (451(39.7%)) of the activities incorporated in the textbook allowed students to remember facts and principles. Activities were provided to teach students about rusting: "Have you ever seen a rusted nail or piece of metal in your surroundings? What color do they have? Is it similar to the original color? Why?" Hence, the textbook was prepared through incorporating problem-solving skill elements and it is best to enhance students' problem-solving skill. However, the problem here is that almost all the process activities that are forwarded in the textbook are followed by brief and elaborate answers immediately under them. This in turn encourages students to simply assess the notes written under to answer questions rather than discussing with others and thinking more about the activities given. Further, it leads students to grasp factual knowledge and information dependence rather than problem-solving skill development.

Table 5*Classification of Questions into Process and Factual by Content*

Content	Type of questions		
	Factual type	Process type	Total
Chemistry	134(55.6%)	107(44.4%)	241
Biology	184(32.9%)	375(67.1%)	559
Physics	110(39%)	171(61%)	281
Total	428(39.6%)	653(60.4%)	1081

As can be seen in Table 5, 134(55.6%) Chemistry content questions are asked in the factual level while the remaining 107(44.4%) tasks are prepared using process type forms. Biology content also incorporates 184(32.9%) factual tasks and 375(67.1%) process type tasks, and lastly Physics contents contain 110(39%) factual tasks and the remaining 653(60.4%) were process types.

Figure 1*Graph Showing the Distribution of Types of Tasks in Textbook*

As shown in Figure 1, Chemistry contents incorporate least amount of process type tasks, which is poor to enhance students' problem-solving skills while in Biology contents most of the tasks are prepared in the form of process type question that is best to enhance students' problem-solving skills. To enhance students' problem-solving skills, the textbook (Chemistry part) should incorporate more process and project-type questions than before. Hence, the textbook (Chemistry part) did not enhance the students' problem-solving skills by incorporating process-type exercises and summary questions.

Evaluating the Textbook against the Use of Graphic Organizers Criterion

A graphic organizer is an instructional tool that can assist students in organizing and structuring information and concepts, as well as promote problem-solving thinking skills regarding relationships between and among concepts. It can also assist pupils in organizing and clarifying their thoughts, inferring answers to issues, and communicating their thinking techniques with others. As graphic organizers have many advantages, the status and quality of graphic organizers included in grade eight general science textbook were examined. All graphic organizers were tallied and classified according to their type and intended usage to assess the status and quality of the graphic organizers included in the textbook.

Table 6*Types of Graphic Organizers Used in the Textbook*

Units	Types of graphic organizer					Total
	Flow chart	Drawing	Picture/photo	Table	Graph	
1	1	1	-	1	-	3
2	-	5	-	3	-	8
3	-	1	5	10	-	16
4	4	48	8	16	-	76
5	5	8	9	6	-	28
6	1	13	1	3	-	18
7	-	30	2	5	-	37
Total	11 (6%)	106 (57%)	25 (13.4%)	44 (23.6%)	-	186

Table 6 shows that to develop the problem-solving skills of students, different forms of graphic organizers are presented in the textbook. From Table 6, the majority of graphic organizers 106(57%) are presented in drawing or sketch forms and, followed by table graphic organizer 44(23.6%). While pictures/photos 25(13.4%), and flow charts 11(6%) are ranked third, and fourth, respectively; there is no graphic organizer in the form of graphs.

A graphic organizer assists students in organizing, analyzing, and synthesizing their knowledge, concepts, relationships, strategies, and communication. It also provides a starting point for each student's problem solving process. In particular, allowing students to develop their own graphic organizers made students to have ownerships, and their creativity increased through the process and their problem-solving skills could be maximized. Most of the content in the textbook was supported and presented using different graphic organizers, which promoted students' problem-solving skills.

In addition, as presented in Table 6, there is graphic representation in the textbook that were forwarded to students to complete or create their own graphic organizers. For instance, on Page 84 activity 4.26, students are allowed to develop their own pictures which ask them to fill parts of the digestive system by their own. On Page 158, activity 6.3, students were allowed to draw geocentric and heliocentric models and asked to describe the model. On Page 91, activity 4.31, students were asked to draw a flow chart and to level organ of the respiratory system from inside to outside and verify the general characteristics of them. As the same fashions, students are allowed to draw pictures and tables by themselves. The textbook best promoted students' problem-solving skills by incorporating graphic organizers. It is also better if it incorporates graphs to enhance students' problem-solving skills.

Evaluating the Textbook against Meta-Cognition Criterion

Problem-solvers who engage in metacognitive activities become aware of their abilities and limitations. To investigate whether eighth grade general science textbook improves students' problem-solving skills, incorporated meta-cognitive strategies were qualitatively evaluated.

To enhance students' problem-solving skills, they must be self-aware of their learning through the metacognitive strategies. As examined, grade eight general science textbook did not incorporate metacognitive strategies, and students had no room that makes them to reflect on their need for learning. As the text shows, even laboratory activities which were forwarded to the students were already pre-determined and strictly closed-type inquiries. One can imagine that students in the laboratory session have a freedom of looking at what is theoretically learned in the class.

However, in reality, students were allowed to perform all the activities strictly following the procedure written in the manual, which may not allow students to freely perform their inquiry in their interest. Generally, meta-cognitive strategies such as asking students to develop their plan, to evaluate themselves, to evaluate their plan, to monitor or correct their mistakes, etc., were not considered in the textbook.

Evaluating the Textbook against Collaborative Learning Criterion

To assess the extent to which grade eight general science textbook supports problem-solving skills development through collaborative instruction, activities that were forwarded to students were counted, and the way that instruct them to do so was identified. The instructed tasks were categorized into group work, pair work, individual work, undefined tasks, and laboratory tasks. By default, it is obvious that laboratory work is a group work. However, the researchers want to give emphasis to laboratory work rather than group work in the class with respect to students' problem-solving skill enhancement, and those tasks were counted independently.

Table 7 demonstrated that, in the grade eight general science textbook, most of the activities, 196(84.8%) engaged students to solve them in their groups. Students learn something mainly if they share their understanding with others and see how they understand issues. As it can be seen from the Table, 8(3.5%) of the tasks were designed to engage students in laboratory activities, which made them to discuss in their group on the real facts that were observed in their laboratory activities.

Table 7

Extent of Activities that Promote Collaborative Learning

Unit	Types of Collaborative task					Total
	Group work	Pair work	Individual work	Not defined	Laboratory work	
1	21	-	3	1	-	25
2	25	-	4	-	-	29
3	29	-	2	2	2	35
4	56	-	1	2	1	71
5	26	-	1	3	4	34
6	15	-	4	1	-	20
7	24	-	1	2	1	28
Total	196 (84.8%)	-	16 (6.9%)	11 (4.8%)	8 (3.5%)	231

And 16(6.9%) textbook activities allowed students to perform it independently. The remaining 11(4.8%) of tasks in the textbook did not address how students were expected to perform them. As 196(84.8%) of the tasks were group tasks that allowed students to perform their tasks in their group, the textbook was prepared in such a way that it targeted to enhance students' problem-solving skills development through collaborative teaching.

Discussion

Out of 161 contents in grade eight general science textbook, 54(33.5%) of the topics were presented in relation to the real-life context approaches, while the remaining 107(66.5%) of the topics were presented in un-contextualized approach. In support of this study, Solomon and Alemayehu (2018) evaluate grade nine geography textbook vis-à-vis the key criteria of problem-solving skill development and the result revealed that 31(23.13%) and 24(17.91%) of the topics were presented in contextualized form addressing actual problems

and students' personal experiences, respectively. The un-contextualized contents account 79(58.96%) of the total topics in the textbook.

The objectives expected from grade eight general science lesson were 59(65.5%) recalling knowledge level, 12(13.3%) comprehension, 7(7.8%) application, 6(6.6%) analysis, 4(4.4%) synthesis, and 1(1.1%) were evaluation levels. In contrast to this finding, grade eight general science textbook of Turkey focuses on comprehension level, which accounts 61% of the total objectives (Zorluoglu et al., 2020). Turkey's textbooks comprised remember 16%, apply 5%, analyze 13%, evaluate 0%, and create 5%. Compared to the Ethiopian textbook, the majority of Turkey's grade eight general science textbook objectives were concentrated at the understanding level. Even if this was so, there were no objectives in Turkey's grade eight general science textbook designed at the evaluation level, while in Ethiopia, 1.1% objectives were designed. Including evaluation questions in the Ethiopian textbooks is promising compared to Turkey's counter parts.

Even if all of these content-based factual activities are designed to be done in groups, students are allowed to list, define, and remember facts and are not allowed to think in a multidisciplinary approach. As compared to Turkey's textbook (86% factual and 14% procedural) learning outcomes Zorluoglu et al. (2020), Ethiopian grade eight general science textbook (39.7% factual and 60.3% procedural/process) learning outcomes are better for enhancing students' problem solving skills. In other hand Mengistie et al. (2020) evaluated grades 9 and 10 mathematics textbooks vis-à-vis fostering problem solving skills and reported that those textbooks are at low level of inclusion of problematic situations and general strategies of problem-solving. The study also concluded that, though the syllabus demands activities that foster problem solving, the upper primary mathematics textbooks in Amhara region do not contain adequate activities that can foster problem-solving skill of students.

Most education systems worldwide are used to adapt curricula and instructions to provide students with cooperative skills. For example, Singapore in 2000 introduced project work for grade 11 students as a main instruction in their pedagogical program and assumed that it gives students the opportunity to synthesize knowledge from various areas of learning and apply it critically and creatively to real-life situations (Tan, 2017).

The findings show that graphic organizers in the grade eight general sciences textbook are predominantly limited to drawings (57%) and tables (23.6%), with pictures (13.4%) and flowcharts (6%) used sparingly, and graphs completely absent. This limited variety constrains students' engagement with diverse visual representations that are crucial for interpreting data and supporting higher-order problem-solving (Novak, 1998; Kim et al., 2004). Procedural, manual-driven activities further restrict inquiry, as students are guided step-by-step rather than allowed to explore and investigate according to their interests (Hmelo-Silver, 2004).

The near absence of metacognitive strategies—planning, monitoring, self-evaluation—also limits learners' capacity to regulate their own learning. This finding is consistent with Mengistie et al. (2020), who reported that Ethiopian upper primary textbooks inadequately foster metacognitive and problem-solving skills. In contrast, Turkey's grade eight science textbook incorporates 5% of learning outcomes based on students' metacognitive knowledge (Zorluoglu et al., 2020), highlighting a comparative shortfall in the Ethiopian textbook.

