

TECHNICAL AND SOFT SKILLS NEEDED BY COMPUTER SCIENCE STUDENTS FOR VIRTUAL AND REMOTE LABORATORIES FOR INDUSTRIAL WORK EXPERIENCE SCHEME IN THE HIGER INSTITUTION.

¹Nwanmadu, Chukwuebuka Eleazer. (ORCID: <https://orcid.org/0000-0001-8848-0114>), ²Ugwuanyi, Sunday C. ³Kanu, Mavis Obianuju; ⁴Ugwuoke, Offorbuike Rowland, ⁵Maduahaonwu, Ukamaka T. & ⁶Ezeaku, Nonyelum Agatha

^{1, 2, 5} Department of Computer Science, Faculty of Natural and Applied Sciences, SUMAS, Igbo-Eno.

³Department of Science Education, Faculty of Education, Nnamdi Azikiwe University, Awka

⁴Department of Computer Science Education, Faculty of Education, Madonna University, Okija

⁶Department of Cyber-Security, School of Physics, Engineering and Computer Science, University of Hertfordshire, UK.

¹chukwuebuka.nwanmadu@sumas.edu.ng; ²sunday.ugwuanyi@sumas.edu.ng ³m.kanu-esimone@unizik.edu.ng ⁴rolandugwoke@gmail.com , ⁵ukamaka.maduahaonwu@sumas.edu.ng; & ⁶ne24aba@herts.ac.uk

ABSTRACT

The study aims at determining the technical and soft skills needed by computer science students for virtual and remote laboratories for Students Industrial Work Experience Scheme. Two research questions were adopted for the study. The research questions were used to design the questionnaire for collection of data from the respondents. The questionnaire contains 15 item statements. The Instrument was face validated by 3 experts. Two (2) of the experts are lecturers in computer science department(s) while the remaining expert is an industrial training staff. Cronbach alpha was used in testing the reliability and validity of the Instrument. Average reliability value of 0.85 was obtained. Sampling technique adopted for the study was total sampling technique. findings of the study revealed that programming aids using sharable devices, coding using virtual lab, debugging of codes in virtual lab, analyzing of data in virtual lab, exploration of data using virtual lab machine, development of software in virtual lab, management of industrial databases from virtual lab and monitoring of industrial network remotely from a virtual lab are all technical skills required by the computer science students for Students Industrial Work Experience Scheme. Identification of industrial computing devices from virtual lab, communication with workers from a virtual lab, detection of industrial computing objects from a virtual lab, sensing of electrical impulse from a virtual lab, Interpretation of electrical signal for action from a virtual lab and manipulation of objects using hepatic/robotic arm from a virtual lab are all soft skills required by computer science students for Industrial Work Experience.

Keywords: Technical skills for Virtual/Remote Lab, Soft skills for Virtual/Remote Lab, Virtual and Remote Laboratory, Industrial Internet of Things, SIWES, Haptic and Tactile sensing

Introduction

Integration of industrial experience for undergraduates is a critical component of higher education programme. Higher education programme is considered to be the final phase of education before the graduates will use their experiences, skills and knowledge in the industries they are trained to work in. Industrial experience is particularly crucial in the field of computer science. Computer science studies how to represent and (algorithmically) process information, as well as the machines and systems that do this (Rapaport, 2017). Computer science requires practical or hands-on in the computing firms. The practical or hands-on is a method of instruction where students are guided to gain skills (Ekwueme, Ekon, & Ezenwa-Nebife, 2015). The authors further explained that, it means giving the students the opportunity to manipulate objects they are studying such as scientific instrument like computer. This manipulation of objects is basically a means of sensing and giving instructions to the manipulated devices to carry-out human desired instructions. The nature of the sensing according to the Society of Robots (2014) is tactile and haptic. Hill (2021) explain tactile as sense of touch which implies how humans feel things on their body while haptic is the use of electronically or mechanically generated movement that a user experiences through the sense of touch as part of an interface (as on a gaming console or smartphone). It implies that both have sensation and feeling of touching objects directly or indirectly.

