Basic Science and Technology Pre-Service Teachers' Knowledge and Gender in Integration of Industry 5.0 in Akwa Ibom State

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Abstract
The study investigated Basic Science and Technology pre-service teachers' knowledge and gender in integration of industry 5.0. Two research questions and two hypotheses were formulated to guide the study. The area of the study was Akwa Ibom State. This study adopted survey research design. The population for this study comprises all pre-service teachers specializing in integrated science from three selected higher institutions in Akwa Ibom State. The study employed a purposive sampling technique to select three higher institutions in Akwa Ibom State that offer integrated science as a course of study. The sample for this study consisted of 85 integrated science pre-service teachers of intact classes from the selected institutions. The instrument for the study was "Questionnaire on Teacher Trainees' Knowledge of Industry 5.0 (QTTKI). The instrument was validated by three lecturers in the Department of Science Education, Faculty of Education. The reliability index obtained for QTTKI was 0.87using Cronbach Alpha. The data collected were analyzed using mean, standard deviation and independent t-test. The results showed that there is no significant difference in the level of knowledge of basic science and technology pre-service teachers towards the integration of industry 5.0. The result showed that gender did not significantly influence Basic Science and Technology pre-service teachers' knowledge towards the integration of industry 5.0. Based on the findings of the study, it was concluded that pre-service teachers' knowledge of Industry 5.0 integration showed no significant variation. It was therefore recommended among others that, Educational policymakers should develop policies that support the adoption of Industry 5.0 in teacher training and provide funding for technological infrastructure in teacher education programs.

Keywords: Basic Science, Pre-service, Teachers, Knowledge, Integration, Industry 5.0, Gender

Introduction

Integration of emerging digital technology in academic learning is becoming prevalent in educational institutions. The fast-changing digital technology is highly influencing education by enhancing effective learning and providing students unprecedented immediate access to up-to-date course content (Abuzir, 2015; Babayemi, Itighise & Raimi, 2022). The advancement of digital technology and the increasing digitalization of the world have heightened the tendency to adopt such technologies for learning in academic institutions. Today, without incorporating digital technology, no educational institution can expect to excel in their students' learning experience (Babayemi & Utibe, 2017; Ferdousi, 2019; Akpan, 2024). Research shows that the advent of digital technology in educational institutions has improved the learning process because students learning skills can be improved using digital technology (Wong & Fong, 2014; Babayemi, Udofia, Abasi, Itighise & Ntegwung, 2023). As a result, increasing numbers of higher education institutions are integrating innovative digital technologies such as learning management systems, digital apps, web 2.0, Gmail or yahoo mail, online data storage solutions such as drop box Google Apps, zoom apps, the internet, social media, and other digital media as instructional tools to enhance implementation of learning objectives (Udofia, Babayemi & Sambo (2024); Itighise & Babayemi, 2023; Atabang & Babayemi, 2024; Udofia & Sambo, 2022). In fact, to remain competitive, education institutions are emphasizing on greater use of digital technology for effective teaching and learning. Hence, the needs for students' development in using digital resources as a means to bridge the knowledge gab in learning (Udofia, Akpan & Sambo, 2025).

Teaching is the process of transmitting knowledge which involves the teacher and learner. It is the process of attending to people's needs, experiences and feelings, and making specific interventions to help them learn a particular thing (Stella, Ihechukwu, & Eucharia-Ndidi, 2017). Teacher preparation and development acts as a major role in the way of growing up quality of education (Halimah, 2019; Babayemi, Udofia, Abasi, Itighise & Ntegwung, 2023). For education to truly respond to the needs of 21st century, teachers play a central role in leveraging technology, in particular, using information communication and technology (ICT) resources in teaching and learning (Akram, Abdelrady, Al-Adwan & Ramzan, 2022). Though ICT seems to be an important tool to support new ways of teaching and learning (Hong & Keng, 2017), 'successful integration of ICT in teaching-learning process is highly dependent on the preparation of teachers' (Singh & Chan, 2014). In this regard, teacher education program is significant and plays a great role in training pre-service teachers to integrate ICT into teaching through acquiring the skills and knowledge essential for ICT use and applying them in their pre-service education period and in their professional life (Aslan & Zhu,2018). The use of new technological devices such as Computer Assisted Instruction (CAI), Computer Based Instruction (CBI), Computer Based Learning (CBL) for curriculum delivery have been found to be very effective in science, technology and mathematics curriculum delivery and also useful to learners in solving of learning tasks in education (Ado, Abasi & Nwankwo, 2017). Akapn et al., 2025; Aslan and Zhu (2014) found that pre-service teachers' pedagogical knowledge, their gains from ICT related courses in their teaching program and their perceived ICT competence significantly predict their ICT integration into teaching practice. Thus, this study aims to explore basic science and technology pre-service teachers' knowledge, perception and competence in integration of industry 5.0.