However, the textbook does provide a strong emphasis on cooperative learning, with 84.8% of tasks designed for group work. This aligns with research suggesting that collaborative learning enhances problem-solving skills through peer discussion and shared reasoning (Johnson & Johnson, 1999; Tan, 2017). Yet, without complementary metacognitive scaffolding and open-ended inquiry, cooperative activities alone may not fully promote independent problem-solving competence (Jonassen, 2000).

Conclusion

Based on the findings above, the researchers have reached the following conclusions:

All topics and subtopics were addressed and assessed through different types of activities, such as startup activities, exercises, and review exercises. These tasks make students aware of and allow them to practice problem-solving strategies. Even if the startup activities and exercises forwarded in the textbook were open-ended and focused on higher-order cognitive domains, the majority of review exercises were concentrated in the lower cognitive domain. In the review question, students were allowed to choose, match, and fill in the blank space, which taught them to recall facts and principles rather than critically and creatively think. All activities presented to students in the textbook were designed for group work. However, summary questions and exercises could be completed individually, while in-text questions lacked explicit instructions regarding grouping. Notably, no tasks throughout the textbook were assigned to be completed in pairs. Almost all problem-solving skill development criteria, such as content presentation relating to real-life situations, phase of learning (initiating students to do it themselves), focusing on process-type content, graphic organizer, and cooperative learning, were considered during textbook preparation. However, metacognition (giving room to students' thinking and feelings) and process type and higher-order thinking questions were found less considered during textbook preparation.

Recommendations

It was established that the textbook mainly emphasizes knowledge of facts and principles. Integrating life-situated problem-related activities, incomplete graphic organizer, and recursiveness should also be emphasized in textbook preparation. The objectives of eighth-grade general science textbook are primarily focused on the lower-level cognitive domain (knowledge and comprehension). Hence, the textbook writers should focus on higher-order cognitive thinking skills to develop problem-solving skills. As a guide, textbook writers should use other collaborative learning efforts, such as field trips, social activity observation, environmental assessment, and various project works, which have received little attention in the evaluated textbook, to improve students' problem-solving skills and achieve the expected learning outcomes.

The textbook writers should incorporate process type questions than factual types. Besides, textbook authors should incorporate metacognitive strategies and emphasize students' needs and interests during the teaching and learning process to promote students' problem-solving skills, as well as understand students' levels of performance through self and peer evaluation.

Declaration of Conflict of Interest

The authors declare that there are no conflicts of interest concerning the authorship or the publication of this article.

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Applying self-determination theory to understand student engagement and achievement in Ethiopian science and mathematics classrooms

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Abstract

This study aims to test Self-Determination Theory (SDT) and its core hypotheses within the Ethiopian science and mathematics classroom context. Data were collected from 332 students in public and private schools using validated questionnaires, while academic achievement was measured using official first-semester mathematics and science scores. The hypotheses were tested using PLS-SEM. The results supported all hypothesized SDT relationships. Path analysis indicated that teacher support was a significant positive predictor of students' psychological need satisfaction ($\beta = 0.587$; $t = 12.257$). Need satisfaction, in turn, strongly predicted both classroom engagement ($\beta = 0.294$; $t = 3.623$) and academic achievement ($\beta = 0.146$; $t = 2.038$). Furthermore, mediation analyses confirmed that classroom engagement partially mediated the relationship between need satisfaction and achievement (indirect effect: $\beta = 0.074$, $t = 2.566$, $p < 0.05$); total effect: ($\beta = 0.232$, $t = 3.304$, $p < 0.001$) and between teacher support and achievement (indirect effect: $\beta = 0.066$, $t = 2.432$, $p < 0.05$; total effect: $\beta = 0.369$, $t = 6.898$, $p < 0.001$). Overall, the findings provide empirical support for SDT in Ethiopian science and mathematics classrooms and suggest that need-supportive teaching practices can enhance student engagement and academic performance.

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Introduction

Student engagement is widely recognized as a critical factor influencing adolescents' academic progress and their future educational and career pathways in STEM fields (Maltese & Tai, 2010; Wang & Degol, 2014). However, evidence suggests that engagement in secondary school mathematics and science tends to decline, particularly among students from disadvantaged backgrounds (Bobis et al., 2016). Importantly, engagement is not a fixed

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student trait but a dynamic and context-sensitive motivational state that can be shaped through classroom experiences and educational interventions (Skinner et al., 2008; Skinner et al., 2009). Understanding the factors that promote or undermine engagement is therefore essential, especially in mathematics and science learning contexts.

The present study is grounded in self-determination theory (SDT) (Deci & Ryan, 2000; Ryan & Deci, 2020), which provides a well-established framework for explaining how social environments influence student need satisfaction, engagement, and achievement. SDT proposes that contextual factors, such as students' perceptions of teacher support, contribute to learning outcomes through the satisfaction of three basic psychological needs: autonomy, competence, and relatedness. Although SDT has been widely applied in educational research, relatively few studies have examined the full motivational sequence linking teacher support, need satisfaction, engagement, and achievement within a single integrated model, particularly in STEM classrooms (e.g., Zhou et al., 2019; Leo et al., 2022).

In this study, classroom engagement is conceptualized as students' cognitive, emotional, and behavioral participation in learning activities that contributes to effective academic outcomes (Fredricks et al., 2004). Behavioral engagement reflects students' active involvement in classroom tasks and persistence in learning. Emotional engagement refers to affective reactions such as interest, enjoyment, and value toward learning activities. Cognitive engagement represents students' investment in deep learning, effortful thinking, and willingness to master challenging content.

Within SDT, teachers play a central role in fostering engagement by supporting students' psychological needs through three key dimensions of need-supportive teaching: autonomy support, structure, and involvement (Reeve et al., 2004; Ryan & Deci, 2020). Autonomy support involves encouraging student choice, acknowledging perspectives, and providing meaningful rationales. Structure refers to creating a clear, consistent learning environment with guidance, feedback, and optimal challenges. Involvement reflects teachers' emotional connection, care, and dedication to students' learning.

Empirical evidence consistently demonstrates that perceived teacher support and need satisfaction are strong predictors of student engagement and academic outcomes. For example, Skinner et al. (2008) found that supportive teacher behaviors promote engagement and reduce disaffection through autonomy satisfaction. Similarly, Tao et al. (2022) reported that teacher support positively influences engagement and achievement in mathematics and science classrooms. However, findings regarding the mediating role of engagement between teacher support and achievement remain mixed, with some studies identifying cognitive engagement as the strongest mediator and others reporting weaker or inconsistent effects across engagement dimensions (e.g., Jelas et al., 2016; Dincer et al., 2019).

Despite growing international evidence, research on student engagement in Ethiopian mathematics and science classrooms remains limited. Existing studies have largely focused on instructional approaches, attitudes, or general engagement levels (e.g., Tuji, 2006; Darge, 2006; Tagele, 2018; Zeleke & Semela, 2015), leaving a significant gap in understanding the psychological mechanisms through which teacher support influences engagement and achievement.

To address this gap, the present study applies SDT to examine how Ethiopian high school students' perceptions of autonomy support, structure, and involvement relate to their

psychological need satisfaction, classroom engagement, and ultimately achievement in mathematics and science. By testing this motivational sequence, the study contributes to a deeper understanding of engagement processes in an under-researched educational context.

Overall, the aforementioned findings have supported the SDT-based motivational model of teacher support -> student need satisfaction -> student classroom engagement -> achievement (Vallerand, 1997; Ryan & Deci, 2020). However, several prior work features limit the possibility to draw a definitive conclusion. Our work contributes to this research field in the following aspects.

Firstly, the bulk of SDT research has focused on autonomy support or considered teacher support as one overall factor. Relatively limited attention has been devoted to the combined roles of autonomy support, structure, and involvement (Hornstra et al., 2021; Olivier et al., 2021). As a result, the current study aimed to investigate the role of the three dimensions of teacher support, therefore expanding earlier findings.

Secondly, numerous SDT studies have examined the interrelations among several motivational variables, yet only a limited number of studies have tested the full sequence of associations within one single integrated model (Leo et al., 2022). So far, the chain of need satisfaction to autonomous motivation has been revealed to mediate the association between overall teacher support and engagement (Standage et al., 2005), as well as between teacher autonomy support and engagement-related variables (Leo et al., 2022). As discussed earlier, however, the relations between need satisfaction and student achievement as well as between perceived teacher support and student achievement have been mediated by classroom engagement (Standage et al., 2005; Leo et al., 2022). As such, the present study applied the mediation role of classroom engagement to the full SDT-sequential model.

Third, previous research in this area has been focused on students from Western cultures (e.g., Standage et al., 2005; Leo et al., 2022). The present study extends the application of the SDT-sequential model to Ethiopian science and mathematics classroom contexts, thereby offering valuable contextual and cross-cultural insights. As a result, it is useful to study the SDT-sequential model using a sample from Ethiopia.

Finally, most of the earlier studies have predominantly been conducted only on one subject (mainly in math) (Vasconcellos et al., 2020). Nevertheless, students can be affected by the teachers in different subjects rather than teachers of one subject. It is necessary to test the predictive role of teacher support across subjects, including chemistry, biology, physics, and mathematics.