The tactile experience no doubt has its advantages to practical learning. It is directly related to laboratory training which often occurs during students industrial training while haptic sensing is directly related to virtual and remote laboratories which occurs when the students' access computing machines in the firm through virtual laboratories. Virtual laboratory is based on software to simulate the laboratory environment while remote laboratory is an experiment that is conducted and controlled remotely through the internet (Chen, Song & Zhang, 2010). Experiments in remote laboratory according to Poo, Lau, Chen (2023) uses real components or instrumentation away from the actual location from where they are being controlled or conducted. Remote laboratories allow users to gain skills by performing experiments and laboratory tasks over the internet without being near the equipment (Wang, Chen, Song & Parsaei, 2020).

Skill is ability and knowledge that enables a person to do something well (Adele, 2020). Skills are of different classifications. Notable among them are technical and soft skills. According to Coursera (2024), technical skills are the specialized knowledge and expertise required to perform specific tasks and use specific tools and programs in real-world situations. The context of this work is ability to use virtual and remote laboratories by the students in augmenting students industrial work scheme. Complementary to technical skills according to Kenton, Kindness and Eichler (2024) is soft skills. The authors defined soft skills as character traits and interpersonal skills that characterize a person's ability to interact effectively with others. Interpersonal skills are behaviors and tactics a person uses to interact with others effectively (Tarver, Clarke & Rosenston, 2024). These skills are needed from the students especially when engaging in students industrial work experience.

Students industrial work experience is a skills training program designed to prepare and expose undergraduate students in Nigeria higher institutions for the industrial work situation they are likely to meet after graduation (Industrial Training Fund, ITF, n. d.). The body adduced that, the scheme affords students the opportunity of familiarizing themselves in handling equipment that are usually not available “physically” in their institutions. This scheme takes a minimum of 4 months for Polytechnics and colleges of education while 6 months to 12 months to be undertaken in the university (ITF, n. d.). It often overlaps with the classroom academic programs of the individual students who are involved in the scheme. This overlapping calls for innovative approach for new alternative. The major problem here is not the importance of SIWES to students but the issue of SIWES overlapping with the academic activity period of the students thereby depriving the students of other important learning opportunities within the institution. The evidence of this overlap was captured in the explanations variances of SIWES program period in the higher institutions between the programme coordinators in two different Universities in Nigeria.

The program coordinator in National Open University of Nigeria, Eyisi (2024) stated that in most institutions, SIWES is done at the end of the 2nd semester examination of either: 300, 400 or 500 level of the student's academic period. Eyisi stated that, the minimum duration for SIWES should normally be 24 weeks (6 months) at a stretch and that the period is longer for engineering and technology programmes. The reason for this duration to the author is that ITF will not pay for any attachment period that is less than 24 weeks. However, the SIWES coordinator in Nnamdi Azikiwe University stated that each (academic) session shall consist of two semesters with a long vacation of 11 to 12 weeks. Owing to this assertion, it is self evident that, the actual implementation of SIWES for 6 months for the student to be paid by ITF as stated by Eyisi (2024) will certainly overlap or interferes

with normal classroom activities of the student, if the longest vacation is expected to be between 11 to 12 weeks. In view of this established facts that SIWES overlaps with classroom learning. It creates a lot of problems when the students use the time allotted for learning in the classroom for students industrial skill programme. This is made worst, when the students have course(s) they are required to retake with their successors who are not on SIWES at that period. Those groups of students often fail the course(s) again or at best, get lower grades. This further depletes their already reduced cumulative grade point (CGP).

Additional shortcomings of SIWES during students academic learning period as highlighted by Ogbonna (n.d.) is lack of accommodation for students trainees. This adds up to the need for better alternative to physical appearance for SIWES. Furthermore, Campus Ambassador (2023) explained that, conflict between SIWES and the regular academic activities in the curriculum often get students to be confused on where to focus their attention and energy more on. When the attention is focused on SIWES, the students tend to lag behind in the classroom activities while when it is focused on classroom activities, they tends to lag behinds in skills acquisition area. In agreement, Dissanayaka, Dissanayake, Bandara, Dissanayake, Tharuka, Bandara, Bandara, Pieris, Dhanapala, Chamil-Rajapaksha, Udara and Arachchige (2023) stated that some students see industrial training as a time-consuming obligation that takes away from their academic studies.

