

AN ASSESSMENT OF DIGITAL LITERACY AND 4Cs AMONG SECONDARY SCHOOL STUDENTS IN NIGER STATE, NIGERIA

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ABSTRACT

The 21st century has ushered in a rapidly changing education landscape, characterized by technological-driven tools and the globalization of knowledge. Science Educators in digital age is prioritising the use of digital technology to drive 21st century skills. Therefore, this study investigate the perceived level of digital literacy and the 4Cs among secondary school students in Niger state, Nigeria. This study uses descriptive survey. The population of the study comprises of all the 2024/2025 senior secondary school students (SS2) in Bosso Local Government of Niger state. The researchers developed and used a structured questionnaire for data collection. The instrument was validated by three experts in Science Education. The internal consistency of the instrument was tested using Cronbach's Alpha formula and 0.76 was obtained. The instrument was distributed by the researcher, and 200 students responded. The researchers analysed the quantitative data using descriptive statistics. The findings of the study reveals that Secondary school students in Bosso local government have high level of perception of digital Literacy and 4Cs in Niger state. It recommends that Teachers should integrate more problem-based and innovation-driven teaching strategies to improve critical thinking, collaboration, communication and creativity among secondary School students.

KEYWORDS: Digital Literacy, Collaboration, Communication, Creativity and Critical thinking.

I. INTRODUCTION

The 21st century has ushered in a rapidly changing world of science, characterized by evolving technologies, changing economic reality and the globalization of knowledge. In response to these changes, education systems worldwide have been called to focus on equipping students with the skills and competencies needed to succeed in the century. The skills referred to as 21st-century learning competencies encompass critical thinking, problem-solving, creativity, collaboration, communication, and digital literacy, among others (Saavedra and Opfer, 2012). The traditional notion of education as a means to acquire basic literacy and numeracy skills is no longer sufficient in preparing students for the challenges of today's world. Instead, education now emphasizes the development of a broader set of competencies, commonly referred to as 21st-century skills which include critical thinking, creativity, communication, collaboration, and digital literacy. Critical thinking is a vital 21st-century skill that enables students to analyze, evaluate, and apply information in meaningful ways rather than just memorizing facts. It involves reasoning, questioning, and making informed decisions based on evidence, which is essential in today's fast-paced, information-driven world. As Facione (2020) notes, critical thinking includes both

cognitive abilities and positive habits of mind like open-mindedness and curiosity, helping learners become independent thinkers and problem-solvers. In Nigeria, where education often emphasizes rote learning, fostering critical thinking can better prepare students for real-life challenges, academic success, and active citizenship in the modern era. Collaboration is one of the most essential 21st-century skills, emphasizing the ability to work effectively and respectfully with others to achieve common goals. In today's interconnected world, students must learn how to share ideas, listen actively, manage disagreements, and contribute meaningfully within a group setting. Unlike traditional learning where individual performance is often prioritized, modern education values teamwork, recognizing that many real-world tasks require people to work together across diverse backgrounds and disciplines. Communication is a foundational 21st-century skill that extends far beyond speaking or writing well. It involves the ability to clearly express ideas, actively listen, interpret messages, and engage others effectively across various platforms and contexts. In our increasingly digital and globalized world, students must learn to communicate not only face-to-face but also through digital tools, written texts, presentations, and social media.

Digital literacy is the ability to effectively and critically navigate, evaluate, and create information using a range of digital technologies. In today's society, where almost every aspect of human activities is increasingly dependent on technology, digital literacy is no longer optional but it is essential. Creativity is a key 21st-century skill that goes beyond artistic expression. It involves the ability to think outside the box, generate new ideas, and approach challenges with innovation. In education, fostering creativity allows students to explore unique solutions, challenge existing assumptions, and develop original perspectives on a variety of subjects. As highlighted by Robinson (2020), creativity is not limited to traditional fields like art or music but is essential in all areas of life, including science, technology, business, and social issues. However, despite global recognition of their importance, there is a notable gap in the acquisition of these skills in many educational contexts, especially in developing countries like Nigeria. In many Nigerian secondary schools, the focus remains heavily on rote memorization and examinations, often sidelining the development of critical competencies such as communication, creativity, and technological proficiency (Ogunyemi, 2018). In Bosso Local Government Area, where schools face challenges, the development of 21st-century competencies among students may be hindered. This research investigates the 21st-century learning competencies among senior secondary school students in Bosso Local Government Area. The study focuses on critical thinking, communication, collaboration, creativity, and digital literacy, which are essential for students to succeed in today's rapidly changing world.