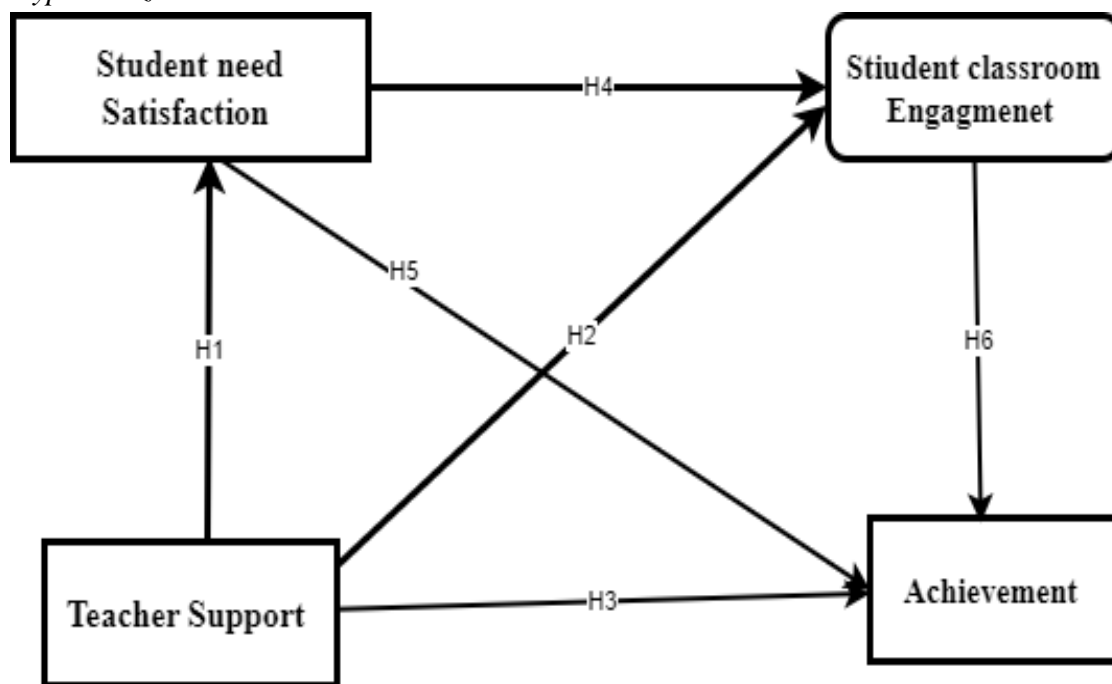
Based on the SDT framework and the relationships outlined above, the following hypotheses were formulated:

- Hypothesis 1 (H1): Perceived teacher support significantly influences students' perceived need satisfaction.
- Hypothesis 2 (H2): Perceived teacher support significantly influences students' classroom engagement.
- Hypothesis 3 (H3): Perceived teacher support significantly influences students' classroom achievement.
- Hypothesis 4 (H4): Students' perceived need satisfaction significantly influences students' classroom engagement.

- Hypothesis 5 (H5): Students' perceived need satisfaction significantly influences students' classroom achievement.
- Hypothesis 6 (H6): Students' classroom engagement significantly predicts students' classroom achievement.
- Hypothesis 7 (H7): Students' classroom engagement mediates the relationship between perceived teacher support and students' classroom achievement.
- Hypothesis 8 (H8): Students' classroom engagement mediates the relationship between students' perceived need satisfaction and students' classroom achievement.

Figure 1 provides a schematic overview of the proposed SDT-based sequential model, illustrating the hypothesized direct and mediated relationships among perceived teacher support, students' need satisfaction, classroom engagement, and academic achievement.

Figure 1
Hypothesized Structural Model



Methods

The study adopted a quantitative analytical approach using a cross-sectional survey design to examine the relationships among teacher support, students' basic psychological need satisfaction, classroom engagement, and academic achievement at a single point in time. This design was suitable for identifying patterns of association among multiple variables and for testing the proposed theoretical model using multivariate statistical techniques. As noted by Dörnyei (2007), cross-sectional designs allow variables and their interrelationships to be examined as they naturally occur. The findings are therefore interpreted as relational rather than causal.

The data were collected from one government and one private secondary school in Wolayta Sodo city, found in south Ethiopia. Both government and private schools were

purposively included to capture variation in students' socioeconomic and educational contexts, thereby enhancing the representativeness of the sample and allowing the findings to reflect differences associated therewith. The number of students in both schools was 2445. In order to get an appropriate sample size, the Krejcie and Morgan (1970), formula was used:

$$n = \frac{NZ_{\frac{\alpha}{2}}^2 p(1-p)}{e^2(N-1) + Z_{\frac{\alpha}{2}}^2 p(1-p)}$$

- the desired sample size
- Z : the standard normal deviate usually set at 1.96 (which corresponds to the 95% confidence level)
- p : the proportion in the target population to having the specific characteristics. If no estimate available, p set at 50% (or .50)
- e is the margin of error tolerated which is normally set at 0.05

According to Krejcie and Morgan (1970), this formula is an appropriate one to get a representative sample if the total number of the population is known. When we apply the above formula for our population, it gives us 332 students as a representative sample of the population.

In addition, more recent methodological research has emphasized that sample size adequacy should also be evaluated in relation to the analytical technique and the complexity of the proposed model. For instance, Chen et al. (2018) argue that in structural equation modelling contexts, sample size should be large enough to ensure stable parameter estimation and adequate statistical power for detecting the hypothesized relationships among constructs. Therefore, the final sample of 332 students was not only consistent with the classical population-based estimation of Krejcie and Morgan (1970), but also aligns with contemporary recommendations for multivariate modelling studies.

The number of students in the private and government schools was not the same. The number of students in the private school was very small as compared to the government school. However, in order to get appropriate information from both government and private school students, an equal number of students (166) from both schools were used as a sample to represent the population. This equal allocation approach is commonly recommended when one stratum is relatively small but must be sufficiently represented to allow valid statistical analysis and comparison across groups (Cochran, 1977; Kish, 1965). As noted by Lohr (2021), equal allocation approach can improve the precision of estimates within smaller subgroups and ensures that each stratum contributes adequate information to the analysis.

A multistage stratified random sampling procedure was employed. Students were first stratified by school type (government vs. private) and grade level (Grades 9–12). Next, one section was randomly selected from each grade within each school. Finally, 42 students were randomly chosen from each selected section using a lottery method, ensuring equal probability of selection for all students.

Of the 332 questionnaires distributed, 67 were excluded from the final analysis due to incomplete or invalid responses. Specifically, 41 questionnaires were removed because substantial portions of the survey question items were left unanswered, and 26 were excluded

because key demographic information (gender, grade level, or school type) was missing. Consequently, data from 265 students (79.8% of the intended sample) were retained and used for statistical analysis.

Importantly, this level of attrition was anticipated during the sampling design stage. Survey-based studies commonly experience losses due to nonresponse and missing or unusable data; therefore, researchers are advised to oversample to compensate for expected attrition and to ensure an adequate final sample for analysis (Johnson & Christensen, 2016). In line with this recommendation, the initial distribution of questionnaires exceeded the minimum required sample size, allowing the study to maintain sufficient statistical power despite the exclusions.

Student classroom engagement was measured using the recently developed Secondary School Classroom Engagement Instrument in Math and Science (Berhanu et al., 2025). This instrument was primarily developed to measure student classroom engagement in the Ethiopian context. The newly developed instrument has 32 items loaded into six components (cognitive engagement, behavioural engagement, emotional engagement, cognitive disengagement, behavioural disengagement, and emotional disengagement).

The validity of the instrument was proven by evidence obtained from Confirmatory Factor Analysis (CFA). The CFA result of this instrument was $CMIN/df = 3.14$, $GFI = 0.939$, $CFI = 0.928$, $TLI = 0.922$, $SRMR = 0.0369$, and $RMSEA = 0.040$. All indices of the model have acceptable fit values. The internal consistency, was measured, and the results are presented below. The reliability of the full-scale reliability, $\alpha = 0.906$; cognitive engagement, $\alpha = 0.841$; behavioral engagement, $\alpha = 0.769$; emotional engagement, $\alpha = 0.754$; cognitive disengagement, $\alpha = 0.609$; behavioral disengagement, $\alpha = 0.609$; and emotional disengagement, $\alpha = 0.79$.

Although the internal consistency coefficients for cognitive disengagement ($\alpha = 0.609$), behavioral disengagement ($\alpha = 0.609$), and autonomy ($\alpha = 0.66$) are relatively lower than those of other subscales, these values remain acceptable for newly developed instruments and for exploratory research or subscale-level analyses. Given the contextual specificity of the instrument and the multidimensional nature of disengagement constructs, these reliability levels were considered sufficient for the purposes of the present study (Hair et al., 2019).

The Korean Basic Psychological Needs Scale (K-BPNS; Lee & Kim, 2008) was used to determine student needs satisfaction. This measure comprises three subscales, each with five items: autonomy, competence, and relatedness. CFA showed $\chi^2 [72] = 254.206$, $p < .001$; $CFI = .93$; $TLI = .91$; $RMSEA = .066$. The internal consistency reliabilities of the instrument were as follows: autonomy ($\alpha = .66$), competence ($\alpha = .79$), and relatedness ($\alpha = .74$) (Hair et al., 2019).

The Teacher as Social Context Questionnaire—Student Report (TASCQ S) examines student perceptions of their teacher's need supportive practices and is derived from the original Teacher as Social Context instrument developed in 1988 (Belmont et al., 1988). Each question opens with "In math class, my teacher does..." The measure has 24 items, with 8 items each for autonomy support, structure, and involvement. The reliabilities of the instrument in terms of internal consistency for each subscale were reported for Autonomy Support ($\alpha = .80$), for Structure ($\alpha = .76$), and for Involvement ($\alpha = .85$). To test the validity

of the final student version, confirmatory factor analysis (CFA) was employed; the model had a reasonably excellent fit ($\chi^2 [130] = 533.715$, $p < .001$; CFI = .92; TLI = .90; RMSEA = .073).

Student achievement in mathematics and science was measured using students' cumulative first-semester results in mathematics, physics, chemistry, and biology, obtained from official school records. Semester grades combine continuous assessments (assignments, quizzes, class participation) and final exams, providing a stable and curriculum-aligned measure of academic performance. Although these were not researcher-developed tests, official grades are widely accepted in educational research as valid and reliable indicators of achievement, reflecting students' performance across multiple assessments and minimizing random measurement error (Kuncel et al., 2005).

To align achievement scores with other variables measured on Likert-type scales and facilitate integrated analyses (e.g., correlation, SEM), students' 0–100 scores were recoded into a 5-point ordinal scale: 0–49% = 1 (Low/Fail), 50–59% = 2 (Satisfactory), 60–79% = 3 (Good), 80–89% = 4 (Very Good), and 90–100% = 5 (Excellent). Transforming continuous scores into ordered categories is a common practice in educational research to preserve rank ordering while enabling comparison across variables (Hair et al., 2019). This recoding is consistent with the Ethiopian Educational Assessment and Examinations Services (EAES) grading framework, which uses 50% as the passing threshold.

By converting to a 5-point scale, the analysis can more effectively integrate academic achievement with other ordinal variables, while still reflecting meaningful differences in student performance across the full range of scores.

Before using the instruments in the Ethiopian context, the English versions were translated into Amharic by a language specialist. The translated items were then reviewed and edited by a second language expert to ensure linguistic accuracy and cultural appropriateness.

A pilot study was subsequently conducted using the finalized Amharic versions of the questionnaires with a sample of 60 Grade ten students. The purpose of the pilot was to assess the clarity, comprehensibility, and internal consistency reliability of the instruments prior to their administration in the main study. This step ensured that the translated version retained the intended meaning and psychometric quality of the original measures.