In the midst of this confusion, there is need to explore smart and efficient alternatives for implementing SIWES program in Nigerian Universities. The smart option here is the deployment of virtual and remote laboratories powered by haptic and hepatic devices for SIWES implementation. This will help in solving the overlapping problems of SIWES with normal classroom learning activities. This necessitated the need for examination and exploration of this alternative such as tactile and haptic sensing in virtual and remote laboratories. Haptic sensing in (Society of Robots, 2005) involves the students manipulating industrial machine and devices remotely. This demonstrates to the notion of manipulation in SIWES as canvassed by (Ekwueme, Ekon, & Ezenwa-Nebife, 2015). The manipulation could be done by wearing a special glove, or by operating miniature robotic arms with position sensors. Society of Robotic (2005) contained that robotic arms for amputees are doing a form of haptic sensing. These robotic arms have feedback sensors (such as touch) that gets [signals as impulse] directed back to the human through vibration of the glove, locking model joints, among other. Remote laboratory is powered by Internet of Things (IoT). Internet of Things was described in (Oracle, 2024) as the network of physical objects—"things"—that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

The advent of the Internet of Things (IoT) which is the backbone to remote laboratories presents a unique opportunity to address the challenges posed in the conflict between the traditional method of practicing SIWES that takes off huge chunk of academic period from students and lecturers. IoT according to Fortino, Guerrieri, Pace, Salvaglio, and Spezzano (2026) involves devices such as sensors for temperature (DHT11, LM35), vibration for sensation (ADXL335, MPU6050), pressure for sensation (BMP180, MPX5010), proximity with (ultrasonic, IR sensors) which collects data from the environment or machinery. Actuators like Servo Motors (MG995) and Stepper Motors (NEMA 17) that effectuate students' interaction through the virtual laboratory with the physical world by moving or controlling a mechanism. Microcontrollers and development boards such as Arduino, Raspberry Pi and ESP8266 / ESP32 which process sensor data and controlling actuators are part of the device. Communication Modules such as Wi-Fi Modules (ESP8266, ESP32), LoRa Modules, Bluetooth Modules (HC-05, HC-06), Zigbee Modules, 5G/LTE Modules, are used for transmission of data from students' virtual laboratories to the industry. Gateways like Edge Gateways serves as a bridge between local IoT devices and cloud platforms for real-time data processing and remote monitoring. Cloud platforms and Software Tools such as AWS IoT: Microsoft Azure IoT, ThingSpeak: Google Cloud IoT Core: and Node-RED for storing, processing, and visualization of IIoT data. Actuated Devices such as Smart Lights, Smart HVAC Systems, Industrial Robots and Conveyor Belts respond to signals from sensors and controllers. Data Storage and Analytics Tools such as Database Systems (MySQL, PostgreSQL), Analytics Software (e.g., MATLAB, Python-based tools) are used for storing and analyzing of collected data. Human-Machine Interface (HMI) devices such as Touch screens and Control Panels allow students to interact with IIoT systems and machinery. Security Devices such as IoT Firewalls: VPNs: which is crucial, particularly in industrial settings where systems are vulnerable to cyber attacks.

The proper usages of the aforementioned technologies have the ability to collect and transmit data; offer a platform for creating immersive learning experiences for students who are on industrial training while in the campus. Incorporation of virtual and remote laboratories into SIWES will make students to engage in hands-on projects that require them to apply theoretical knowledge in solving practical problems while learning in the universities.

Nigerian Universities now divide the course for the SIWES programme into two in the current Core Curriculum Minimum Academic Standard (CCMAS). The danger here is that, the students will not be paid as enunciated by (Eyisi, 2024) because of non-participation in the program for consecutive 6 months. In view of this, there is the need to look toward using of innovative approach through virtual

and remote laboratories to achieve the same purpose set out for SIWES. The achievement of this required the students to possess both technical and soft skills in virtual and remote laboratories. This necessitated the need to study technical and soft skills needed by computer science students for virtual and remote laboratories for Students Industrial Work Experience Scheme.

