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Investigating Perception of the 21st Century Skills among Nigerian Pre-service Science, Technology and Mathematics Teachers

Research Article

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ABSTRACT

The growth of 21st Century skills in this fast shifting universally linked world assists to get learners ready for the real work and creates opportunities for additional schooling beyond secondary education. In accessing higher education, 21st century skills in education show a complete learner who swims in the pool of authentic and pragmatic skill sets outside educational competencies. This study examined the perception of pre-service science, technology and mathematics teachers on the 21st century skills in education in Nigeria. A quantitative research within the blueprint of the causal-comparative research design was adopted for the study and the participants were three hundred (300) senior pre-service science, mathematics, and technology teachers in one public university in southwest, Nigeria. One valid and reliable instrument tagged "perception of 21st century skills in education questionnaire (Cronbach α=0.87)'' was used for data collection and the collected data were analysed using the descriptive statistics of mean and standard deviation and inferential statistics of independent samples t-test and analysis of variance. The results showed that pre-service science, mathematics, and technology teachers' perception of the 21st century skills in education was low and their perceptions were neither gender sensitive nor academic discipline specific. Based on these findings, it was thus recommended that pre-service science, mathematics, and technology teachers should be more able to exhibit dexterity in collaboration and communication in network location, adept at growing future students' mindset in critical, creative and innovative thinking, and inspire future students to embrace invention and high self-direction in education

Keywords:
Pre-service teacher, science, mathematics, technology, 21st century skills, Nigeria

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Introduction

In the past three decades, the world has changed histrionically and the mode by which institutions of learning cater for their students in this fast shifting universally linked world should keep abreast of this change. Nurturing 21st century skills in students could be a better way to foster in students the knowledge and skills to deal with this vibrant and effervescent future. 21st century skills are not only developmentally apposite to students of all ages but are genuinely content opulent learning proficiencies needed to bridge the gap between work and education. In the citadel of learning, 21st century skills are viewed differently from the traditional content because they are popularly concept-driven that show how stakeholders in the classroom learn and teach and perfecting one's capability to implement this skills set is an enduring and lifetime effort. The term 21st century skills is fuzzy and fraught with many definitions as there are many practitioners in the field (Partnership for 21st Century skills, 2013; Lisbon Council, 2007; ISTE NETS, 2013; ETS iSkill, 2013). This career readiness skills set, indispensable in kindergarten through university, has been used interchangeably to mean cross-curricular skills, cross-disciplinary skills, interdisciplinary skills, transferable skills, transversal skills, soft skills, non-cognitive skills, life skills, applied skills, workforce skills, and interpersonal skills to mention but a few. Even though these dissimilar concepts may not be exactingly identical, which may result in them having conflicting or specific connotations in assured methodical milieus, these different skills sets are primarily described as 21st century skills in this study for wants of sensibleness and utility. The 21st century skills are a set of capabilities that are imperative for learners to cultivate in order to flourish in the knowledge and information driven digital age. The concept of 21st century skills can be defined as a comprehensive set of work habits, skills, knowledge, and personality traits that stakeholders in the education industry enunciated to be analytically significant to victory in educational programmes and modern day professions and workstations. The Partnership for 21st Century Skills lists three types of 21st century skills. They are learning skills, literacy skills, and life skills. The learning skills deal with the cognitive processes needed to become accustomed with a 21st century job environ and consist of critical thinking, creative thinking, collaboration, and communication.

The literacy skills are concerned with the way students recognize information and facts, printing orifices, and the accompanied technology. The literacy skill helps students to consciously extrapolate reliable sources of genuine information as a prelude to sieving factual information from misinformation that inundates the internet. The literacy skills consist of information literacy, media literacy, and technology literacy. The life skills depict the imperceptible and unnoticeable personal and specialized qualities of a learner's daily life and consist of flexibility, initiative, social skills, productivity and leadership. The Assessment and Teaching of 21st Century Skills (ATC21S) scholars established that 21st Century skills can be congregated into four comprehensive classes: (i) ways of thinking; (ii) ways of working; (iii) tools for working; and (iv) skills for living in the world (Binkley, Erstad, Herman, Raizen, Ripley and Rumble, 2010). The ways of thinking include: creativity and innovation, critical thinking, problem solving, decision making, learning to learn, and metacognition. Ways of working include: communication, and collaboration. Tools for working include: information literacy and ICT operation and concepts. Skills for living in the world include: citizenship, life and career skills, personal and social responsibility. In the sequel, we discuss some of these important skills in details.

Problem solving: This is the capability of students to crack difficult problems in tangible and genuine time. As the world improves in tackling difficult problems now so will there be more difficult problems in the nearest future that will require carefully planned elucidations and solutions. Students need to come to term with difficult problems as the world progresses in technology and invent unique and efficient solutions to be more successful. Being a problem-solver is to engage in initiative taking that will help to blossom in risk not minding learning from mistakes to build more resourceful and cost-effective solutions. It is important to note

that graduates of STM education can only be prosperous in the international marketplace only if they are able to reason pre-emptively towards cracking difficult problems.