The study aims to assess the extent to which these competencies are being developed in Bosso's secondary schools, exploring the relationship between these skills and students' academic. This study is guided by the following research questions:

- (a). What is the perceive level of critical thinking among senior secondary school students in Bosso Local Government Area?
- (b). What is the perceive level of creativity among senior secondary school students in Bosso Local Government Area?
- (c). What is the perceive level of collaboration among senior secondary school students in Bosso Local Government Area?
- (d). What is the perceive level of communication among senior secondary school students in Bosso Local Government Area?

- (e). What is the perceive level of digital literacy among senior secondary school students in Bosso Local Government Area?

II. LITERATURE REVIEW

The role of Science Education in national development cannot be over emphasised as it helps learners understand scientific concepts and apply them to solve real-life problems. Recently, Science education has transcend teaching facts and formulas. It now focuses on helping students develop skills that prepare them for life, work, and further learning in a digital world. These skills include digital literacy, communication, collaboration, creativity, and critical thinking. These skills are importance for the overall growth and development of learners and must be taught. The rapid growth of digital technology has changed how science is taught and learned. Digital tools such as computers, mobile devices, simulations, online videos, and virtual laboratories are now widely used in education. These tools help students explore scientific ideas, conduct experiments, analyze data, and communicate results more effectively (OECD, 2019). In Nigeria, science education at the senior secondary school level is very important because it prepares students for national examinations and science-related careers. However, many schools still face challenges such as limited access to digital resources, poor internet connectivity, and lack of teacher training (Yusuf, 2018). These challenges may affect students' development and perceived levels of digital literacy and the 4Cs, especially in states like Niger State.

Digital literacy refers to the ability to use digital technologies effectively, responsibly, and creatively for learning and problem-solving. In science education, digital literacy involves using digital tools to search for scientific information, analyze data, conduct experiments, and present findings (Ng, 2018). According to Redecker (2018), digital literacy includes technical skills, information skills, communication skills, and ethical awareness. Technical skills involve operating digital devices, information skills involve evaluating online content, communication skills involve sharing ideas using digital tools, while ethical awareness involves responsible use of technology. These skills are important for science students who must work with data, evidence, and digital resources. Recent studies show that digital literacy improves science learning outcomes. Siddiq *et al* (2019) found that students with higher digital competence performed better in tasks that required problem-solving and scientific reasoning. Digital tools also help students understand abstract scientific concepts through simulations and animations. In Nigeria, digital literacy among secondary school students is still developing. While many students can use smartphones and computers for social purposes, fewer can use digital tools for academic science activities such as research and data analysis (Aduwa-Ogiegbaen & Iyamu, 2018). This gap may affect students' confidence and perception of their digital abilities. Students' perceived digital literacy is important because it affects how often and how well they use technology in science learning. In Niger State, limited ICT facilities and irregular access to digital tools may reduce students' confidence and limit their engagement with digital learning resources.

Communication is a key skill in science education. It involves explaining scientific ideas, discussing observations, asking questions, and presenting results clearly. Communication can be oral, written, or digital. In modern science classrooms, digital communication tools such as slide presentations, online discussions, and multimedia reports are widely used. In science education, communication allows students to explain experiments, describe results, and defend conclusions. Digital literacy supports communication by providing tools for presenting information in different formats. Van Laar *et al.* (2018) noted that students with good digital skills are better at organizing information and communicating ideas clearly using digital media. In Nigerian secondary schools,

communication skills are often developed through classroom discussions and written assignments. However, digital communication is not fully integrated into many science classrooms. Yusuf and Fakomogbon (2018) observed that technology is often used by teachers for presentation rather than for student interaction. Students' perceived communication skills depend on how often they are encouraged to participate in discussions, presentations, and group activities. When students are not given opportunities to express their ideas, they may lack confidence in their communication abilities, especially in digital environments.