Industry 5.0, also known as the Fifth Industrial Revolution, is a new and emerging phase of industrialization that sees humans working alongside advanced technology and artificial intelligence (AI) powered robots to enhance workplace processes. This is coupled with a more human-centric focus as well as increased resilience and an improved focus on sustainability. Encompassing more than just manufacturing, this new phase builds upon the fourth industrial revolution (Industry 4.0) and is enabled by developments in Information Technology that include facets such as artificial intelligence, automation, big data analytics, the Internet of Things (IoT), machine learning, robotics, smart systems, and virtualization (Thenmozhi & Mathi, 2023).

Industry 5.0 refers to robot and smart machines working alongside people with added resilience and sustainability goals included. Where Industry 4.0 focused on technologies such as the Internet of Things and big data, Industry 5.0 seeks to add human, environmental and social aspects back into the equation. In this regard, Industry 5.0 can be seen as complementing the advances made in Industry 4.0 to support rather than supersede humans. This allows humans to intervene where required and moves away from excessive automation to incorporate critical thinking and adaptability, while still taking advantage of the precision and repeatability of machines (Thenmozhi & Mathi, 2023). Another variable considered in this study is gender.

According to Akpan et al., (2025); Akpan and Akpan (2017), globally, promoting gender equality in science is currently used as a developmental strategy for socioeconomic development of any nation. Gender differences in learning science related subjects generated due to some genetic difference between females and males, and socio-cultural forces contributed to sex differences in Basic Science and Technology achievement and ability which include: the effects of family; neighborhood; peer; school influences; training and experience;

and cultural practices. Gender is defined as the personality traits, attitudes, behaviors, values, relative power, influence, role and expectations that society ascribe to the two sexes (male and female) on a differential basis (Zell, Krizan & Teeter, 2015). Gender usage is also altered when it comes to the virtual learning multitasking phenomenon.

Research showed that females tend to use multiple virtual learning and social media platforms at the same time while doing other things. Also, Ularo (2014) found that females are better at multitasking than males. Akpan (2022); Mowafy (2018) reported that mothers spend 10 more hours a week multitasking compared with fathers. Several researchers have investigated on gender differences in virtual platforms usage (Olagunju & Babayemi, 2014; Ularo, 2014; Mowafy, 2018). For instance, one of the conducted studies to analyze this phenomenon showed that females listen to less music on social media sharing platforms than males (Putzke, Fischbach, Schoder & Gloor, 2014). The knowledge of basic science and technology pre-service teachers on how they perceived and their competence in integrating technology into teaching of the subject has remained inconclusive as researchers share differing views (Akpan et al., 2023). While the study of Yebowaah (2018), Akpan (2024) and Babayemi (2014)found that male students achieved significantly better than female students in science subjects whereas in another study by Akpan et al., (2025); Babayemi and Ahmed (2019), the researchers reported no significant two-way interaction effect of treatment and gender on achievement. There is need therefore to investigate the moderating influence of gender on basic science and technology pre-service teachers' knowledge, perception and competence in integration of industry 5.0.

Statement of the Problem

Most developing countries are unable to take advantage of this innovation in higher education for teaching purposes. However, the advent of new affordable technologies such as smartphones, and the ease of access to online technologies such as the internet, makes it easier for developing countries to take advantage of such technologies and integrate them into their higher education systems. In developing countries, research has shown that university students and lecturers are heavy users of, and are highly dependent on, different types of technology such as smart phones and smart phones apps like Gmail or yahoo mail, online data storage solutions such as drop box Google Apps, zoom apps, and the internet. However, their use of such technologies is commonly for personal and social purposes and not for teaching and learning process. This could be because of pre-service teachers' lack of knowledge in using this technology appropriately in teaching. To tackle these problems, there is need to investigate Basic Science and Technology pre-service teachers' knowledge and in integration of industry 5.0.

Research Questions

The study sought to provide answers to the following research questions

1. What is the level of knowledge of Basic Science and Technology pre-service teachers towards the integration of industry 5.0?
2. What is the difference in Basic Science and Technology pre-service teachers' knowledge of integration of industry 5.0 based on gender?

Hypotheses

Three research hypotheses were formulated to efficiently guide the study.