Problem Statements

The integration of practical industrial experience with classroom learning is a critical aspect of modern higher education, particularly in field of computer science aiming to equip students with practical skills. Unfortunately, challenges still remain. Prominent among the problem is the confusion on where the students will focus their attention and energy more on between SIWES and classroom learning during the period of SIWES when it overlap. Other issues is disconnect between academic learning and real-world industrial applications during the period of Industrial Training (IT). Traditional method of providing industrial work experience hinders classroom learning, resulting in a distorted educational learning experience for students. Furthermore, limited duration of the programme, transportation expenses and the conflict between regular academic activities in the curriculum with SIWES make the students to be confused on which area to focus attention more on. Moreover, Traditional industrial work experience schemes often operate in isolation from the academic curriculum, limiting students' ability to apply classroom learning to real-world challenges simultaneously thus making the students to lag behind academically.

Objectives of the Study

1. Determine the technical skills needed for virtual and remote laboratories for Students Industrial Work Experience in Universities in Enugu state.
2. Determine the soft skills in virtual and remote laboratories for Students Industrial Work Experience in Universities in Enugu state.

Research Questions

1. What are the technical skills needed for virtual and remote laboratories for Students Industrial Work Experience in Universities in Enugu state?
2. What are the soft skills needed for virtual and remote laboratories for Students Industrial Work Experience in Universities in Enugu state?

Methodology

The study adopted a descriptive survey research design. The design aims to systematically obtain information to describe application of virtual and remote laboratories to compliment students industrial work experience scheme in Universities in Enugu State. The population of the study is 70.

The population comprised the 35 third year students and 35 second year students of the department of computer science in State University of Medical and Applied Sciences (SUMAS). The study adopted total sampling technique because of the manageability of the population. To elicit responses from the respondents, a structured questionnaire instrument containing 15 items statements on a response scale of Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD) with nominal values of 5, 4, 3, 2 and 1 respectively was used. The instrument was face validated by 3 experts after which, it was subjected to reliability test. The internal consistency of the instrument was ascertained through Cronbach Alpha technique that yielded a co-efficient of .90, and .80 for the two instruments respectively. The average of .85 was obtained and was considered high enough for the study. The response level of the respondent is 73% which is considered high enough for the study.

The data collected for the study was analyzed using IBM SPSS Statistics 20. Mean was used to determine the level of acceptance or rejection of the item statements while Standard Deviation was used to determine the closeness or otherwise of the responses from the Mean. In decision making, any item statement with a mean value greater than or equal to cut-off mark of 2.50 was considered as accepted by the respondents while any item statement with mean value lower than cut-off mark of 2.50 was considered to be rejected by the respondents.

Results

The findings of the study are presented and discussed as follows:

Table 1: Shows the Mean Ratings and the Standard Deviation of the respondents on technical skills needed for virtual and remote laboratories for Students Industrial Work Experience

S/N	Item Statements	Mean	Std. Dev	Remark
1	Ability to program using sharable devices	4.26	1.05	Agreed
2	Ability to code using virtual lab	4.30	1.02	Agreed
3	Ability to debug of codes in virtual lab	4.17	1.11	Agreed
4	Ability to analyze data in virtual lab	4.30	1.02	Agreed
5	Ability to explore data using virtual lab machine	4.30	1.02	Agreed
6	Ability to develop software in a virtual lab	4.09	1.12	Agreed
7	Ability to deploy software in a virtual lab	4.00	1.21	Agreed
8	Ability to manage industrial database from virtual lab	4.09	1.12	Agreed
9	Ability to monitor industrial network remotely from a virtual lab	4.09	1.00	Agreed
Cluster Mean and Std.Dev.		4.17	1.07	Agreed

Key: \bar{x} = Mean, Std. Dev = Standard Deviation from the Mean, N = total number of respondents

Table 1 shows the mean ratings and standard deviation of respondents on the technical skills needed for virtual and remote laboratories for Students Industrial Work Experience. The data in Table 1 indicated that all the 9 items statements have mean ratings ranging from 4.00 - 4.30 with a cluster mean of 4.17. This implies that the respondents agreed that those items were technical skills required for Students Industrial Work Experience. Also standard deviations range from 1.02 - 1.21 with average Standard Deviation as 1.07 which is below 1.96. This indicates that the dispersion of the respondents were not far from the mean in the responses of the respondents about the Research Question 1.