Cronbach's alpha was used to establish internal consistency reliability. The Basic Psychological Needs Scale and the Teacher as Social Context Questionnaire—Student Report (TASCQ-S) demonstrated acceptable reliability coefficients of $\alpha = 0.779$ and $\alpha = 0.812$, respectively.

To test the research hypotheses, a structural equation modelling (SEM) technique was used. Given the nature of the constructs, the latent indicators, the sample size, and the causal relationships involved, partial least squares (PLS) was deemed the most suitable SEM technique. Compared to other structural equation modeling approaches, such as the covariance-based structural equation method, PLS, a variance-based structural equation method, better suits when the focus is on prediction and theory development (Reinartz et al., 2009). Furthermore, like in this study case, the conceptual model is extensive and incorporates many indicators and latent variables (Vinzi, 2010). The Smart PLS 3.2.9 software was applied to conduct the analysis.

Data analysis was conducted in two stages. First, the measurement model was assessed by examining internal consistency reliability (Cronbach's α and composite reliability), convergent validity (average variance extracted [AVE]), and discriminant validity using the Fornell–Larcker criterion (Hair et al., 2019).

Second, the structural model was evaluated to test the study hypotheses. This included assessing multicollinearity (VIF), the significance of path coefficients through bootstrapping with 5,000 resamples, explanatory power (R^2), predictive relevance (Q^2), and overall model fit indices such as SRMR, d_ULS, and d_G (Hair et al., 2019; Henseler et al., 2016).

Because the number of items differed across subscales, composite scores were created by averaging item responses within each sub-component. This approach is commonly used in SEM to represent each construct with a single indicator while maintaining comparability across dimensions.

Data were collected from students who gave their informed consent to participate in the study. To collect data from participants under the age of 18, the researchers worked with school administrators to inform parents about the study five days before distributing the instruments.

Findings

In this section, results obtained from Smart PLS were presented. The results were put into two parts: the first part addressed the measurement model, and the second focused on the structure of the model.

Assessment of Measurement Model

Table 1 shows that Cronbach's alpha values for all constructs ranged between 0.703 and 0.895 and composite reliability was greater than 0.800, exceeding the threshold limit of 0.7 (Hair et al., 2019), exhibiting high reliability. The AVE values for all constructs are greater than 0.5 (ranging from 0.626 to 0.784), higher than the threshold limit of 0.5 (Hair et al., 2019), exhibiting good convergent validity for all constructs.

Table 1

Construct Validity and Reliability of Study Instruments

Construct	Cronbach's Alpha	rho_A	Composite Reliability	AVE
Achievement	0.895	0.900	0.927	0.760
Student Classroom Engagement	0.862	0.862	0.916	0.784
Student Need Satisfacion	0.703	0.714	0.834	0.626
Teacher support	0.830	0.834	0.898	0.746

To assess the discriminant validity, the Fornell–Larcker Criterion (Fornell & Larcker, 1981) was applied; the square root of the AVE of each latent construct was equated with its inter-construct correlation. Acceptable DV is achieved when the square root of the AVE of a construct is greater than its correlation with other constructs (Hair et al., 2019). As shown in Table 2, DV was supported since the square root of AVE for the construct was greater than

the correlation with the other constructs. This revealed that all constructs had acceptable discriminant validity.

Table 2

Discriminant Validity of Study Constructs Using the Fornell-Larcker Criterion

Construct	Achievement	Classroom Engagement	Student Need Satisfaction	Teacher support
Achievement	0.872			
Student Classroom Engagement	0.395	0.885		
Student Need Satisfaction	0.393	0.485	0.791	
Teacher support	0.369	0.472	0.583	0.864

The constructs demonstrated satisfactory reliability and validity. All measures met established thresholds for internal consistency, convergent validity ($AVE > 0.50$), and discriminant validity based on the Fornell–Larcker criterion (Fornell & Larcker, 1981; Hair et al., 2019). These findings confirm that the instruments were appropriate for structural model evaluation.

Assessment of Structural Model

Structural model relationships were examined using PLS-SEM after establishing adequate reliability and validity. Model explanatory and predictive power were assessed through path coefficients, R^2 , and Q^2 values (Hair et al., 2019).

After confirming that the measurement model's reliability and validity match the requirements, the structural model should be evaluated further to examine the path relationships between the latent variables.

The first step is to determine whether there are any possible multicollinearity concerns between the predictor and endogenous factors in the structural model. If there is significant multicollinearity, it may result in skewed path coefficient estimations, reducing the explanatory power and stability of the structural model. Multicollinearity concerns are often examined by calculating the predictor variables' variance inflation factor (VIF) (Hair et al., 2019). According to Hair et al. (2019), the ideal VIF values are 3 or below. As demonstrated in Table 3, all VIF values in this study are much lower than the crucial value of 3 (varying from 1.00 to 1.658), showing that there are no multicollinearity concerns across the predictor variables.

The second step examined the path relationships in the study. The results demonstrated in Table 3 shows that perceived teacher support had a strong influence on students' perceived need satisfaction, confirming hypothesis 1 ($\beta = 0.587$; $t = 12.257$). Perceived teacher support had significantly influenced students' classroom engagement ($\beta = 0.294$; $t = 3.623$), supporting hypothesis 2. The results provided support for a positive link between perceived teacher support and classroom achievement ($\beta = 0.146$; $t = 2.038$), supporting hypothesis 3. The results in Table 3 also indicated that students' perceived need satisfaction had a positive and significant influence on students' classroom engagement ($\beta = 0.311$; $t = 4.149$), supporting H4. Similarly, as proposed in H5, students' perceived need satisfaction had a significant influence on students' classroom engagement ($\beta = 0.196$; $t =$

2.484). Students' classroom engagement had a positive and significant impact on students' classroom achievement ($\beta = 0.239$; $t = 3.304$), supporting H6.

The third step involves evaluating the model's ability to explain endogenous variables using the coefficient of determination (R^2). The R^2 value measures the extent to which exogenous variables explain endogenous variables and is a key indication of model explanatory power. Higher R^2 values denote a model with more explanatory ability; the R^2 ranges from 0 to 1 (Hair et al., 2019). As a general guideline, Cohen, (1998) suggested R^2 values for endogenous latent variables are assessed as follows: 0.26 (substantial), 0.13 (moderate), and 0.02 (weak). As shown in Figure 2, the squared multiple correlation (R^2) values show that 34% of the variance in student need satisfaction was explained by teacher support. The model explained 28.9% of variance in student classroom engagement, influenced by teacher support and student need satisfaction. This model also explained 22.2% of the variance in math and science subjects' achievement among students as a result of teacher support, student need satisfaction, and student classroom engagement. All the values are demonstrating significant explanatory power. This demonstrated that the model has adequate explanatory power for the endogenous variables.

The fourth step involves evaluating the model's prediction capacity for endogenous variables using predictive relevance (Q^2). According to Hair et al. (2019), a Q^2 value greater than 0 indicates strong predictive ability, meaning the model can effectively explain the variance of endogenous variables. As demonstrated in Table 4, the Q^2 values for achievement ($Q^2 = 0.161$), student classroom engagement ($Q^2 = 0.221$), and student need satisfaction ($Q^2 = 0.204$) are all considerably larger than zero, showing that the model has good predictive relevance for the endogenous variables.

Table 3

Structural Model

Hypotheses	β	SD	T	P	R^2	Q^2	VFI
H1: Teacher support -> Student Need Satisfaction	0.587	0.048	12.257	0.000			1.000
H2: Teacher support -> Student Classroom Engagement	0.294	0.079	3.623	0.000			1.516
H3: Teacher support -> Achievement	0.146	0.072	2.038	0.042			1.631
H4: Student Need Satisfaction -> Student Classroom Engagement	0.311	0.077	4.149	0.000			1.516
H5: Student Need Satisfaction -> Achievement	0.196	0.069	2.848	0.005			1.658
H6: Student Classroom Engagement -> Achievement	0.239	0.070	3.304	0.001			1.407
Achievement					0.222	0.161	
Student Classroom Engagement					0.289	0.221	
Student Need Satisfaction					0.340	0.204	

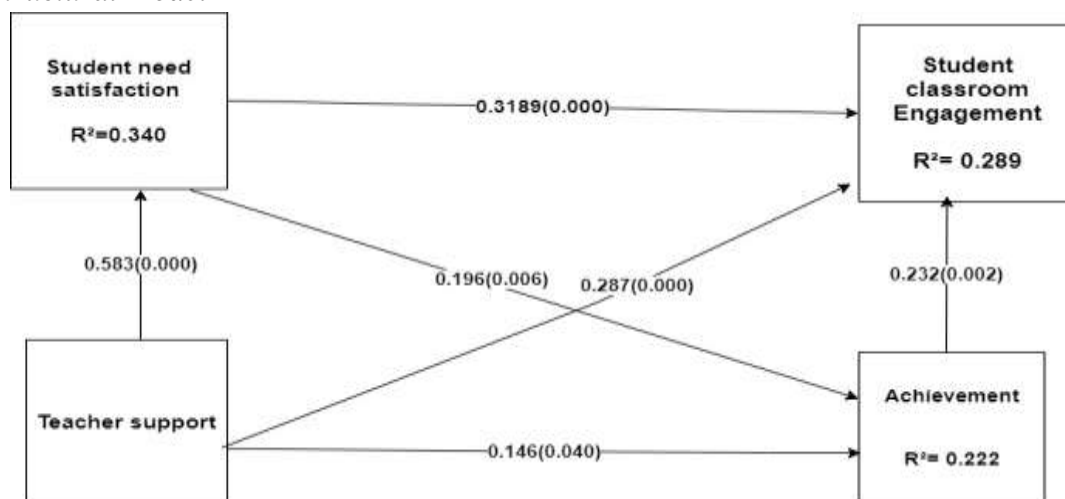
Finally, the overall model fit is evaluated using Standardized Root Mean Squared Residuals (SRMR), unweighted least squares discrepancies (d_ULS), and geodesic discrepancies (d_G). According to Henseler et al. (2016), an SRMR value < 0.08 indicates good model fit; in this study, the SRMR value = 0.067, which is significantly lower than the threshold (0.08), indicates that the model fits well. Fits to a saturated model are generally considered valid when their squared Euclidean distance (d_ULS) is lower than the bootstrapped value of 95% of their estimated d_ULS and their d_G is lower than the bootstrapped value of 95% of their estimated d_G. Thus, Table 4 shows that d_ULS sat < est and d_G sat < est are in line with these model fit requirements, as suggested by Henseler et al. (2016) and Quintana & Maxwell (1999). The three model fit criteria indicated in Table 4 support the model being fit to explain the relationship among variables in this study.