Creativity: This is the ability to reason and work innovatively in both numerical and non-numerical milieus to cultivate inimitable and worthwhile solutions. In this digital age, students are inspire with using technology and they create and use information using different social media in a way different from the students of 20th century. Creativity is a skill which pre-service STM teachers should have and this can be cultivated through meaningful STM learning and engagement in the classroom that calls for imaginative ways of thinking. Creativity combines ingenuity with vision in figuring out solutions to interesting difficulties. Pre-service STM teachers who possess this quality will not only be inspired in their learning but will have the creative mind power to surmount difficult problems that may arise in their learning.

Critical thinking: This is the capacity to think rationally, which comprises adeptness at relating, contrasting, valuing, creating, and comparing in the absence of tutoring and control. It is the ability to put the brain to work to develop Bloom digital taxonomy of higher order thinking. Pre-service STM teachers with critical thinking engage in non-routine cognitive work needed to prosper beyond the four walls of the classroom. Critical thinkers are skillful at analysis, synthesis and evaluation of knowledge and conceive, interpret and classify data using different perspectives. The skill of critical thinking is precious to pre-service STM teachers who want to be empowered to tackle problems of scientific significance for effective decision making in socio-mathematical milieu.

Collaboration: This is the capacity to cooperate impeccably and mutually in corporeal and cybernetic milieus, with genuine and virtual cronies internationally. Pre-service STM teachers in this digital era are naturally sociable and were born into technology and that is why they are being called digital natives. They often like to typescript, send, discuss, and persistently synthesize information in virtual rich milieus with one another. Students' inability to achieve this in school may make them to be disengaged and uncommitted to their studies which may lead to frustration and eventual poor performance. Cooperation with colleagues is not only a way of catching social skills in learning but a means of developing cognitive and affective wellbeing needed for all round development of a student. In this digital age, no nation is a highland unto itself and ditto for individual. Nations and individuals are globalizing to produce a global village where distance is not an issue or a barrier. It is now imperative for nations and persons to connect and engage in shopping through collaborative fluency for global competitiveness. When students collaborate with one another they become better students and this leads to healthier citizens who can go places. Group functioning is progressively being simplified using digital tools that permit geographically isolated group members to cooperate.

Communication: This is one of the educational qualities that students must imbibe to be 21st century compliant. Communication is the process of transferring information from the sender to the receiver through a channel. Pre-service STM teachers must possess the ability to communicate not only with text and speech, but visually with diverse interactive program designs via imagery and video. Communication involves a deeper level of interaction between the parties involved in information sharing and communicating via technology comes naturally to pre-service STM teachers. Most times pre-service STM teachers engage in media fluency and use digital media to influence social interaction for personal benefits and effectiveness. Being able to communicate either through face-to-face in verbal form, by texting, or blogging in virtual format will help pre-service STM teachers to sharpen their communication skills for professional and personal enrichment. Communication is a pre-requisite all pre-service STM teachers need to sustain success in academics and it is also vital for them to learn exactly how to efficiently and competently express ideas among diverse personalities to clear confusion in the classroom. Though undervalued in Nigeria, effective communication in the view of many people is innate and some organisations sometimes take it with flippancy and glibness. Without effective and good communication, pre-service STM teachers will wallow in inadequate essential

skills needed for their career progress and success. Communication involves not only sharing information visibly and successfully via speaking, writing, and reading but also depends on constructing worthwhile arguments and reviewing the recurrent thinking of others with precision.

Digital literacy: This is the capability to utilize information and communication technologies to discover, appraise, generate, and transfer knowledge and information, needing both intellectual and methodical skills. Digital literacy involves the prevention of cyberbullying, making the internet safe for the users and gaining better understanding of the moral and lawful matters connecting to the right to use ICT. In today's world pre-service STM teachers are pre-occupied with using ICT for learning. They look for information on the internet to do assignment and engage in research.

Self-direction: This involves students being accountable for their learning in which they identify topics to study and procedural steps for personal learning, and engage in personal evaluation of their work to getting feedback.

It is important to note that ICT can be used to enhance the development and growth of 21st century skills (Ananiadou & Claro, 2009) in students and to promote their cross-curricular nature, substantial alterations need to be done in the area of pedagogical approaches and educational practices (Voogt, & Pareja Roblin, 2012) to fit into the 21 century milieu. While the policymakers and the employers of labour are canvassing for the integration of 21st century skills in teaching and learning, in reality, teachers strongly show lack of adeptness and less space to cultivate these skills in their students (Voogt, Erstad, Dede, & Mishra, 2013). So there is a skill mismatch in today's classrooms, hence the need for students to cultivate 21st century skills.

A strong and persuasive economic reason for systems of education to cultivate 21st century skills is that ICT including computers are conveniently taking the place of employees whose jobs require simply repetitive knowledge and skills, meaning that the workstations require less employees with rudimentary skill sets and more employees with complex thinking skills. Also, the globalised marketplace engenders rivalry for employees who can enhance company value by deploying non-routine, higher-order thinking, and communicative problem solving skills to solve novel problems in new environments.