Collaboration refers to the ability to work with others to achieve a common goal. In science education, collaboration takes place when students work together during experiments, projects, and problem-solving activities. Collaborative learning helps students share ideas, learn from peers, and develop teamwork skills (Johnson & Johnson, 2019). Digital technologies support collaboration by allowing students to work together using shared documents, online platforms, and virtual learning environments. Van Laar et al. (2019) explained that digital collaboration improves interaction and joint problem solving, which are important for science learning. Research shows that collaborative learning improves students' understanding of scientific concepts. When students discuss and solve problems together, deeper understanding and stronger reasoning skills is developed. In Nigeria, collaborative learning in science classrooms is often limited by large class sizes, lack of resources, and traditional teaching methods. Yusuf (2018) reported that many science teachers rely on lecture-based instruction, which reduces opportunities for group work and collaboration. Students' perceived collaboration skills depend on their learning experiences. If students rarely work in groups or use digital tools for teamwork, they may not see collaboration as an important skill. In Niger State, limited ICT resources may further reduce students' exposure to digital collaboration.

Creativity in science education involves generating new ideas, designing experiments, and finding innovative solutions to scientific problems. Creativity is essential in science because scientific discoveries often require imagination and originality (Henriksen et al., 2018). Digital tools support creativity by allowing students to design models, create simulations, and present ideas in creative ways. Technology-rich environments encourage exploration and experimentation, which help students develop creative thinking skills (Henriksen et al., 2018). However, creativity in science classrooms depends largely on teaching methods. When teachers focus mainly on examination preparation and memorization, students have limited opportunities to think creatively. This challenge is common in science classrooms (Aina & Akinbobola, 2019). Studies in Nigeria show that creativity is not strongly emphasized in science teaching. Many students are not encouraged to ask questions, design experiments, or explore alternative solutions. As a result, students may not perceive themselves as creative learners. Students' perceived creativity improves when teachers encourage inquiry, experimentation, and use of digital tools. When students are given freedom to explore ideas, they become more confident and engaged in science learning.

Critical thinking is a core skill in science education. It involves analyzing data, evaluating evidence, and making logical conclusions. According to Facione (2020), critical thinking helps learners make informed decisions based on evidence and reasoning. Digital literacy supports critical thinking by helping students evaluate online information and scientific sources. Students need to be able to identify reliable information and avoid misinformation, especially when using the internet for research (Ng, 2018). Technology-supported inquiry-based learning has been shown to improve critical thinking. When students use digital tools to investigate problems, analyze results, and reflect on findings, they develop stronger reasoning skills (Van Laar et al., 2018). In

Nigeria, several studies report that students struggle with critical thinking in science subjects. Teaching methods that emphasize memorization rather than inquiry limit the development of reasoning skills (Aina & Akinbobola, 2019). Students' perceived critical thinking skills depend on classroom practices. When teachers encourage questioning, experimentation, and discussion, students are more likely to see themselves as critical thinkers. Van Laar et al., (2018) shows that digital literacy and the 4Cs are closely related. Digital literacy provides the foundation for effective communication, collaboration, creativity, and critical thinking. In science education, integrating digital literacy with the 4Cs helps students develop skills needed for modern scientific work. However, in Bosso local Government in Nigeria, limited research has examined these skills together, especially from students' perspectives.