Table 4
Overall Measurement Model Fit Indices for Study Constructs

Criterion	Saturated Model (sat)			Estimated Model (est)		
	Value	HI 95	Remarks	Value	HI 95	Remarks
SRMR < 0.08	0.067	0.045	Support	0.07	0.046	Support
d_ULS _{sat} < HI ₉₅	0.407	0.231	Support	0.447	0.249	Support
d_G _{sat} < HI ₉₅	0.207	0.172	Support	0.217	0.178	Support

Figure 2 illustrates the standardized path coefficients and variance explained (R²) for the structural model examining teacher support, need satisfaction, engagement, and achievement.

Figure 2
Structural Model



Mediation Analysis

Mediation analysis was performed to assess the mediating role of student classroom engagement in the relationship between Student Need Satisfaction and achievement. The results (see Table 5) revealed a significant indirect effect of student need satisfaction on achievement ($H_7: \beta = 0.074, t = 2.566, p < 0.05$). The total effect of student need satisfaction on achievement ($\beta = 0.232, t = 3.304, p < 0.001$), with the inclusion of the mediator, the effect of student need satisfaction on achievement is still significant ($\beta = 0.074, t = 2.566, p < 0.05$). This shows that student classroom engagement partially mediates the relationship between student need satisfaction and achievement. The result obtained in this mediation analysis supports Hypothesis 7.

In addition, mediation analysis was performed to understand the mediating role of student classroom engagement in the relationship between teacher support and achievement. The results (see table 5) indicated that there was a significant indirect effect of teacher support on achievement ($H_8: \beta = 0.066, t = 2.432, p < 0.05$). The total effect of teacher support on achievement ($\beta = 0.369, t = 6.898, p < 0.001$), with the inclusion of the mediator, the effect of teacher support on achievement is still significant ($\beta = 0.223, t = 4.431, p < 0.05$). This confirms that student classroom engagement partially mediates the relationship between teacher support and achievement. This result was providing to support for Hypothesis 8.

Table 5

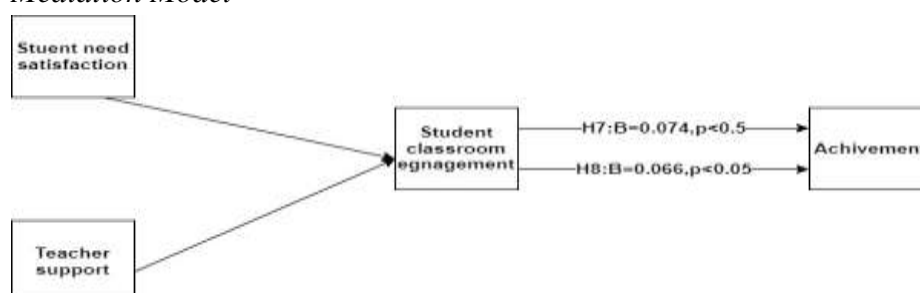
Specific Indirect Effects of Teacher Support and Need Satisfaction on Achievement via Classroom Engagement

Specific indirect effect	Original Sample (O)	M	SD	t	P
Student Need Satisfaction -> Student Classroom Engagement -> Achievement	0.074	0.074	0.029	2.566	0.11
Teacher support -> Student Classroom Engagement -> Achievement	0.066	0.070	0.027	2.432	0.015

Figure 3. Mediation model showing the indirect effects of teacher support and need satisfaction on achievement through classroom engagement. Standardized path coefficients are presented; $p < .05$.

Figure 3

Mediation Model



Discussion

The main purpose of this study was to test the applicability of Self-Determination Theory (SDT) in an Ethiopian high school context. Specifically, the study examined the sequential SDT process whereby teaching context (teacher support) predicts students' psychological need satisfaction, which in turn fosters classroom engagement and ultimately academic achievement. Grounded in SDT, the present study investigated how Ethiopian high school students' perceptions of teachers' autonomy support, structure, and involvement relate to their need satisfaction and subsequent classroom engagement, as well as how engagement functions as a mediating mechanism linking these variables to achievement in science and mathematics.

SDT in Ethiopian Context

Consistent with the proposed SDT framework, the findings generally supported the hypothesized sequence of Teacher Support → Need Satisfaction → Classroom Engagement → Achievement. Within mathematics and science classrooms, students who perceived higher levels of autonomy support, structure, and involvement reported greater satisfaction of their needs for autonomy, competence, and relatedness. This pattern indicates that supportive teaching practices are meaningfully associated with students' internal motivational resources. Students whose psychological needs were satisfied demonstrated higher levels of behavioral, emotional, and cognitive engagement in classroom activities. In turn, engagement emerged as a significant predictor of academic achievement in both mathematics and science. These findings align with prior SDT-based research (Vallerand, 1997; Reeve, 2012; Dincer et al., 2019; Ryan & Deci, 2020), providing cross-cultural support for the robustness of the SDT motivational sequence.

Teacher support and Psychological need satisfaction

The model showed that a substantial proportion of variance in students' psychological need satisfaction was explained by teacher support in mathematics and science classrooms. This underscores the central role of teachers in shaping motivationally supportive learning environments.

To foster autonomy, teachers need to provide meaningful choices, encourage student responsibility, and allow flexibility in learning activities. To support competence, teachers should offer clear instructional guidance, structured problem-solving strategies, and constructive feedback. Relatedness is enhanced when teachers demonstrate care, respect, and emotional sensitivity, thereby cultivating a sense of belonging in the classroom. These findings are consistent with earlier studies emphasizing the role of teacher support in satisfying students' basic psychological needs (Skinner et al., 2008; Dupont et al., 2014; Hornstra et al., 2021; Dincer et al., 2019).

Influence of Teacher support and Need satisfaction on Classroom Engagement

The model accounted for a considerable proportion of variance in students' classroom engagement, indicating that teacher support and need satisfaction are among the most influential predictors of engagement in mathematics and science learning. Together, these factors explained nearly 30% of the variance in engagement, highlighting their combined motivational importance.

Both teacher support and need satisfaction independently and significantly predicted student engagement. When students experienced autonomy, competence, and relatedness, they were more likely to demonstrate cognitive engagement, such as investing sustained effort and using deep learning strategies. This finding suggests that engagement reflects not only behavioral participation but also meaningful cognitive involvement in learning tasks.

Similarly, emotional engagement—manifested through interest, enjoyment, and positive classroom-related emotions—was higher when students' psychological needs were satisfied. Behavioral engagement, including active participation, asking questions, and sustained attention, was also strongly associated with need satisfaction. These results collectively reinforce the view that engagement is a multidimensional construct shaped by students' motivational experiences.

Regarding teacher support, students who perceived higher levels of autonomy support, structure, and involvement reported greater engagement in classroom activities. This finding corroborates prior evidence that comprehensive teacher support simultaneously enhances multiple dimensions of student engagement (Hornstra et al., 2021; Olivier et al., 2021).

Influence of teacher support, need satisfaction, and engagement on achievement

The results indicated that teacher support, need satisfaction, and classroom engagement each had a significant positive effect on students' achievement in mathematics and science. Previous research has provided important insights into these predictors, and the present study builds on this evidence by considering their combined contribution within an integrative model.

Collectively, these variables explained more than 20% of the variance in academic achievement. While this proportion may appear modest, it is meaningful within the Ethiopian context, where national examination results indicate persistently low achievement levels in mathematics and science. For instance, in the 2022 and 2023 national school-leaving examinations, only about 3% of students achieved a passing score above 50% (Ministry of Education, 2023). Against this backdrop, identifying motivational and instructional factors associated with achievement is particularly important.

Consistent with prior researches, classroom engagement emerged as a key proximal predictor of achievement. Studies across diverse contexts have similarly shown that behavioral, emotional, and cognitive engagement jointly contributes to academic success (Fung et al., 2018; van Rooij et al., 2017). These findings reinforce the argument that enhancing engagement is a critical pathway for improving student outcomes in secondary education.

Although the SDT model was largely supported, the explained variance in achievement was modest, suggesting that additional contextual factors such as examination

pressure and limited resources may also influence student performance in Ethiopian high schools.

Mediation role of classroom engagement

The results revealed that classroom engagement partially mediated the relationship between psychological need satisfaction and achievement. This indicates that need satisfaction enhances achievement both directly and indirectly by fostering higher levels of engagement. Such findings are consistent with Wang et al. (2015), who argued that psychologically supportive learning environments promote achievement through multiple motivational pathways.

Similarly, classroom engagement partially mediated the association between teacher support and achievement. This suggests that while supportive teaching practices directly influence achievement, their effects are also transmitted through increased student engagement. This finding aligns with previous research (Skinner et al., 2009; Dincer et al., 2019) and highlights the dual role of teacher support in shaping both motivational processes and learning outcomes.

Overall, the mediation results emphasize that engagement functions as a key mechanism through which teacher support and need satisfaction translate into academic success, thereby reinforcing the explanatory power of the SDT framework in the Ethiopian secondary school context.

While PLS-SEM and the use of composite scores provided a strong framework for testing the model and examining explained variance, the findings should be interpreted with caution. The cross-sectional design, reliance on self-report measures, and differences in the number of items across subscales may have affected the strength of the observed relationships. Therefore, the results primarily reflect predictive associations rather than definitive causal effects.

Conclusion

This study examined the applicability of Self-Determination Theory (SDT) within Ethiopian high school mathematics and science classroom contexts. Overall, the findings provided empirical support for the key assumptions of SDT. Consistent with theoretical expectations, students' perceptions of teacher autonomy support, structure, and involvement were positively associated with the satisfaction of their basic psychological needs. In turn, need satisfaction was linked to higher levels of classroom engagement, which ultimately contributed to improved academic achievement. These results highlight the importance of supportive teaching practices in fostering students' need satisfaction, engagement, and learning outcomes in Ethiopian secondary school sciences and mathematics education.

This study makes several key contributions. First, it provides empirical support for the applicability of SDT in Ethiopian mathematics and science classrooms, extending prior work that focused primarily on language classrooms (Dincer et al., 2019) or general education contexts (Dupont et al., 2014). Second, it identifies critical factors—teacher support and need satisfaction—that influence classroom engagement, offering actionable guidance for educators seeking to enhance student engagement and learning outcomes.