Another reason for education systems to promote the growth of 21st century skills is that rudimentary civic knowledge about government and social responsibility is necessary but not sufficient to engender civic engagement. An engaged citizen is one who is able to deploy the resources within his/her disposal to scrutinize news, single out prejudices, exercise his/her franchise in a responsible manner and partake and collaborate with others in political campaigns to mitigate social problems. Students at all times need to be civil and they should be ready to declare their opinions verbally and in paper and pencil, protect their civic rights and challenge obnoxious policies of government. In the present day Nigeria, participation in local and national politics is not encouraging and this can be traced to the widening gap between the poor and the rich, which in some ways tend to decrease people's obligation to functional democracy. In essence, lack of 21st century skills can accentuate a decline in citizens' commitment to claim their civic rights and make them less committed to their responsibilities thereby making a hale and hearty society a mirage.

Another important justification for developing 21st century skills in classrooms is globalization. Globalisation is the rising interconnectedness of the world's markets, ethos, and people, actioned by international trade in commodities, expertise, and movements of asset, population, and information. This interdependence makes it imperative for pre-service STM teachers to engage in learning how to team up, communicate, and problem-solve with colleagues outside national shores.

It is important to acknowledge that despite the importance of 21st century skills in this information driven age, many students around the world are not catching 21st century skills. One major barrier to students' cultivation of 21st century skills is that traditional pedagogy of instruction pervades most of the educational

systems in the world. For instance in Nigeria, classroom pedagogies are teacher-centred and follow the transmission model where the teacher is the authority and the sage in the stage who transfers genuine knowledge to learners via print media and lectures and assesses learners through recall-based appraisals. Realizing the negative effect of this model, many countries educational systems are moving towards constructivist model where learners actively have a role to play in acquisition of knowledge. In the traditional model learners are faced with the difficulty of transferring gained knowledge to engaging and disentangling novel problems. Thus, this model is not the best platform for learners to acquire communicative skills and develop problem solving and creativity skills needed in this 21st century.

Another reason for students' inability to develop 21st century skills is that students don't acquire them in disciplinary subjects like mathematics, biology, chemistry, economics etc. As teachers don't teach these skills in separate stand-alone subjects, students find it pretty difficult to learn and acquire them. It thus means that educational systems should integrate these skills into disciplinary subjects for their effective teaching and learning in the classroom and teachers should engage them using constructivist teaching pedagogies.

A third obstacle in the way of students' acquisition of 21st century skills is that these skills are pretty difficult to evaluate than the disciplinary subjects. Because these skills are not evaluated on accountable and certificated assessments, teachers are incline to decline their priority in the classroom thereby reducing them to something not important for students to learn. While standardized test can be used to assess disciplinary subjects, it cannot be deployed in assessing 21st century skills. For instance, it is very difficult to assess thinking in the classroom using test.

For students to learn and acquire 21st century skills, teachers' roles in cultivating them are central. Therefore, in this study, attempt was made to investigate the perception of 21st century skills in education among Nigerian pre-service science, technology and mathematics teachers. This study would be the first to be conducted in Nigeria as literature search revealed no similar studies in the past.

Research Questions

RQ1. What is the level of pre-service science, technology and mathematics teachers' perception of 21st century skills in education in Nigeria?

RQ2. Is there any significant relation of gender to pre-service science, technology and mathematics teachers' perception of 21st century skills in education?

RQ3. Is there any significant relation of academic discipline to pre-service science, technology and mathematics teachers' perception of 21st century skills in education?

Method

The study adopted a quantitative research method within the scheme of the causal-comparative research design. It is ex-post facto because the variables of interest have already existed and the researchers only investigated and describe them as they are. The population of this study comprised all pre-service science, technology and mathematics teachers in the Department of Science and Technology Education in the University of Lagos in Southwest of Nigeria. The participants in this study were 300 senior pre-service science, technology and mathematics teachers (160 males and 140 females) purposively selected from the Department of Science and Technology Education in the University of Lagos. Their age ranged from 20 to 32 years with mean age of 22.4 years and SD=2.4 years. The participants could also be categorised as 180 (60%) within the age bracket below 25 years and 120 (40%) within the age bracket 25-32 years. 230 (76.67%) were from science education which consisted of biology education, chemistry education, physics education, and integrated science education cohorts [120 (52.17%) males, 110 (47.83%) females, Mean age = 22.1 years, SD=2.1 years, age range: 20-32 years], 40 (13.33%) were from mathematics education cohort [20 (50%) males, 20 (50%) females,

Mean age = 22.4 years, SD=2.3 years, age range: 20-30 years], and the remaining 30 (10%) were from technology education cohort [20 (66.67%) males, 10 (33.33%) females, Mean age = 23.1 years, SD=2.6 years, age range: 20-32 years].