III. METHODOLOGY

This researcher adopted a descriptive research design. To investigate the students' perceived level of digital Literacy, Critical thinking, creativity, collaboration and communication among students in Bosso Local Government of Niger state. The population of the study consists of one thousand (1000) public and private Senior Secondary Schools (SS2) in Bosso Local Government Area Minna, Niger State. Using Simple random sampling, the sample size of this consist of 200 participant drawn from 6 public and 6 private schools. The instrument used for data collection in is a 21st century Competency based structured questionnaire (CCBSQ). The demographic section seeks to obtain basic information about the respondents such as gender, age, school type, and location, which helps in categorizing the data for analysis. The main section of the questionnaire contains 25 items specifically designed to assess students' levels of 21st-century learning competencies. These items are structured using a four-point Likert scale with response options of Strongly Agree, Agree, Disagree, and Strongly Disagree. To ensure their quality, relevance, and alignment with the study objective, three experts validated the instrument, and pilot-tested with a 0.76 Cronbach's Alpha index. The data for this study was collected using a structured questionnaire personally administered by the researcher to the selected respondents in the sampled schools. Prior to the distribution of the instrument, permission was sought from the school authorities, and the purpose of the study was clearly explained to both the school management and the students to gain their consent and cooperation. The final copy of the instrument was administered between August and December, 2025. Descriptive analysis was undertaken using Microsoft Excel for quantitative analysis. The data collected from the respondents was systematically organized and analysed using descriptive and inferential statistical methods of mean and standard deviation.

IV. RESULTS & DISCUSSION

Research Question One: What is the perceived level of critical thinking among senior secondary school students in Bosso Local Government Area? To answer research question one, mean and standard deviation were used and is presented in Table 4.1.

Table 1 shows the mean and standard deviation of the perceived level of critical thinking among senior secondary school students in Bosso Local Government Area, the results indicated that all the five (5) items scores more than (2.50) above the decision mean, and therefore agreed with all the statements regards to the perceived level of critical thinking among senior secondary school students in Bosso Local Government Area with an average mean of 3.60 and 0.599. Based on the result, responses on perceived level of critical thinking among senior secondary school students in Bosso Local Government Area was high with an average mean of 3.60 and standard deviation of

0.599 respectively. This revealed that there is a high perceived level of critical thinking among senior secondary school students in Bosso Local Government Area.

Table 1: Mean and standard deviation of the perceived level of critical thinking among senior secondary school students in Bosso Local Government Area.

S/NO	Items	Mean	S. D	Decision
1.	I can find good ways to solve a problem	3.55	.607	High
2.	I think well before I make a decision	3.73	.448	High
3.	I listen to different ideas before I choose one	3.57	.639	High
4.	I can give reasons for what I believe is right	3.48	.672	High
5.	I learn from my mistakes to do better next time	3.63	.627	High
	Average	3.60	.599	High

The high perceived level of critical thinking among senior secondary school students in Bosso aligns with the findings of Chukwudi and Ezeh (2020) and Okoro and Musa (2020), who both reported that students who engage in inquiry-based and problem-solving tasks demonstrate stronger analytical reasoning. Similarly, Adebayo and Ogunleye (2019) found that exposure to modern pedagogies enhances students’ cognitive skills. However, unlike their findings, which showed gender disparities in critical thinking, the present study found an overall high perception across the board. This suggests that efforts to promote reasoning and reflection are increasingly effective in Bosso schools. The result implies that critical thinking is being nurtured through improved instructional strategies and exposure to real-life learning contexts.

Research Question Two: What is the perceived level of creativity among senior secondary school students in Bosso Local Government Area? To answer research question one, mean and standard deviation were used and is presented in Table 4.2.

Table 2 shows the mean and standard deviation of the perceived level of creativity among senior secondary school students in Bosso Local Government Area, the results indicated that all the five (5) items scores more than (2.50) above the decision mean, and therefore agreed with all the statements regards to the perceived level of creativity among senior secondary school students in Bosso Local Government Area with an average mean of 3.29 and 0.722. Based on the result, responses on perceived level of creativity among senior secondary school students in Bosso Local Government Area was high with an average mean of 3.29 and standard deviation of 0.722 respectively. This revealed that there is a high perceived level of creativity among senior secondary school students in Bosso Local Government Area.

Table 2: Mean and standard deviation of the perceived level of creativity among senior secondary school students in Bosso Local Government Area.