Finally, these findings have broader implications for educational practice and policy. They highlight the importance of promoting autonomy-supportive teaching, providing structure, and fostering teacher involvement to strengthen students' psychological needs and engagement. Moreover, the results underscore the relevance of SDT-based interventions in contexts with low academic achievement, suggesting that targeted motivational strategies can contribute to improved student outcomes. Other researches could further explore additional contextual factors that influence achievement and investigate the longitudinal effects of need-supportive teaching in diverse Ethiopian classroom contexts.

Based on the findings, several implications can be drawn for improving student engagement and achievement in Ethiopian mathematics and science classrooms. Since teacher autonomy support, structure, and involvement were positively associated with students' psychological need satisfaction and engagement, teachers should adopt supportive practices that encourage student choice, provide clear guidance and feedback, and build positive teacher–student relationships. In addition, promoting behavioral, emotional, and cognitive engagement through active participation and timely learning support may strengthen achievement outcomes. These strategies should be implemented in ways that are feasible within the Ethiopian context, including the use of peer collaboration and culturally relevant instructional examples.

This study should be interpreted in light of several limitations. First, the reliance on survey data and a quantitative design limits deeper insight into students' lived experiences; future studies could apply mixed-method approaches. Second, the model was tested only from students' perspectives, and future research should incorporate teachers' views. Third, data were collected from a single city, which may restrict generalizability; further studies using more diverse national samples are recommended.

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Effects of paper-based problem scenarios on high school students' critical-thinking skills in biology

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Abstract

This study aimed to examine students' critical thinking skills through paper-based problem-scenarios instructional approach, guided by Ennis's five critical thinking skills categories: elementary clarification, credibility of sources, inference, advanced clarification, and tactics and strategies. A mixed-methods approach was employed, adopting a quasi-experimental design for the quantitative component and content analysis for qualitative insights. Two intact Grade 10 classes, comprising a total of 84 students, were randomly selected. In addition, six students participated in interviews to provide qualitative data. Data were collected using an open-ended biology critical thinking essay test and semi-structured interview questions. The quantitative data were analyzed using independent sample t-test and ANOVA, while the qualitative data were analyzed through content analysis. The results showed that BCTS posttest scores were significantly higher in the intervention group than the control group ($t(79) = 9.45, p < .001$; $F(1, 79) = 89.30, p < .001$). Moreover, post-interview results showed that 35% of the responses were identified as correct, clear, and specific, compared to 18% in the pre-interview. Overall, the findings indicate that paper-based problem scenarios can effectively improve students' critical thinking skills. These results offer valuable implications for biology teachers and curriculum developers seeking to strengthen critical thinking instruction in secondary schools.

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Introduction

Critical thinking [CT], a cornerstone of effective problem-solving and decision-making, is defined as an active, skilled process of interpreting and evaluating information and arguments (Kumala et al., 2022), underpinning rational decision-making (Palavan, 2020) and

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reflective thinking to guide beliefs and actions. Unlike rote memorization, CT empowers students to apply knowledge to novel situations, making it indispensable across educational contexts. However, fostering CT faces significant barriers, including definitional complexity (Indrašienė et al., 2018), challenges in assessment (Ennis, 1993), and difficulties integrating pedagogies like problem-based learning (PBL). Globally, curricula often prioritize exam performance over CT, leading to student disengagement (Sowunmi et al., 2022) and limited analytical thinking (Wilson, 2017). In science education, these issues are compounded by teachers' limited familiarity with learner-centered approaches (Teshome & Ordofa, 2023) and a lack of engagement with controversial topics that foster critical inquiry (Nganga et al., 2020), contributing to widespread CT deficiencies (Lopez et al., 2023).

Despite the recognized importance of CT in high school biology education, where students grapple with complex topics like human systems, disease mechanisms, and wellness to build health literacy and real-world problem-solving skills (Nuraini & Antika, 2024), significant gaps persist in its effective cultivation. Theoretically, dominant CT frameworks are largely adapted from higher education contexts, rendering them abstract and insufficiently aligned with secondary-level pedagogy, adolescent cognitive development, and the resource constraints typical of developing countries (Kirko & Woldearegawi, 2024).

Studies conducted in Ethiopian secondary schools report short-term gains from inquiry-oriented biology instruction but lack longitudinal or transfer-focused assessments, constraining conclusions about durable CT development (Chengere et al., 2025a; Sisay, 2019). Practically, biology classrooms continue to be dominated by lecture-based, rote memorization, reinforced by teachers' limited pedagogical understanding of constructivist approaches and resulting in persistent student disengagement from inquiry-driven learning (Chengere et al., 2025b). Together, these limitations underscore the urgent need for low-cost, contextually grounded, and pedagogically feasible CT interventions in secondary biology education, justifying the present study's examination of paper-based problem scenarios as a scalable alternative for resource-constrained settings.

Paper-based problem scenarios (PBPS), a constructivist form of problem-based learning, addresses these gaps by using narrative, ill-structured problems to foster reasoning, problem-solving, and decision-making (Çeliker, 2021). PBPS has been shown to improve CT scores, creativity, and cognitive engagement (Adebisi, 2023)—for example, a Grade 11 forensic science intervention increased scores from 67% to 84% (Meesamran & Polyiem, 2024). In Ethiopia, PBPS is particularly suitable, linking abstract biology concepts to real-world health challenges without relying on advanced technology or laboratories. This study therefore evaluates PBPS as a feasible, evidence-based strategy to enhance secondary school students' biological CT skills. To systematically investigate its impact, this study is guided by the following research questions:

Research questions

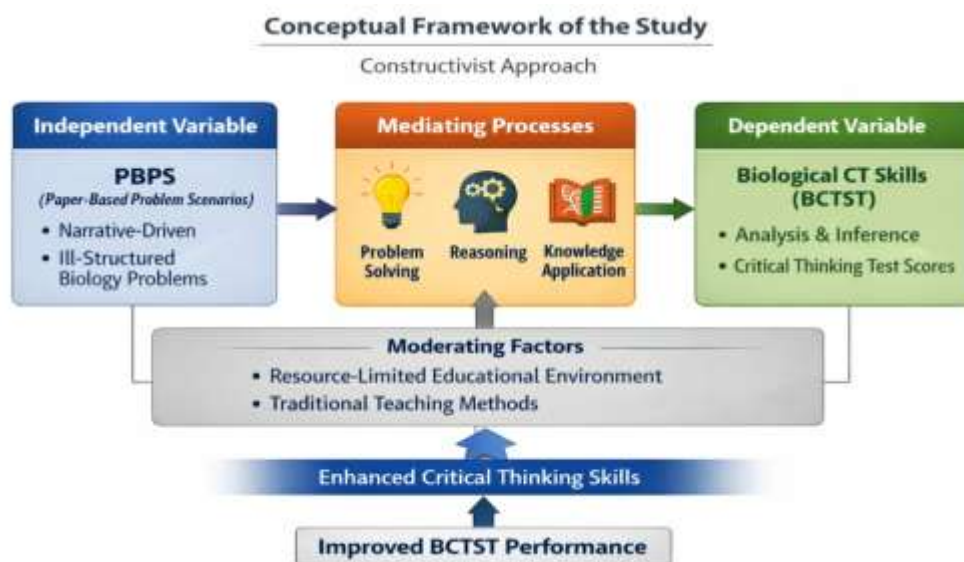
1. To what extent does the paper-based problem scenario approach enhance high school biology students' critical thinking skills?
2. How does paper-based problem scenario improve students' critical thinking skills?
3. Does PBPS lead to a significant shift in the distribution of critical thinking response categories?

Conceptual Framework

The conceptual framework for this study, grounded in constructivism, illustrates the hypothesized relationship between the independent variable, PBPS, and the dependent variable, students' biological CT skills, measured by the Biological Critical Thinking Skills Test (BCTST). PBPS, involving narrative-driven, ill-structured biology problems, is posited to enhance CT through mediating processes like problem-solving, reasoning, and knowledge application. Contextual factors, such as Ethiopia's resource-constrained educational environment and reliance on conventional teaching methods, moderate this relationship, potentially influencing the intervention's effectiveness (Ahmed et al., 2025; Zekiros, 2020). The constructivist framework, which emphasizes active knowledge construction through authentic experiences (Monrad & Mølholt, 2017; Servant-Miklos et al., 2019), guided the study's design and execution. It justified the use of PBPS to foster experiential learning, addressing gaps in CT cultivation in Ethiopian high school biology education (Teshome & Ordofa, 2023). The framework shaped the study that PBPS would improve BCTST scores compared to a control group, informed the selection of the BCTST to measure skills like analysis and inference, and guided pretest and posttest assessments to capture iterative learning. By providing empirical evidence for a scalable, low-cost intervention, the study contributes methodologically to education in resource-constrained settings, advocating for a shift from rote memorization to inquiry-based pedagogy.

Figure 1

Conceptual Framework of the Study



Methods

The study employed a concurrent embedded mixed-methods design, with a dominant quantitative approach supported by qualitative data (Scott & Usher, 2010). The quantitative component used a nonequivalent control group quasi-experimental design, involving pretests and posttests to examine the effect of paper-based problem scenarios (PBPS) on students'

biological critical thinking skills. Intervention groups received PBPS-based instruction, while a control group received conventional instruction. Embedded qualitative interviews complemented the quantitative findings by providing contextual insights into students' experiences and perceptions of critical thinking development.

Table 1

Study Design for PBPS Intervention

Group	Pretest	Intervention	Posttest
IG	O ₁	X ₁	O ₂
CG	O ₁		O ₂

The study employed a purposive sampling strategy to select two intact Grade 10 classes from a government secondary school in Sekota town, Ethiopia. The classes were selected not to achieve statistical representativeness, but to ensure developmental and contextual representativeness of adolescents at a stage conducive to critical thinking development (Keating, 1988). Grade 10 students typically range from 15 to 17 years of age, a period characterized by the emergence of formal reasoning and higher-order cognitive processes, making this cohort theoretically appropriate for examining critical thinking development.

Following group selection, the two intact classes were randomly assigned to either the intervention group (n = 41) or the control group (n = 43) using a simple randomization technique, which enhanced internal validity by minimizing selection bias and ensuring comparable baseline characteristics between groups. For the qualitative component, six students (three from each group) were purposively selected for in-depth interviews based on prior academic performance (high, average, and low achievers), as documented in school records. This strategy ensured diversity of perspectives and enriched the interpretation of the quantitative results. To minimize data contamination and teacher effects, the two classes were scheduled separately in time and space, intervention materials were restricted to the experimental group, interviews were conducted privately, and the same teacher taught both groups to ensure instructional consistency.