One instrument, Perception of 21st Century Skills in Education Questionnaire (P21CSEQ) was used to collect data in this study. The P21CSEQ consisted of 44 items anchored on a 5-point Likert scale ranging from: much like me - 5, more like me - 4, not like me- 3, less like me - 2, to least like me – 1. The scores could range between 44 and 220. All items on the P21CSEQ were positively worded statements. The P21CSEQ has five dimensions namely: critical thinking and reasoning in education, information literacy in education, collaboration in education, self-direction in education, and invention in education and was subjected to face validity by two experts in measurement and evaluation for appropriateness for the study and their suggestions were incorporated into the instrument. In a separate study yet to be published, the authors had validated the P21CSEQ with a sample of 1200 pre-service science, technology and mathematics teachers and found that 21st century skills in education is a multi-dimensional construct consisting of critical thinking and reasoning in education, information literacy in education, collaboration in education, self-direction in education, and invention in education using exploratory factor analysis and a high internal consistency reliability coefficient of 0.86 computed using Cronbach alpha for the entire scale. The internal consistency reliabilities for the subscales of 21st century skill in education in the study were: critical thinking and reasoning in education (α = 0.84), information literacy in education (α = 0.86), collaboration in education (α = 0.81), self-direction in education (α = 0.78), and invention in education (α = 0.89). In the present study the P21CSEQ was pilot tested on a sample of 120 pre-service science, technology and mathematics teachers not part of the study sample and internal consistency reliability of the instrument was computed using the Cronbach alpha (α) with value of 0.87. This value pointed to the fact that the instrument was highly reliable and could be used for the study (Awofala & Akinoso, 2017). The researchers together with five research assistants administered the P21CSEQ to the whole sample and in a regularly scheduled class in the University of Lagos for the purpose of this study. Data collected were summarized and analysed using the descriptive statistics of mean and standard deviation and the inferential statistics of analysis of variance (ANOVA), and independent samples t-test at α=0.05 level of significance.

Findings

Research Question One: What is the level of pre-service science, technology and mathematics teachers' perception of 21st century skills in education in Nigeria?

A total score was computed from the 5 point Likert scale, the range being 1 to 5. A score of 3 is the middle point so higher scores indicate a high perception of 21st century skills in education. Of the 300 pre-service STM teachers, 237 (79%) had scores less than 3 (M=2.26, SD=0.28, score range: 2.00-2.95, 95%CI= 2.23–2.30) while 63 (21%) had scores higher than 3 (M=3.58, SD=0.35, score range: 3.11-4.33, 95%CI= 3.49–3.67). A large proportion of these pre-service STM teachers had low perception of 21st century skills in education. In short, the overall M=2.54, SD=0.61, score range: 2.00-4.33, and 95%CI= 2.47–2.61 for the entire sample showed low perception of 21st century skills in education of pre-service STM teachers. Table 1 showed the descriptive statistics of the 44 items of perception of 21st century skills in education. The critical thinking and reasoning in education subscale has nine items with means ranging from 2.00 to 2.91. In short, these pre-service STM teachers exhibited low perception of critical thinking and reasoning in education. The information literacy in education subscale has 10 items with means ranging from 2.01 to 2.82. In general, these pre-service STM teachers exhibited low perception of information literacy in education. The collaboration in education subscale has 10 items with means ranging from 2.10 to 2.95. Thus, these pre-service STM teachers exhibited low perception of collaboration in education. The self-direction in education subscale has eight items with means ranging from 2.00 to 2.91. In short, these pre-service STM teachers showed low perception of self-direction in

education. The invention in education subscale has seven items with means ranging from 2.12 to 2.82. Thus, these pre-service STM teachers displayed low perception of invention in education.

Table 1. Descriptive statistics of pre-service STM teachers' perception of 21st century skills in education questionnaire

Item	Statement	m	sd
Critical thinking and reasoning in education Cronbach alpha *(α) = 0.87*			
1. I have the capacity for logical thought and capable of solving educational problems using analytical skills		2.86	.62
2. I am adept at collecting and analyzing quantitative and qualitative data in educational research		2.90	.76
3. I am skillful in conducting education research utilizing standard and conventional research methods		2.49	.60
4. I can create strong, intelligible, and convincing arguments by research and text proof in education		2.66	.91
5. I can discern between relationship and causality of events in education		2.53	.75
6. I am capable of inferential and inductive thinking in educational research		2.84	.64
7. I can isolate and delineate problems/conflicts and develop ingenious, coherent, sound solutions in education		2.90	.72
8. I am capable of responding analytically, bring forth complex fact-finding interrogations, and personally reflect on educational issues		2.00	.55
9. I can evaluate diverse research methodologies to decide suitable use in education		2.91	.79

Table 1 (continued)
Descriptive statistics of P21CSEQ

Information Literacy in education Cronbach alpha *(α) = 0.92*		M	SD
10. It is easy for me to access informational texts in educational discourse		2.51	.72
11. Adhering to the virtuous usages of information in education as well as proper referencing is easy for me		2.01	.54
12. I can evaluate primary and secondary sources of data in education		2.11	.87
13. I can engage in communication of rigorous thought in education using speech, visuals, and texts		2.12	.88
14. It is easy for me to curate information from numerous resources in education		2.74	.89
15. I can appraise and authenticate the trustworthiness and germaneness of information in education		2.20	.75
16. I can explore divergent thinking and sundry points of view in education		2.26	.53
17. I can incorporate and relate suitable technical knowhow to access and appraise original information in education		2.61	.65
18. I can deduce information analytically to perceive prejudice and/or resolve for a target spectators		2.12	.69
19. I can create/congregate proof from numerous sources to fortify arguments		2.82	.76
Collaboration in education Cronbach alpha *(α) = 0.88*		M	SD
20. I am capable of creating equilibrium between individual educational agenda and the group educational interests		2.70	.95
21. I have prowess in leadership skills and capable to work within a team in education		2.21	.67
22. I am capable of engaging in fruitful deliberation related to educational content using opinion, text evidence, and research		2.10	.54
23. I can nurture a nonviolent milieu for educational discourse between and among my colleagues		2.81	.66

