Journal of Education and Learning Technology (JELT)
ISSN 2720-7730
Volume 6 Issue 9 2025 pp 919 - 930
Available online at: https://noyam.org/journals/jelt/
DOI: https://doi.org/10.38159/jelt.20256915

The Compatibility of Computer Science Curriculum in Preparing Undergraduates for the Future of Work in South Africa

Ranta Patrick Langa [1], Damtew Teferra[2] & Thokozani Isaac Mtshali [3]

[1] University of Limpopo, South Africa.
[2] University of KwaZulu Natal, South Africa.
[3] Tshwane University of Technology, South Africa.

ABSTRACT

The critical goal of universities is multifaceted and includes economic participation, societal service, and the development of students' social skills, critical thinking, empathy, and commitment to civic engagement. Equally, it is expected that universities represent this goal and have it reflected in their graduates through adequate provision of a responsive curriculum. The purpose of this study was to explore the compatibility of computer science curricula in preparing undergraduates for the future of work. This qualitative study followed an exploratory case design where eleven (11) computer science lecturers from two universities in South Africa were sampled. Data was collected through interviews and classroom observations. The findings of this study reveal that the undergraduate computer science curriculum in one of the sampled South Africa's universities is not compatible with preparing undergraduates for the future of work. This lacuna was mainly caused by the lack of internationalisation and globalisation components in the curriculum to foster internal and external collaboration, underutilisation of digital technology and the available learning management systems for synchronous and asynchronous instruction. A further finding indicates that academics and those working in eLearning did not seem to understand the new normal that the 4IR has brought to our attention. As a result, this study recommends that the computer science curriculum needs to be restructured, do away with the bundling of critical skills and knowledge with other modules and constant curriculum review to the national skills alignment framework. It is hoped that this study will provide a lifeline on where to improve in order to stay relevant in computer science.

Correspondence
Ranta Patrick Langa
Email:
ranta.langa@ul.ac.za

Publication History
Received:
27th March, 2025
Accepted:
20th August, 2025.
Published:
29th September, 2025.

To Cite this Article:
Langa, Ranta Patrick , Damtew Teferra and Thokozani Isaac Mtshali. "The Compatibility of Computer Science Curriculum in Preparing Undergraduates for the Future of Work in South Africa." *Journal of Education and Learning Technology* 6, no. 9 (2025): 919-930. https://doi.org/10.38159/jelt.20256915.

Keywords: *Computer Science, Future of Work, Universities, Undergraduates*

INTRODUCTION

The field of computer science studies how to solve problems using computer-implemented solutions. These issues can come from a number of fields, including science, engineering, mathematics, mining, commerce, finance, entertainment, and even music. It is given that all computer scientists should exhibit strong analytical, mathematical, creative and critical thinking abilities. [1] In fact, they should demonstrate an all-encompassing skill in programming and artificial intelligence (AI). Whether

[1] Ranta Patrick Langa and Damtew Teferra, "An Exploration of the Relevance of the Undergraduate Computer Science Curriculum in Preparation of the Fourth Industrial Revolution in One of South Africa's Universities" (University of KwaZulu Natal, 2022).

© 2025 The Author(s). Published and Maintained by Noyam Journals.
This is an open access article under the CCBY license (http://creativecommons.org/licenses/by/4.0/).

universities are prepared to train this ideal computer scientist is the most important question. According to Leicht et al., universities have the propensity to teach students skill sets that are effective for surviving in the working world.[2] Owing to this fact, universities should present a curriculum that is progressive forecasting the upcoming industrial revolutions.

Indeed, in previous years, scholars such as Ohei and Brink have claimed that the curriculum received in universities and the skill set required by industries do not speak the same language.[3] Even Moueddene et al., posit that the difficulties graduates have in obtaining jobs imply that the bulk of student skill sets are incompatible with the demands of industries.[4] The greatest lacuna is that graduates are at a disadvantage for employment as industries find themselves having to reskill and upskill all those they hire, which is an expensive process. To circumvent this in computer science, there is a need to constantly evaluate the compatibility of the content and delivery approaches in universities offering these programs. This study seeks to close the gap that Menon and Castrillon foresaw that university curricula and programmes are not consistently evaluated in light of national skill set demands.[5] Computer science is demanded by the needs of the current disruptive technologies.

Universities are generally seen as a hub for cultural transformation, lifelong learning culture and haste for economic growth.[6] Based on the United Nations (UN) Sustainable Development Goal (SDG) 4: Quality Education, universities offer equitable and universal quality education, promoting lifelong learning provisions for all and increasing opportunities to broaden the scope of education with the goal of wider learning, including world-base citizenship, sustainability and gender equality. This implies that courses such as computer science are seen as the benchmark to world standard citizenship. It is thus important that computer science lecturers provide cutting-edge direction on what to be taught, how and for what future purpose.

This study therefore seeks to investigate the compatibility of the curriculum for computer science in preparing their candidates for the future of work. The following segments, look into the current realities of computer science in South African universities. This is to shed light on the national and international audience on the knowledge, skills and competitiveness of the course in producing future-ready citizens. This study is guided by the following research question: How compatible is the curriculum for computer science in preparing undergraduates for the future of work?