The primary quantitative instrument was the Biological Critical Thinking Skills Test (BCTST), a validated tool adapted from the literature to measure critical thinking skills within the context of biology education. The BCTST consists of multiple-choice and short-answer questions aligned with Grade 10 biology curricula. It assesses key critical thinking skills, including analysis, interpretation, inference, evaluation, reasoning, problem-solving, and application of biological knowledge to novel contexts. To complement this, the Critical Thinking Embedded Essay Test (CTEET), developed by Zubaidah et al. (2020), was employed to assess students' ability to articulate and apply critical thinking in written responses. The CTEET includes open-ended essay questions that require students to demonstrate reasoning, problem-solving, and evidence-based argumentation in English.

The study adhered to strict ethical guidelines to protect participants' rights and well-being. Ethical clearance was obtained from the IRB of Bahir Dar University (Ref: PRCSVD/654/2023), and a permission letter was obtained from Department of Biology, Science College, BDU, to seek approval from officials at the selected secondary school before starting the research. Informed consent was secured from all participants, with parental

consent obtained for students under 18. The participants were informed of the study's purpose, procedures, and their right to withdraw at any time without consequences. Anonymity was ensured by assigning unique identifiers to all data, and no personally identifiable information was collected or reported.

For the intervention group, care was taken to ensure that the experimental treatment posed no harm and was integrated into regular classroom activities to avoid disruption. The control group received standard instruction and was offered access to the intervention materials post-study to ensure equitable benefits. Interview participants were selected carefully to avoid coercion, and interviews were conducted in a private, comfortable setting to encourage open responses. Data were stored securely on password-protected devices, accessible only to the research team, and will be destroyed after a retention period of five years, as per BDU guidelines. Cultural sensitivity was prioritized by ensuring that all instruments and interactions were conducted in the participants' primary language (Amharic) and were contextually appropriate for the local educational setting, during the first semester of the 2023-24 academic year.

The quantitative instruments were evaluated for content and face validity by experts from biology education and curriculum and instruction. The expert validation results, summarized in Table 2, confirmed that the instrument was valid in terms of content, clarity, legibility, alignment between critical thinking skills indicators and test items, compatibility of indicators within each item, conceptual accuracy, and the effectiveness of diagrams in simplifying terms. However, language posed a challenge as students struggled to express their thoughts in English, preferring Amharic, their native language. Of the 35 original BCTST items, 20 were deemed valid and understandable. Following revisions to the remaining 15 items, the BCTST was refined to include 30 open-ended essay items. A small-scale pencil-and-paper pilot test revealed the need to revise five items for clarity and adjustment. As a result, a final version consisting of 25 Amharic-language items was developed, with a recommended completion time of 40 to 50 minutes.

Table 2
Expert Validity of BCTST

No	Description of instrument with	Validator					%	Category	Comment
		1	2	3	4	5			
1	Clarity of words, phrases and the diagram	4	4	-	3	4	93.7%	Very valid	Minor revision
2	The grammar	4	4	-	4	4	100%	Very valid	Minor revision
3	Accuracy of information	3	4	-	4	4	93.7%	Very valid	Minor revision
4	Learner's level of development	4	4	-	3	4	93.7%	Very valid	Minor revision
5	Evaluation requirements	-	-	4	4	3	91.6%	Very valid	Minor revision
6	Consideration of CT skills indicators	-	-	4	4	4	100%	Very valid	Minor revision
Mean		3.75	4	4	3.5	3.8	73%	Valid	Revision

As shown in Table 3, the r-count (Pearson correlation) for each item exceeded the r-table value (0.279) for product-moment correlations with 53 students, indicating that all 25 critical-thinking skills test items were statistically significant.

Table 3
Construct Validity of BCTST

Item	Validation		N	Sig. (2-tailed)	Information
	Pearson-r	r-table			
1	0.671**	0.279	53	0.000	Valid
2	0.693**	0.279	53	0.000	Valid
3	0.594**	0.279	53	0.000	Valid
4	0.713**	0.279	53	0.000	Valid
5	0.677**	0.279	53	0.000	Valid
6	0.431**	0.279	53	0.001	Valid
7	0.585**	0.279	53	0.000	Valid
8	0.536**	0.279	53	0.000	Valid
9	0.640**	0.279	53	0.000	Valid
10	0.499**	0.279	53	0.000	Valid
11	0.639**	0.279	53	0.000	Valid
12	0.512**	0.279	53	0.000	Valid
13	0.551**	0.279	53	0.000	Valid
14	0.593**	0.279	53	0.000	Valid
15	0.638**	0.279	53	0.000	Valid
16	0.563**	0.279	53	0.000	Valid
17	0.597**	0.279	53	0.000	Valid
18	0.564**	0.279	53	0.000	Valid
19	0.742**	0.279	53	0.000	Valid
20	0.673**	0.279	53	0.000	Valid
21	0.650**	0.279	53	0.000	Valid
22	0.621**	0.279	53	0.000	Valid
23	0.566**	0.279	53	0.000	Valid
24	0.580**	0.279	53	0.000	Valid
25	0.375**	0.279	53	0.006	Valid

The internal consistency of the BCTST was assessed using Cronbach's alpha, which is considered acceptable at $\alpha \geq 0.7$. As shown in Table 4, the overall Cronbach's alpha for the 25 items was 0.93. Additionally, the Cronbach's alpha values for the five variables were 0.821 for variable one, 0.856 for variable two, 0.806 for variable three, 0.816 for variable four, and 0.846 for variable five. These results indicate that the internal consistency of both the overall test items and the items related to each critical thinking indicator was sufficient for measuring critical thinking skills.

Table 4
Cronbach's Alpha Values of Variables

Variables	Cronbac h's alpha	No . of items
Basic clarification	0.821	5
Credible sources	0.856	5
Inference	0.806	5
Advanced clarification	0.816	5
Strategies and tactics	0.846	5
All items	0.93	25

As presented in Table 5, the difficulty levels of all 25 questions were classified as moderate. For example, Question 1 (Q1) had an average score of 174 out of a full score range of 5, resulting in a difficulty index of 0.66. Additionally, the discrimination index was rated as excellent. For instance, in Q1, with $\sum UL = 62$, $\sum LL = 4$, $N = 25\% = 13.25$, and a

maximum score of 5, the discrimination index was calculated as 0.88. Similarly, the discrimination indices for 24 other questions were categorized as excellent, while question 6 (Q6) fell into the good category. This indicates that the instrument avoids overly easy or difficult questions and effectively discriminates as an excellent measure of students' critical thinking (CT) in the human body system, with minor improvements needed for Q6. Overall, the content and construct validity results confirm that the BCTST items are valid tools for assessing critical thinking in biology.

Semi-structured interview questions were employed to collect qualitative data, as they are widely regarded as one of the most effective methods for gaining deep insights into students' reasoning and thinking about specific topics. A total of 13 questions were initially designed to assess participants' critical thinking skills. These questions were then reviewed for clarity and relevance by two experts: a biology education instructor with a PhD and a curriculum professor from the Faculty of Education at Bahir Dar University. Based on their feedback, three questions were removed, leaving 10 questions for the final semi-structured interview.

Quantitative data were collected using a questionnaire comprising 25 open-ended essay questions designed to assess critical thinking (CT). Qualitative data were gathered through semi-structured interview questions, analyzed based on Ennis's critical thinking skills framework. Pre-interviews were conducted with six participants before the intervention. The semi-structured interviews, lasting about 20 minutes each, were scheduled flexibly to encourage participants to introduce themselves freely and allow the interviewer to ask follow-up questions for clarification. During the first week, students received a brief introduction to paper-based problem scenarios and critical thinking concepts. The intervention group engaged in paper-based problem scenarios, while in the control group, lessons were primarily teacher-centered, focusing on lecture delivery, textbook reading, and memorization of key concepts. Students completed standard class activities, including exercises and assessments assigned by the teacher, but they did not engage in paper-based problem scenarios or structured problem-solving tasks designed to stimulate critical thinking.

The intervention lasted eight weeks, with three 40-minute lessons per week. In the intervention group, students collaborated in groups of 4–5, guided by the teacher. Throughout the intervention, students followed (Ennis, 2018) five critical thinking indicators. First, they clarified the problem in the given scenario (Step 1). Next, they judged the credibility of information sources using prior knowledge (Step 2). Then, they made inductive and deductive inferences to form the best explanations (Step 3). Afterward, they defined terms and evaluated definitions (Step 4). Finally, they developed tactics and strategies for action (Step 5).

Table 5
Difficulty and Discrimination Index of BCTST

Items	$\sum UL$	$\sum LL$	Mark ranges				No. students	Dif. I	Dis. I
			* 3.5 – 5	2– 3	.5 - 1.5	0			
1	62	4	27	18	1	7	53	0.66	0.88
2	57	0	29	18	0	6	53	0.66	0.86
3	57	4	31	16	2	4	53	0.71	0.8
4	69	12	36	9	3	5	53	0.75	0.86
5	58	4	32	15	2	4	53	0.73	0.82
6	27	5	17	24	3	9	53	0.54	0.33
7	47	0	21	19	2	11	53	0.54	0.71
8	64	21	38	7	2	6	53	0.76	0.65
9	69	17	24	12	3	4	53	0.73	0.78
10	65	19	33	13	2	5	53	0.75	0.69
11	67	14	33	15	1	4	53	0.72	0.8
12	54	9	21	22	2	8	53	0.58	0.68
13	47	9	25	19	3	6	53	0.63	0.57
14	54	9	27	20	6	0	53	0.68	0.68
15	69	30	37	12	2	2	53	0.79	0.59
16	50	4	22	13	2	16	53	0.5	0.69
17	42	0	16	22	3	12	53	0.5	0.63
18	52	4	25	16	1	11	53	0.59	0.72
19	68	0	32	17	2	2	53	0.74	1.03
20	60	0	23	22	1	7	53	0.6	0.91
21	53	4	19	13	2	19	53	0.44	0.74
22	41	0	12	14	5	22	53	0.37	0.62
23	49	5	16	12	5	19	53	0.42	0.66
24	40	0	13	13	5	22	53	0.37	0.6
25	60	26	32	8	3	10	53	0.65	0.51

Note. $\sum UL$ = Upper-level students' total score; $\sum LL$ = Lower-level students' total score; Mark ranges indicate the correct answer score ranges (3.5–5); Dif. I = item difficulty index; Dis. I = item discrimination index; N = 53 students

Quantitative and qualitative datasets were analyzed separately, followed by a comparison and interpretation to determine whether the results aligned with or contradicted each other. Quantitative data were analyzed using descriptive and inferential statistical techniques via SPSS version 26. Since the data met the assumptions of normal distribution, homogeneity of variance, and homogeneity of slopes, parametric statistical methods (independent samples t-test and ANOVA) were applied. The independent samples t-test was used to assess statistical differences between the mean scores of the two groups before the intervention, while ANOVA was employed to compare posttest results between the intervention and control groups. For the qualitative data, content analysis was used to triangulate the findings alongside the quantitative results, addressing the potential limitations of localized interventions and instruments in contributing to the broader scientific community. Face-to-face interviews were recorded using an audio recorder, and later transcribed. Students were coded as S1, S2, S3, S4, S5, and S6 to maintain anonymity.