24. I can form elaborate and complex group projects in education	2.86	.74
25. I like providing productive feedback on educational matters to colleagues	2.62	.59
26. I am aware of the worth of teamwork in education for a shared tenacity/aim	2.75	.88
27. I reverence the diversity of individuals, groups, and cultures in education	2.95	.90
28. I like solving problems collectively and interceding in conflict resolution on educational matter	2.75	.59
29. I can work successfully with others in a diversity of groups in education (e.g., one-on-one, small group, large groups)	2.66	.91

Table 1 (continued)
Descriptive statistics of P21CSEQ

Self-Direction in education Cronbach alpha *(α)=0.86*	M	SD
30. I can strike a balance between self-advocacy in education and the consideration of others	2.53	.75
31. I am capable of displaying honest and ethical behaviours in educational discourse	2.84	.64
32. I am good at demonstrating persistence/perseverance in educational discourse	2.90	.52
33. I normally participate in self-detection and life planning via assessment of career options in education	2.00	.49
34. I can show possession of own learning in various ways (e.g., create questions, plan investigations, demonstrate superiority in work, look back on choices, appraise results, adjust/review to nurture growth) in education	2.91	.53
35. I am self-efficacious in completing accustomed and unaware tasks in education	2.51	.72
36. I am capable of initiating learning and follow through autonomously	2.01	.54
37. I can engage in effective time management and strategize, place in order, and appraise improvement toward own goals	2.11	.67
Invention in education Cronbach alpha (*α)=0.78*	M	SD
38. I can produce novel works within and across educational disciplines	2.12	.48
39. I can critique, re-purpose, incorporate and synthesize ideas or practices in education	2.74	.79
40. I am capable of demonstrating an ingenuousness to "thinking outside the box" to solving educational problems	2.20	.75
41. I can engage in creative and innovative practices in education	2.26	.93
42. I can create, enact, and appraise novel ideas and new approaches in education	2.61	.65
43. I can re-design, re-state, and refabricate prevailing projects, practices, and beliefs in education	2.12	.79
44. Taking risks and learning from successes and failures in education come naturally to me	2.82	.76

Research Question Two: Is there any significant relation of gender to pre-service science, technology and mathematics teachers' perception of 21st century skills in education?

Table 2 below showed the descriptive statistics of mean and standard deviation and t-test values on perception of 21st century skills in education score and its dimensions by male and female pre-service STM teachers. With respect to the aggregate 21st century skills in education score, the female students recorded slightly lower mean score ($\bar{X}$ *=2.52*, *S.D =0.60*) than their male counterparts ($\bar{X}$ *=2.56*, *S.D =0.62*). However, this slight difference in mean score was statistically not significant (t_{298} *= .58*, *p=.56*). Table 2 below showed that the female students recorded slightly lower mean score ($\bar{X}$ =2.*55*, *S.D =0.64*) in critical thinking and reasoning in education than their male counterparts ($\bar{X}$ *=2.59*, *S.D =0.65*) and this difference was statistically not significant (t_{298} *= .53*, *p=.60*).

Table 2. Independent samples t-test analysis of pre-service STM teachers' perception of 21st century skills in education based on gender

	Gender	n	Mean	sd	df	*t*	p
CTRE	Male	160	2.59	0.65			
	Female	140	2.55	0.64	298	.53	.60
ILE	Male	160	2.60	0.61			
	Female	140	2.56	0.58	298	.64	.52
CIE	Male	160	2.56	0.62			
	Female	140	2.53	0.61	298	.45	.65
SDE	Male	160	2.56	0.62			
	Female	140	2.51	0.60	298	.64	.52
IIE	Male	160	2.59	0.61			
	Female	140	2.56	0.59	298	.40	.69
21st century skills	Male	160	2.56	0.62			
	Female	140	2.52	0.60	298	.58	.56

NB: CTRE=critical thinking and reasoning in education; ILE=information literacy in education; CIE=collaboration in education; SDE=self-direction in education; IIE=invention in education.

In Table 2, the female students recorded slightly lower mean score ($\bar{x}$ =2.56, *S.D =0.58*) in information literacy in education than their male counterparts ($\bar{x}$ =2.60, *S.D =0.61*). The difference was statistically not significant (t_{298} = *.64, p=.52*). With respect to collaboration in education, the female students recorded slightly lower mean score ($\bar{x}$ =2.53, *S.D =0.61*) than their male counterparts ($\bar{x}$ =2.56, *S.D =0.62*). However, this difference in mean score was statistically not significant (t_{298} = *0.45, p=.65*). Table 2 revealed that female students recorded slightly lower mean score ($\bar{x}$ =2.51, *S.D =0.60*) in self-direction in education than their male counterparts ($\bar{x}$ =2.56, *S.D =0.62*). This difference in mean score was not statistically significant (t_{298} = *.64, p=.52*). With respect to invention in education, the female students recorded slightly lower mean score ($\bar{x}$ =2.56, *S.D =0.59*) than their male counterparts ($\bar{x}$ =2.59, *S.D =0.61*). However, this difference in mean score was statistically not significant (t_{298} = *.40, p=.69*). In actual fact, we concluded that gender was not a significant factor in pre-service STM teachers' perception of 21st century skills in education even at the 21st century skills in education subscale levels. Thus, it can be assumed that gender had no significant relation to the pre-service STM teachers' perception of 21st century skills in education.