1. The level of knowledge of Basic Science and Technology pre-service teachers towards the integration of industry 5.0 is not significantly high.
2. There is no significant difference between the mean ratings of male and female Basic Science and Technology pre-service teachers' knowledge of integration of industry 5.0.

Methods

This study adopted a descriptive survey research design. A descriptive survey is appropriate for this study as it enables the researcher to systematically collect, analyzes, and interprets data from a representative sample of pre-service teachers. The area of the study was Akwa Ibom State. The population for this study comprises all pre-service teachers specializing in Integrated Science from three selected higher institutions in Akwa Ibom State. These institutions were chosen based on their commitment to teacher education and their role in preparing future educators in the field of science and technology. The pre-service teachers in these institution also represent a critical demographic, as they are expected to develop the knowledge, perception, and competence required for the integration of Industry 5.0 technologies into classroom instruction upon graduation. The study employed a purposive sampling technique to select three higher institutions in Akwa Ibom State that offer Integrated Science as a course of study. These institutions are chosen deliberately because they are the only higher institutions in the state that provide training for pre-service teachers in Integrated Science. The sample for this study consisted of the intact classes of pre-service Integrated Science teachers from the selected institutions of 85 students. The choice of final-year students is strategic, as they are at the advanced stage of their teacher training and are expected to have acquired the necessary knowledge, skills, and competencies related to science education and emerging instructional technologies.

The instrument used for data collection was questionnaire tagged "Questionnaire on Teacher Trainees' Knowledge of Industry 5.0 (QTTKI)". The instrument was in two parts (A and B). Part A contains demographic information like gender while part B contains 20 items for QTTKI placed on a four-point Likert type rating scale of EK = Extensive Knowledge, MK = Moderate Knowledge, SK = Some Knowledge LK = Little Knowledge to each item raised respectively. After developing the instrument QTTKI by the researcher, the contents and face validity were done by three lecturers in the Department of Science Education, Akwa Ibom State University to determine the appropriateness of the items set. The questionnaires consisted of knowledge in integration of industry 5.0 variables. The corrections made by the validators were considered and incorporated into the final copy of the instruments. The reliability of the QTTKI was established by administering the instrument to thirty students from the Department of Computer Science, Akwa Ibom State University, who were not part of the main study sample. The data obtained were analyzed using the Cronbach's Alpha reliability method, yielding reliability index of 0.87.

The researcher collected the Departmental timetable to know when final year Integrated Science teacher trainees would be having lectures. The instruments were administered to the pre-service teachers before starting lecture. On completion, the instruments were collected for analysis. Mean and standard deviation were used to answer the two (2) research questions used in this study while and independent t-test were used to test the two null hypotheses of this study at 0.05 level of significance.

Results

Answering the Research Questions

Research question one: What is the level of knowledge of basic science and technology pre-service teachers towards the integration of industry 5.0?

Table 1: Descriptive analysis of Mean and Standard Deviation of Basic Science and Technology pre-service teachers' knowledge towards the integration of industry 5.0

Level of Knowledge	N	Mean	SD
High	32	71.34	10.09
Moderate	30	72.33	10.25
Low	23	67.22	19.40

The result in Table 1 showed that the mean responses of 71.34, 72.33 and 67.22 for high, moderate and low respectively levels of knowledge of basic science and technology teachers towards the integration of industry 5.0 were obtained. The results depicts that basic science and technology teachers have moderate knowledge towards the integration of industry 5.0 since the mean scores 72.33 of responses associated to moderate knowledge is greater than the mean scores 71.34 and 67.22 of responses associated to other levels of high and low knowledge.

Research question two: What is the influence of gender on basic science and technology pre-service teachers' knowledge towards the integration of industry 5.0?

Table 2: Descriptive analysis of Mean and Standard Deviation on the influence of gender on basic science and technology pre-service teachers' knowledge of integration of industry 5.0

Variables	Gender	N	Mean	SD
Knowledge	Male	40	70.08	14.37
	Female	45	71.02	12.42

The result as shown in Table 2 revealed that the mean scores 70.08 and 71.02 for male and female basic science and technology pre-service teachers' responses of their knowledge towards the integration of industry 5.0 were obtained. Since the mean score 71.02 of female basic science and technology pre-service teachers' responses is slightly greater than that of their male counterpart, it therefore implies that there is an influence of gender on basic science and technology pre-service teachers' knowledge towards the integration of industry 5.0. Hence, female basic science and technology pre-service teachers tend to have more knowledge towards the integration of industry 5.0.

Testing the Hypotheses

Hypothesis one: There is no significant difference in the level of knowledge of basic science and technology pre-service teachers towards the integration of industry 5.0.