S/NO	Items	Mean	S. D	Decision
1.	I like thinking of new ways to do things	3.45	.671	High
2.	I can find more than one way to solve a problem	3.30	.723	High
3.	I try new ideas when doing my school work	3.35	.654	High
4.	I enjoy creating new things during school activities	3.13	.739	High
5.	I can use old ideas to make something better	3.19	.823	High
	Average	3.29	.722	High

The study found a high perceived level of creativity among students, consistent with Adetunji and Olaniyan (2020), who identified creativity and innovation as key predictors of academic engagement. Similarly, Adebayo and Ogunleye (2019) reported that exposure to teaching approaches enhances students’ creative problem-solving ability. However, while Adetunji and Olaniyan (2020) emphasized individual innovation, the current study shows that creativity is also embedded in group learning contexts, where collaboration fosters new ideas. The finding suggests that students in Bosso are increasingly encouraged to think independently and express originality in their learning processes, reflecting gradual progress toward creativity- focused education. This supports the integration of project-based and exploratory learning to further enhance creative capacity.

Research Question Three: What is the perceived level of collaboration among senior secondary school students in Bosso Local Government Area? To answer research question one, mean and standard deviation were used and is presented in Table 4.3:

Table 3 shows the mean and standard deviation of the perceived level of collaboration among senior secondary school students in Bosso Local Government Area, the results indicated that all the five (5) items scores more than (2.50) above the decision mean, and therefore agreed with all the statements regards to the perceived level of collaboration among senior secondary school students in Bosso Local Government Area with an average mean of 3.41 and 0.740. Based on the result, responses on perceived level of collaboration among senior secondary school students in Bosso Local Government Area was high with an average mean of 3.41 and standard deviation of 0.740 respectively. This revealed that there is a high perceived level of collaboration among senior secondary school students in Bosso Local Government Area.

Table 3: Mean and standard deviation of the perceived level of collaboration among senior secondary school students in Bosso Local Government Area.

S/NO	Items	N	Mean	S. D	Decision
1.	I like working with others in a group	200	3.46	.807	Agree
2.	I share my ideas and notes with my classmates	200	3.16	.805	Agree
3.	I listen to everyone when we work together	200	3.48	.680	Agree
4.	I help my friends when they find a topic hard	200	3.42	.704	Agree
5.	I can lead my group when needed	200	3.52	.701	Agree
	Average	200	3.41	.740	Agree

The high level of collaboration found in this study supports Eze and Umeh (2021), who established that collaborative learning significantly improves students’ engagement and performance. Similarly, Adebayo and Ogunleye (2019) noted that teamwork enhances problem-solving efficiency and knowledge sharing. However, unlike Eze and Umeh’s (2021) findings, which highlighted variability in collaboration depending on gender and subject area, the current study shows a consistently high perception across schools. This implies that teamwork and peer learning are becoming integral to the classroom culture in Bosso. The finding reinforces the importance of social learning and cooperative strategies, suggesting that collaboration enhances not just academic success but interpersonal and leadership competencies.

Research Question Four: What is the perceived level of communication among senior secondary school students in Bosso Local Government Area? To answer research question one, mean and standard deviation were used and is presented in Table 4.4.

Table 4 shows the mean and standard deviation of the perceived level of communication among senior secondary school students in Bosso Local Government Area, the results indicated that all the five (5) items scores more than (2.50) above the decision mean, and therefore agreed with all the statements regards to the perceived level of communication among senior secondary school students in Bosso Local Government Area with an average mean of 3.39 and 0.699. Based on the result, responses on perceived level of communication among senior secondary school students in Bosso Local Government Area was high with an average mean of 3.39 and standard deviation of 0.699 respectively. This revealed that there is a high perceived level of communication among senior secondary school students in Bosso Local Government Area.