Research Question Three: Is there any significant relation of academic discipline to pre-service science, technology and mathematics teachers' perception of 21st century skills in education?

Table 3. Means, standard deviations, and F-test value on 21st century skills in education and its dimensions score of pre-service STM teachers based on academic discipline

Variable	Discipline	n	Mean	sd	Min	Max	df	f	p
CTRE	Science	230	2.57	0.64	2.00	4.33		0.09	0.92
	Technology	30	2.56	0.64	2.00	3.89	[2, 299]		
	Mathematics	40	2.61	0.69	2.00	4.00			
	Total	300	2.57	0.64	2.00	4.33			
ILE	Science	230	2.54	0.63	1.58	4.22		0.71	0.49
	Technology	30	2.53	0.57	2.10	4.00	[2, 299]		
	Mathematics	40	2.68	0.20	2.20	4.50			
	Total	300	2.58	0.60	1.58	4.50			
CIE	Science	230	2.55	0.62	2.10	4.60		1.37	0.26
	Technology	30	2.57	0.58	2.10	4.10	[2, 299]		
	Mathematics	40	2.40	0.45	2.00	4.30			

	Total	300	2.54	0.62	2.00	4.60			
SDE	Science	230	2.52	0.67	1.62	4.00		2.51	0.08
	Technology	30	2.57	0.58	1.62	4.00	[2, 299]		
	Mathematics	40	2.34	0.38	1.62	4.00			
	Total	300	2.54	0.61	1.62	4.00			
IIE	Science	230	2.57	0.64	1.43	4.00		0.24	0.79
	Technology	30	2.57	0.58	1.43	4.00	[2, 299]		
	Mathematics	40	2.64	0.24	1.43	4.00			
	Total	300	2.58	0.60	1.43	4.00			
21st Century	Science	230	2.55	0.63	1.36	4.43		2.21	0.11
	Technology	30	2.55	0.58	1.36	4.43	[2, 299]		
	Mathematics	40	2.35	0.38	1.39	4.00			
	Total	300	2.54	0.61	1.36	4.43			

Table 3 above showed the means, standard deviations, and F-test value on perception of 21st century skills in education and its dimensions score of pre-service STM teachers based on academic discipline. With respect to the academic discipline of pre-service teachers, there was an increase in the critical thinking and reasoning in education dimension of 21st century skills from technology to the mathematics cohort. The technology cohort recorded the lowest mean score with the least standard deviation ($\bar{X}$ *=2.56*, *S.D =0.64*) followed by the science cohort ($\bar{X}$ *=2.57*, *S.D =0.64*), and this was followed by the mathematics cohort ($\bar{X}$ *=2.61*, *S.D =0.69*). It should be noted that the mathematics cohort recorded the highest standard deviation. However, these differences in critical thinking and reasoning in education scores of the pre-service teachers were statistically not significant (*F[2 299] = 0.09, p = 0.92*). Thus, we concluded that there was no significant relation of academic discipline to pre-service teachers' perception of critical thinking and reasoning in education dimension of 21st century skills.

Table 3 showed there was an increase in the information literacy in education dimension of 21st century skills from technology to the mathematics cohort. The technology cohort recorded the lowest mean score with the second to the highest standard deviation ($\bar{X}$ *=2.53*, *S.D =0.57*) followed by the science cohort ($\bar{X}$ *=2.54*, *S.D =0.63*), and this was followed by the mathematics cohort ($\bar{X}$ *=2.68*, *S.D =0.20*). It should be noted that the mathematics cohort recorded the lowest standard deviation. However, these differences in perception of information literacy in education mean scores of the pre-service teachers were statistically not significant (*F[2, 299] = 0.71, p = 0.49*). Thus, we concluded that there was no significant relation of academic discipline to pre-service teachers' perception of information literacy in education dimension of 21st century skills. Table 3 showed there was an increase in the collaboration in education dimension of 21st century skills from the mathematics cohort to the technology cohort. The mathematics cohort recorded the lowest mean score with the least standard deviation ($\bar{X}$ *=2.40*, *S.D =0.45*) followed by the science ($\bar{X}$ *=2.55*, *S.D =0.62*), and then the technology cohort ($\bar{X}$ =2*.57*, *S.D =0.58*). The science cohort had the highest standard deviation. However, these differences in collaboration in education scores of the pre-service teachers were statistically not significant (*F[2, 299] = 1.37, p = 0.26*). Thus, we concluded that there was no significant relation of academic discipline to pre-service teachers' perception of collaboration in education dimension of 21st century skills.