Table 2: Shows the Mean Ratings and the Standard Deviation of the responses of Computer Science Students on the soft skills needed for virtual and remote laboratories for Students Industrial Work Experience

S/N	Item Statements	Mean	Std. Dev	Remark
1	Ability to identify industrial computing devices from virtual lab	4.17	1.11	Agreed
2	Ability to communicate with workers from a virtual lab	4.17	1.23	Agreed
3	Ability to detection industrial computing objects from a virtual lab	4.35	.78	Agreed
4	Ability to sense electrical impulse from a virtual lab	4.26	1.00	Agreed
5	Ability to interpret signal for action from a virtual lab	4.13	1.09	Agreed
6	Ability to manipulate objects using hepatic/robotic arm from a virtual lab	4.30	1.02	Agreed
Cluster Mean and Std. Dev.		4.23	1.04	Agreed

Key: \bar{x} = Mean, Std. Dev = Standard Deviation from the Mean, N = total number of respondents

Table 2 revealed the mean ratings and standard deviation of respondents on soft skills needed for virtual and remote laboratories for Students Industrial Work Experience. The data in Table 2 indicated that all the 6 items recorded mean ratings ranging from 4.13 - 4.35 while their average mean is 4.23 which is above the cut off mark of 2.50. This implies that the respondents agreed that those items were the soft skills required for Students Industrial Work Experience. The table also shows the standard deviations range from 0.78 - 1.23 with average Standard Deviation as 1.04 which is below 1.96 thus indicating the dispersion of the respondents from the mean in their opinion to the Research Question 2 is not far.

Discussion of the findings

The findings from the data analyzed revealed that programming aids using sharable devices, coding using virtual lab, debugging of codes in virtual lab, analyzing of data in virtual lab, exploration of data using virtual lab machine, development of software in virtual lab, management of industrial

databases from virtual lab and monitoring of industrial network remotely from a virtual lab are all technical skills needed for virtual and remote laboratories for Students Industrial Work Experience. The import of these skills are in line with the observations of (Poo, Lau and Chen, 2023) that Virtual and remote laboratories offered promising avenues to enhance learning during the disruption of in-person education. The authors argued that, it offers a safe and convenient workshop environment for student learning assessments

In the same vein, the findings revealed that: identification of industrial computing devices from virtual lab, communication with workers from a virtual lab, detection of industrial computing objects from a virtual lab, sensing of electrical impulse from a virtual lab, interpretation of electrical signal for action from a virtual lab and manipulation of objects using hepatic/robotic arm from a virtual lab are all soft skills needed for virtual and remote laboratories for Students Industrial Work Experience. This finding is similar to the observations of (Poo, Lau and Chen, 2023) in that virtual lab and remote lab can maximize time and space flexibilities to improve time efficiency and simplify complex procedures so that more complicated workshops can be carried out.

However, on the flip side of this technology is their observation of de-motivation of students from becoming familiar with physical instruments and real devices and discourage direct collaboration and interaction.

Conclusion

This study was conducted to bring scientific evidence on technical and soft skills needed by computer science students for virtual and remote laboratories to compliment industrial work experience scheme with classroom learning. To deal with the issue, the study treated two out of many possible questions needed to be answered. Two research questions were used to generate responses. The data gotten were analyzed using mean and standard deviation. The analysis revealed that technical and soft skills are needed by computer science students for virtual and remote laboratories to compliment industrial work experience scheme. However, this technology should be used in tandem with the current practices of industrial training whenever there is opportunity of doing so. This assertion is in alignment to the suggestion of (Dareen and Alnaser, n. d.) that a blended approach in which the teacher can integrate virtual and traditional laboratories will ensure full access to science inquiry skills and promote students' overall learning experience.

Recommendation

Based on the findings of the study, the following recommendations were made: A similar study should be replicated using experimental or quasi-experimental design to determine the impacts of

virtual and remote laboratories on the skills identified in this study. This is to utilize the findings of this study to solve SIWES problem. In addition, another study should be done to determine the challenges and opportunities arising from integrating virtual and remote laboratories to compliment other similar academic schemes like SIWES in the university. This is to avoid the clash of those schemes and the classroom learning activities.

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