Table 4: Mean and standard deviation of the perceived level of communication among senior secondary school students in Bosso Local Government Area

S/NO	Items	Mean	S. D	Decision
1.	I can speak clearly when I talk to others	3.47	.664	High
2.	I pay attention when someone is talking	3.59	.533	High
3.	I can talk with confidence in class	3.15	.841	High
4.	I can explain my ideas in simple words	3.13	.750	High
5.	I respect other people’s opinions	3.57	.706	High
	Average	3.39	.699	High

The high level of communication skills reported among students agrees with Bello and Olayemi (2021) and Nwachukwu and Adeyemi (2019), who both found that effective communication positively influences academic engagement and performance. Students who can articulate ideas clearly tend to perform better in collaborative and problem-solving tasks. However, while earlier studies emphasized verbal and written communication, this study likely reflects a broader integration of digital communication channels in learning. This shift underscores how modern classrooms increasingly rely on technology for interaction. The finding implies that improved communication skills among Bosso students may result from more participatory and technology-aided instruction, enhancing their readiness for higher education and workplace communication demands.

Research Question Five: What is the perceived level of digital literacy among senior secondary school students in Bosso Local Government Area? To answer research question one, mean and standard deviation were used and is presented in Table 4.5.

Table 5: Mean and standard deviation of the perceived level of digital literacy among senior secondary school students in Bosso Local Government Area.

S/NO	Items	Mean	S. D	Decision
1.	I use the internet to do my school work	3.21	.900	High
2.	I can tell if a website gives correct information	3.10	.902	High
3.	I use social media to learn new things	3.35	.813	High
4.	I keep my personal information safe online	2.91	1.090	High

5.	I can use computer programs such as words excel or PowerPoint	2.96	1.084	High
	Average	3.11	0.958	High

Table 5 shows the mean and standard deviation of the perceived level of digital literacy among senior secondary school students in Bosso Local Government Area, the results indicated that all the five (5) items scores more than (2.50) above the decision mean, and therefore agreed with all the statements regards to the perceived level of digital literacy among senior secondary school students in Bosso Local Government Area with an average mean of 3.11 and 0.958. Based on the result, responses on perceived level of digital literacy among senior secondary school students in Bosso Local Government Area was high with an average mean of 3.11 and standard deviation of 0.958 respectively. This revealed that there is a high perceived level of digital literacy among senior secondary school students in Bosso Local Government Area.

The finding of a high level of digital literacy (mean = 3.11) aligns with Ibrahim and Danjuma (2022), who reported growing digital competence among senior secondary students in Abuja, particularly in accessing and applying online resources. Likewise, Adebayo and Ogunleye (2019) found that exposure to digital tools enhances learning efficiency. However, while Ibrahim and Danjuma (2022) emphasized disparities due to access and socioeconomic factors, the current study suggests that digital literacy levels in Bosso are improving across schools. This could be due to increased smartphone use and online learning exposure. The implication is that students are developing essential digital skills, but continued investment in ICT infrastructure remains necessary for equitable access and deeper digital engagement.

CONCLUSION

This study investigated the 21st-century learning competencies of senior secondary school students in Bosso Local Government Area, Minna, with a focus on critical thinking, creativity, collaboration and communication. This study reveals that the perceived level of the 4Cs was high. The results showed that students demonstrated a high level of competence across all four domains of 21st-century skills. Critical thinking recorded the highest average mean score (3.60), followed by collaboration (3.41), communication (3.39), and creativity (3.29), indicating that students possess appreciable readiness for 21st-century learning demands. It is recommended that

- (a). Teachers should integrate more problem-based and innovation-driven teaching strategies. To improve critical thinking and creativity, teachers should adopt project-based learning, inquiry methods, debates, role-playing, and real-life task simulations rather than relying solely on lecture methods.
- (b). Regular workshops and professional development should be organized for teachers on 21st-century skills. Training programs should focus on digital pedagogy, collaborative learning techniques, and communication enhancement strategies to help teachers facilitate learning beyond theoretical knowledge.
- (c). School administrators should promote peer collaboration through group projects and competitions. Since collaboration and communication did not differ significantly between school types, schools can further strengthen this area by encouraging team-based assignments, inter-school challenges, and student clubs to foster teamwork and leadership.
- (d). Education policymakers should include 21st-century competencies as core assessment criteria in school evaluations. Beyond academic performance, critical thinking, creativity,

communication, collaboration, and digital literacy should be measured and rewarded during examinations, awards, and school inspections to encourage a balanced development approach.

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