Table 3 showed there was an increase in the self-direction in education dimension of 21st century skills from the mathematics cohort to the technology cohort. The mathematics cohort recorded the lowest mean score with the least standard deviation ($\bar{X}$ *=2.34*, *S.D =0.38*) followed by the science cohort ($\bar{X}$ *=2.52*, *S.D =0.67*), and this was followed by the technology cohort ($\bar{X}$ =2*.57*, *S.D =0.58*). The technology cohort had the highest standard deviation. However, these differences in the self-direction in education mean scores of the pre-service teachers were statistically not significant (*F[2, 299] = 2.51, p = 0.08*). Thus, we concluded that there was no significant relation of academic discipline to pre-service teachers' self-direction in education dimension of 21st

century skills. Table 3 showed there was a similarity in the invention in education dimension of 21st century skills between science and technology cohorts. The mathematics cohort recorded the highest mean score with the lowest standard deviation ($\bar{X}$ =2.64, S.D =0.24). The technology cohort ($\bar{X}$ =2.57, S.D =0.58) and the science cohort ($\bar{X}$ =2.57, S.D =0.64) showed similar mean scores with different largest standard deviations. However, these differences in perception of invention in education mean scores of the pre-service teachers were statistically not significant ($F[2, 299] = 0.24$, $p = 0.79$). Thus, we concluded that there was no significant relation of academic discipline to pre-service teachers' perception of invention in education dimension of 21st century skills. Table 3 showed there was an increase in the 21st century skills from the mathematics cohort to the science and technology cohorts. The science ($\bar{X}$ =2.55, S.D =0.63) and technology ($\bar{X}$ =2.55, S.D =0.58) cohorts recorded similar mean scores but different standard deviations. The mathematics cohort recorded the lowest mean score with the least standard deviation ($\bar{X}$ =2.35, S.D =0.38). However, these differences in perception of 21st century skills mean scores of the pre-service teachers were statistically not significant ($F[2, 299] = 2.21$, $p = 0.11$). Thus, we concluded that there was no significant relation of academic discipline to pre-service teachers' perception of 21st century skills. However, the it is emphasised that there is no significant relation of academic discipline to pre-service STM teachers' perception of 21st century skills. This implies that academic discipline had no substantial relation to pre-service STM teachers' perception of 21st century skills in education even at the subscale levels.

Discussion and Conclusion

The study investigated a survey of pre-service STM teachers' perception of the 21st century skills in education in the University of Lagos, Nigeria. Stemming from the outcomes of this study is that senior pre-service STM teachers had low perception of the 21st century skills in education. This low perception may be as a result of pre-service STM teachers' low perception of critical thinking and reasoning in education, low perception of information literacy in education, low perception of collaboration in education, low perception of self-direction in education, and low perception of invention in education. In the present study, the low perception of 21st century skills in education by the pre-service STM teachers may be partly ascribed to the non-integration of the 21st century skills in education into the curricula of pre-service STM teachers in Nigeria and partly to the non- teaching of these skills as stand-alone subjects in teacher education programmes in Nigeria. The pre-service STM teachers only hear about these skills but do not have experience in teaching in the 21st century skills in education. This low perception of 21st century skills in education may spell doom for pre-service STM teachers in their movement from training to work in this present ICT driven digitally connected age. It is high time the stakeholders in the education sector promoted the teaching and learning of 21st century skills in education in teacher education programmes in Nigeria to bridge the gaps that exist between training and work for graduate STM teachers.

Pre-service STM teachers in this study showed low capacity for logical thought and were incapable of solving educational problems using analytical skills; low adept at collecting and analyzing quantitative and qualitative data in educational research; low skill in conducting education research utilizing standard and conventional research methods; low capacity for creating strong, intelligible, and convincing arguments by research and text proof in education; could not discern between relationship and causality of events in education; were incapable of inferential and inductive thinking in educational research; could not isolate and delineate problems/conflicts and develop ingenious, coherent, sound solutions in education; were incapable of responding analytically, bringing forth complex fact-finding interrogations, and personally reflecting on educational issues; and could not evaluate diverse research methodologies to decide suitable use in education.

In addition, this study showed that pre-service STM teachers were incapable of accessing informational texts in educational discourse; could not evaluate primary and secondary sources of data in education; could not engage in communication of rigorous thought in education using speech, visuals, and texts; could not

appraise and authenticate the trustworthiness and germaneness of information in education; could not explore divergent thinking and sundry points of view in education; could not incorporate and relate suitable technical knowhow to access and appraise original information in education; could not deduce information analytically to perceive prejudice and/or resolve for a target spectators; and could not create/congregate proof from numerous sources to fortify arguments.