Table 3: Summary of ANOVA analysis on the significance of the level of knowledge of basic science and technology pre-service teachers towards the integration of industry 5.0

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	370.954	2	185.477	1.050	.355
Within Groups	14487.798	82	176.680		
Total	14858.753	84			

Not significant @ 0.05 level of significance

The result in Table 3 showed that there is no significant difference in the level of knowledge of basic science and technology pre-service teachers towards the integration of industry 5.0. ($F = 1.050$; $df = 2, 82$ @ $p > 0.05$), thus the null hypothesis was upheld. This is because the associated probability (p) value of .355 is greater than 0.05 level of significance. Hence, the conclusion drawn is that basic science and technology pre-service teachers do not significantly differ in their level of knowledge towards the integration of industry 5.0.

Hypothesis two: There is no significant influence of gender on Basic Science and Technology pre-service teachers' knowledge towards the integration of industry 5.0.

Table 4: Summary of independent t-test analysis on the influence of gender on Basic Science and Technology pre-service teachers' knowledge towards the integration of industry 5.0

Variables	Gender	N	Mean	SD	df	t-value	Sig.
	Male	40	70.08	14.37			
Knowledge					83	-0.33	.745
	Female	45	71.02	12.42			

Not Significant @ 0.05 level of significance

Results shown in Table 4 revealed that gender do not significantly influence Basic Science and Technology pre-service teachers' knowledge towards the integration of industry 5.0. ($t = -0.68$; $df = 83$ @ $p > 0.05$), thus the null hypothesis was upheld. This is because the associated probability (p) value of .745 is greater than 0.05 level of significance. Hence, the conclusion drawn is that gender is not a significant factor that influences Basic Science and Technology pre-service teachers' knowledge towards the integration of industry 5.0.

Discussion of Findings

Hypothesis one sought to ascertain whether there is a significant difference in the level of knowledge of basic science and technology pre-service teachers towards the integration of industry 5.0. The results of testing this hypothesis as shown in table 3 revealed that there is no significant difference in the level of knowledge of basic science and technology pre-service teachers towards the integration of industry 5.0. Hence, based on the responses obtained, it could be concluded that basic science and technology pre-service teachers' knowledge towards the integrated of industry 5.0 is not limited in as much as it is not also high. The emergence of digital technologies in meeting the needs of the society is gaining popularity across the world including Nigeria and of course Akwa Ibom State, though there seems to be some constraints in the applicability of these trending technologies in teaching/learning context hence the limited knowledge observed in the result of this study. The above findings agrees with previous findings from Okebiorun, Oyekan and Zacchaeus (2021) and

Kisalama and Kafyulilo (2012) whose studies revealed amongst others that professional educators do not have enough access to modern technologies that can produce society 5.0 graduates. Also, limited access to ICTs, limited lecturers' knowledge of ICTs and limited use of the available ICTs affected usage of the technologies.

Hypothesis two sought to ascertain whether there is a significant influence of gender on basic science and technology pre-service teachers' knowledge, perception and competence towards the integration of industry 5.0. The results of testing this hypothesis as shown in table 4 revealed that there is no significant influence of gender on basic science and technology pre-service teachers' knowledge towards the integration of industry 5.0. Hence, based on the responses obtained, it could be concluded that gender has no influence on basic science and technology pre-service teachers' knowledge towards the integrated of industry 5.0. The emergence of digital technologies in our today's world is not gender bias as it provides equal opportunities for both genders to meet the needs of their diverse demands at ease. The above findings agrees with previous findings from Akpan et al (2025); Mwei (2020) whose findings revealed that subject specialization, gender and teaching experience had marginal or no significant influence on teachers' perception of factors affecting the integration of Information and Communication Technology for instructional purposes.

Conclusion

This study investigated Basic Science and Technology pre-service teachers' knowledge in integration of industry 5.0. The findings showed that: there is no significant difference in the level of knowledge of basic science and technology pre-service teachers towards the integration of industry 5.0 and gender did not significantly influence Basic Science and Technology pre-service teachers' knowledge towards the integration of industry 5.0. Hence, the study found that pre-service teachers' knowledge of Industry 5.0 integration showed no significant variation regarding Industry 5.0 integration.

Recommendations

In view of the above findings, the researcher made the following recommendations:

1. Higher education institutions should incorporate Industry 5.0 technologies such as AI, robotics, automation, and smart technology into the teacher education curriculum to ensure pre-service teachers acquire relevant skills.
2. Organizing seminars, professional development programs, and certification courses in Industry 5.0 for pre-service teachers will help build their confidence and readiness to integrate emerging technologies into their teaching practices.

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