Transcripts were independently coded by two researchers, and the codes were compared to identify discrepancies. Inter-rater reliability was determined using Cohen's Kappa in SPSS version 26, with agreement values for the interview transcripts of S1, S2, S3, S4, S5, and S6 being 0.82, 0.80, 0.78, 0.85, 0.83, and 0.84, respectively, indicating strong agreement between raters. Subsequently, all transcribed recorded interviews were categorized into five modified rubric-based categories adapted from Zubaidah et al. (2020) to organize response patterns before and after the intervention. The five categories were: Correct, Clear, and Specific (CCS), Most Exact, Clear, and Specific (MECS), Some Correct, Clear, and Specific (SCCS), Unclear, Exaggerated, or Confusing (UEOC), Incorrect or Insufficient Concepts (IIC) and No Answer (NA).

Findings

Pretest Results

As shown in Table 6, BCTST scores for the intervention group (N=41, Mean=52.00, SD=5.717, SE=0.915) and the control group (N=43, Mean=52.40, SD=6.530, SE=1.008) are compared. The control group's mean is 0.40 points higher, but a t-test ($t \approx 0.299$, $df=82$) indicates no significant difference ($p > 0.05$). An F-test ($F=1.304$) supports equal variances.

Table 6

Pretest Data Results

	Groups	N	M	SD	Std. Error
BCTST	Control	43	52.40	6.530	1.008
	Intervention	41	52.00	5.717	0.915

T-test and variance assumption

Table 7 shows the Levene's Test results ($F=0.376$, $p=0.541$) confirming equal variances between the intervention and control groups's BCTST scores, as the p -value exceeds 0.05. The t-test ($t=0.296$, $df=79$, $p=0.768$) indicates no significant mean difference (0.405, $SE=1.368$), with a 95% confidence interval (-2.318 to 3.128) including zero. Thus, the intervention likely had no significant effect on BCTST scores at the baseline. Thus, this confirms comparable baseline performance between the groups.

Table 7

Results of T-Test and Variance Assumptions for Pretest Data

Levene's Test for Equality of Variances		t-test for Equality of Means							
F	Sig.	T	Df	Sig.	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
							Lower	Upper	
0.376	0.541	0.296	79	0.768	0.405	1.368	-2.318	3.128	

Posttest Results

ANOVA Results for Post-Test Scores

The ANOVA results in Table 8 ($F(1,79) = 89.298$, $p < 0.001$) indicate a significant difference between the intervention and control groups' posttest scores on the Biological Critical Thinking Skills Test (BCTS), confirming that paper-based problem scenarios significantly enhance high school biology students' critical thinking skills compared to traditional methods.

Table 8

ANOVA Posttest Results on BCTS

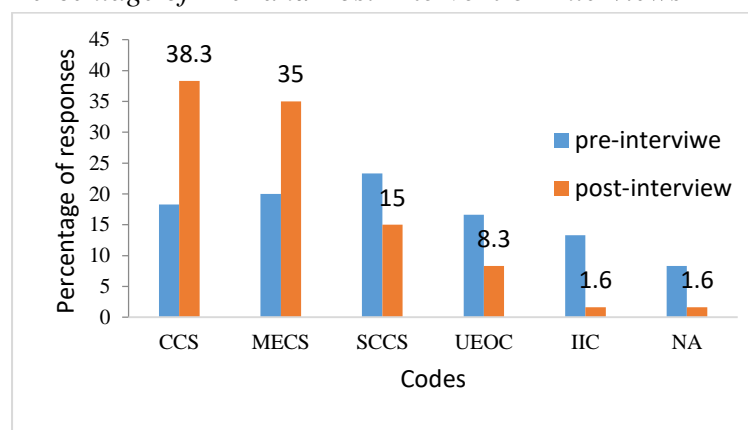
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5197.057	1	5197.057	89.298	0.000
Within Groups	4597.709	79	58.199		
Total	9794.765	80			

Categorical Shifts in Responses

Figure 2 displays the percentages of learners' responses in each category. In the pre-intervention interview, the responses were distributed as follows: 18.3% in the CCS category, 20% in the MECS category, 23.3% in the SCCS category, 16.6% in the UEOC category, 13.3% in the IIC category, and 8.3% in the NA category. In contrast, the post-intervention results showed 38.3% in the CCS category, 35% in the MECS category, 15% in the SCCS category, 8.3% in the UEOC category, 1.6% in the IIC category, and 1.6% in the NA category. Thus, the highest percentages of responses were in the CCS and MECS categories. This shows a significant shift in high school biology students' critical thinking responses post-intervention, particularly within CCS and MECS categories, as demonstrated by paper-based problem scenarios.

Figure 2

Percentage of Pre- and Post-intervention Interviews



Discussion

The posttest outcomes demonstrate a statistically significant enhancement in critical thinking skills among students who received the PBPS intervention. The independent samples t-test ($t = 9.449$, $df = 79$, $p < 0.001$) and ANOVA results ($F(1,79) = 89.298$, $p < 0.001$) clearly show that the intervention group's performance on the Biological Critical Thinking Skills Test (BCTS) was superior to that of the control group. These results suggest that PBPS—structured, context-rich problem scenarios—effectively promote higher-order cognitive skills compared to conventional instruction, aligning with research that problem-based instructional strategies significantly improve secondary school students' critical thinking skills in Ethiopia. For instance, quasi-experimental research in Ethiopian secondary schools reported significant gains in critical thinking skills using problem-based learning activities, noting improvements in students' analytical and reasoning abilities when learners engaged with challenging tasks (Tamene et al., 2026).

Importantly, the qualitative data from interviews reinforce this quantitative evidence. Before the intervention, student responses were concentrated in less sophisticated reasoning categories. After the PBPS intervention, there was a marked shift, with higher proportions of responses in advanced reasoning categories, particularly conceptual critical thinking (CCS) and methodological evaluation and conceptual synthesis (MECS). This indicates that PBPS did not merely increase test scores but fundamentally improved how students approached biological problems—moving from basic recall toward deeper analysis, evaluation, and synthesis. Such shifts resonate with broader findings in Ethiopian education research, where learners' critical thinking proficiency has historically been weak under traditional pedagogy that emphasizes memorization over application (Yeseraw et al., 2023)

This evidence supports the view that active, student-centered instructional strategies like PBPS are particularly effective in contexts where teacher-centered instruction is prevalent. Despite policy support for active learning in Ethiopia, classroom practices still often limit student engagement and higher-order thinking due to curricular constraints, large class sizes, and limited teacher training (Telore & Damtew, 2023). The success of PBPS in the present study suggests that even low-cost, paper-based methods can circumvent resource barriers and foster critical thinking more effectively than traditional methods.

Furthermore, the improvements observed align with the wider educational emphasis on problem-based and inquiry-based approaches across the Ethiopian context. Research employing guided inquiry models in biology demonstrated benefits for student attitudes, engagement, and conceptual understanding—outcomes closely related to facets of critical thinking. Although much of this work has focused on attitudes or content comprehension, these studies underscore a broader pedagogical shift toward strategies that support deeper engagement and cognitive involvement, which studies on PBPS intervention seems to advance (Negerie et al., 2025).

The documented increase in students' abilities to justify reasoning, evaluate evidence, and apply conceptual understanding also speaks to the relevance of integrating PBPS within existing curricular frameworks aimed at 21st-century skills development. Meta-analyses and empirical studies from secondary education contexts affirm that learner-centered,

problem-based designs promote autonomous thinking and reflective learning far more robustly than lecturer-dominated instruction—a pattern consistent in Ethiopian education research (Chengere et al., 2025b) .

Collectively, these results bridge a crucial gap in Ethiopian secondary science education research, where much prior work has focused on general active learning implementations but comparatively little has tested structured problem scenario interventions in biology specifically. These findings demonstrate that PBPS can effectively enhance both the quantitative measurement of critical thinking skills and qualitative reasoning behaviors, underscoring their pedagogical value. At a time when Ethiopian education policy increasingly advocates for higher-order thinking outcomes, these results support the practical integration of PBPS into biology curricula as a feasible approach to improving learner outcomes in resource-constrained environments.

Conclusion

The study demonstrates that paper-based problem scenarios (PBPS) significantly enhance high school students' critical thinking skills in biology, as evidenced by both quantitative and qualitative measures. Students exposed to PBPS not only achieved higher posttest scores but also exhibited more sophisticated reasoning, moving from rote memorization to deeper analysis, evaluation, and synthesis of biological concepts. These findings highlight the effectiveness of active, learner-centered, problem- and inquiry-based pedagogies in contexts where traditional, teacher-centered instruction dominates. By providing a low-cost, accessible strategy for fostering higher-order thinking, PBPS addresses a critical gap in Ethiopian secondary science education and offers a practical approach for integrating 21st-century skills development into biology curricula. Overall, the results underscore the potential of PBPS to improve cognitive and reasoning outcomes, supporting its broader adoption in resource-constrained educational settings.

Based on the findings, it is recommended that Ethiopian secondary schools integrate paper-based problem scenarios (PBPS) into biology instruction to promote higher-order thinking, moving students beyond memorization toward analysis, evaluation, and synthesis. Schools should also adopt active, learner-centered pedagogies, encouraging problem-based and inquiry-oriented strategies to enhance engagement, reasoning, and autonomous learning. Teacher training is essential to equip educators with the skills to design and facilitate PBPS activities, guide inquiry, and assess higher-order thinking, even in large classes. PBPS can also be adapted across other science subjects to strengthen critical thinking and problem-solving skills broadly, and locally relevant, low-cost materials should be developed to make active learning accessible in resource-limited classrooms.

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