Moreover, in this study pre-service STM teachers were incapable of creating equilibrium between individual educational agenda and the group educational interests; have low prowess in leadership skills and incapable to work within a team in education; were incapable of engaging in fruitful deliberation related to educational content using opinion, text evidence, and research; could not nurture a nonviolent milieu for educational discourse between and among colleagues; could not form elaborate and complex group projects in education; lack ability to provide productive feedback on educational matters to colleagues; were unaware of the worth of teamwork in education for a shared tenacity/aim; could not reverence the diversity of individuals, groups, and cultures in education; lack ability to solve problems collectively and intercede in conflict resolution on educational matter; and showed low capacity to work successfully with others in a diversity of groups in education (e.g., one-on-one, small group, large groups). In addition, pre-service STM teachers were incapable of striking a balance between self-advocacy in education and the consideration of others; were incapable of displaying honest and ethical behaviours in educational discourse; were not good at demonstrating persistence/perseverance in educational discourse; could not participate in self-detection and life planning via assessment of career options in education; lacked possession of own learning in various ways (e.g., create questions, plan investigations, demonstrate superiority in work, look back on choices, appraise results, adjust/review to nurture growth) in education; were less self-efficacious in completing accustomed and unaware tasks in education; lacked the capability of initiating learning and following through autonomously; and could not engage in effective time management and strategize, place in order, and appraise improvement toward own goals.

In addition, pre-service STM teachers could not produce novel works within and across educational disciplines; could not critique, re-purpose, incorporate and synthesize ideas or practices in education; incapable of demonstrating an ingenuousness to "thinking outside the box" to solving educational problems; could not engage in creative and innovative practices in education; could not create, enact, and appraise novel ideas and new approaches in education; and could not re-design, re-state, and refabricate prevailing projects, practices, and beliefs in education. This study indicated that gender had no significant relation to pre-service STM teachers' perception of 21st century skills in education. Thus, both male and female pre-service STM teachers displayed comparable practices and showed similar challenges and experiences in 21st century skills in education. This result revealed that male and female pre-service STM teachers do not show disparity in 21st century skills in education. However, gender did not seem to enhance or reduce pre-service STM teachers' 21st century skills in education. Specifically in this study, gender parity existed in critical thinking and reasoning in education, information literacy in education, collaboration in education, self-direction in education, and invention in education. This result did not corroborate the finding of Taylor and Dalal (2017) that showed gender differences in information literacy skills. While female participants seemed more sensitive than males in assessing information, males showed stronger confidence in the trustworthiness and precision of the information turned out by search engines (Taylor & Dalal, 2017). This result ran contrary to the view that women faculty members showed higher order thinking skills, active and collaborative learning, and diversity experiences more than males (National Survey of Student Engagement, 2005) but affirmed the position that critical thinking is not gender sensitive (Bagheri & Ghanizadeh, 2016). The non-sensitivity of critical thinking to gender is buttressed by the fact that today's women portray themselves as good critical thinkers as men in combating daily challenges, and to use critical thinking abilities in spite of their gender. Thus, females seem to be learning how to think critically to profit from taking charge of their own lives and not be at the mercy of

the men. To sum it all, it means females' education proponents who often point to gendered barriers may not be important so as to create wave for gender perspectives in 21st century skills in education and prioritize growing females' life skills.

It is pertinent to consider that if socio-emotional skills seem more treasured as the skills for the future partly because they are tougher to automate and partly because they will gradually regulate youth job-readiness, men may be shortchanged for the reason that they may be instructed that socio-emotional skills are feminine or are prevented from growing and cultivating these skills based on the fact that they are regarded as not being masculine. In essence, the result of this study on gender did not support the age long stereotypes in education that females are deficient in science, technology and mathematics ability because science, technology and mathematics are for men (Awofala, 2017; Awofala & Anyikwa, 2014; Awofala, 2011; Ogunleye, Awofala & Adekoya, 2014), men are the leaders and the heads of the home while women are mere supportive members (Awofala, 2011; Awofala, 2008) and women should take care of the house chores and be responsible for the young siblings while men are final decisions makers and movers in the home (Arigbabu & Mji, 2004; Awofala, 2011).

The results of this study clearly showed that senior pre-service STM teachers' perceptions of 21st century skills in education were not academic discipline specific. This finding indicated that no mutual supportive difference existed between the pre-service teachers' perception of the 21st century skills in education and the varying academic disciplines of the pre-service teachers who willingly took part in the study. Thus, one outcome to be derived from this finding is that being science education or technology education or mathematics education inclined did not show any difference in pre-service teachers' perception of 21st century skills in education. So, the relation of academic discipline (science, technology, and mathematics) to pre-service teachers' perception of 21st century skills in education may not be so important. One limitation of this study is that the study did not investigate the factor analytic structure of the 21st century skills in education questionnaire. Determining only the Cronbach alpha coefficient may not provide enough sound psychometric properties of the questionnaire and this could be a good source of research needing further investigation. Based on the findings of this study, it was thus recommended that pre-service STM teachers should be more able to exhibit dexterity in collaboration and communication in network location, adept at growing future students' mindset in critical, creative and innovative thinking, and inspire future students to embrace invention and high self-direction in education. All these skills will be caught by the pre-service STM teachers only if the teacher education programmes in Nigeria integrate 21st century skills in education into their curricula and also if possible create stand-alone curricula for the 21st century skills in education to run concurrently with the disciplinary courses at the tertiary education level. This will help to ginger teaching effectiveness (Awofala, 2012) and makes learning of 21st century skills practical for the pre-service STM teachers in Nigeria.

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