LITERATURE REVIEW

Training computer science students for socio-economic efficiency

For a person to be productive in the extensive and rapid technological changes, knowledge alone is insufficient.[7] The workforce readiness skill set, soft skill set, entrepreneur skill set, technical skill set and dispositions that are connected to knowledge will all be necessary for graduates from a computing curriculum to meet the rising demands of a rapidly evolving technology environment. According to the Joburg Centre for Software Engineering (JCSE) and the Institute of Information Technology Professionals South Africa's (IITPSA) 2021 poll, the most in-demand skill sets are those related to the current batch of developing technologies, including AI, the IoT, blockchain, automation, data science and programming. Despite the hype around the fourth industrial revolution (4IR) in South Africa, there is still a lack of all types of information and communications technology (ICT) skills necessary to

---

[2] A. Leicht, J. Heiss, and W. J. Byun, *Issues and Trends in Education for Sustainable Development* , vol. 5 (UNESCO Publishing, 2018).

[3] Kenneth Nwanua Ohei and Roelien Brink, "Investigating the Prevailing Issues Surrounding ICT Graduate Employability in South Africa: A Case Study of a South African University," *The Independent Journal of Teaching and Learning* 14, no. 2 (2019): 29–42.

[4] Karim Moueddene et al., "Expected Skills Needs for the Future of Work: Understanding the Expectations of the European Workforce," *UK: Deloitte*, 2019, 1–20.

[5] Kirti Menon and Gloria Castrillón, "Reimagining Curricula for the Fourth Industrial Revolution," *The Independent Journal of Teaching and Learning* 14, no. 2 (2019): 6–19.

[6] Independent Evaluation Group, " Higher Education for Development: An Evaluation of the World Bank Group's Support," 2017, https://openknowledge.worldbank.org/handle/10986/26486.

[7] Melanie Arntz, Terry Gregory, and Ulrich Zierahn, "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis," 2016.

support local organisations in the digital economy.[8] The skills gap is caused by universities not doing enough to prepare graduates to work and fill crucial vacancies in the nation's ICT sector.

Like most developing countries, the South African education system faces a shortage of skill sets critical to the Fourth Industrial Revolution (4IR) as a result of the post-schooling education system that is in slow motion with educational technologies.[9] Hence, the restructuring of the curriculum to adopt 4IR opportunities is slow. Mzekandaba posit that, the Minister of Higher Education in 2019, reported that only 11 of 26 universities in South Africa had adapted their modules to harness the opportunities 4IR presents and these are mainly those in cities than in rural settings.[10] Therefore, this study seeks to close this gap by focusing on two universities in rural settings of South Africa focusing on computer science.

The recent Statistics South Africa (StatSA) report highlights that unskilled workers are estimated at 30%, semiskilled workers at 46%, and skilled workers are at 24% and this is inclusive of soft skill disciplines. Nevertheless, the immediate goal in getting ready for the 4IR must be reskilling and skilling the workforce.[11] Many individuals who are semi-skilled and unskilled come from historically underrepresented communities.[12] These populations have been denied socioeconomic possibilities like access to high-quality education for many years. More than 20 years after South Africa's transition to democracy, the impacts of the social injustices committed by the Apartheid system are still felt, even in the universities where the current study was conducted.

High-routine jobs are under threat from AI, automation, and IoT, yet the students who should be in charge of AI are somehow incompatible with it, a worrisome situation. The worst-case scenario is that within the next 10 to 20 years, 14% of jobs face a high danger of automation, while another 32% have a high chance of considerable change.[13] According to Lund et al., by 2030, automation may force up to 375 million workers to switch occupational categories.[14] The Manufacturing Skills Mismatch Report predicts that two million of those jobs will go vacant as a result of the skill sets gap.[15] In South Africa, youth unemployment is heart-breaking, 63.9% unemployment was recorded in the first quarter of 2022, and in the second quarter, it was recorded as 46.5% .[16] Youth unemployment in South Africa is heartbreaking; in the first quarter of 2022, it was recorded at 63.9% and in the second quarter, it was recorded at 46.5%.[17] Finding a job is the next step for a student following graduation and so, lecturers should prepare their students well for computer science opportunities.

Computer Science in universities

Dealing with the realities of universities around the globe is worrisome in that they are constantly graduating students that are not bridging into the market place. In a generic perspective, Tasfi and Mostofa posit that there are far too many universities whose programs are pricey with subpar student support that leads to high failure rate.[18] Raihan, et.al., claim that computer science students fail because

[8] Víctor J. García-Morales, Aurora Garrido-Moreno, and Rodrigo Martín-Rojas, "The Transformation of Higher Education After the COVID Disruption: Emerging Challenges in an Online Learning Scenario," *Frontiers in Psychology* 12 (February 11, 2021), https://doi.org/10.3389/fpsyg.2021.616059.

[9] G. Gillis, " SA's Education System Needs a Radical Overhaul for the Fourth Industrial Revolution," Daily Maverick, 2018, https://www.dailymaverick.co.za/opinionista/2018-11-26-sas-education-system-needs-a-radical-overhaul-for-the-fourth-industrial-revolution/.

[10] S. Mzekandaba, " SA Universities Must Lead Industry 4.0 Curriculum," Business Technology Media Company , March 22, 2019, https://www.itweb.co.za/content/PmxVE7KXLopMQY85.

[11] Thokozani Isaac Mtshali and Sylvia Manto Ramaligela, "Contemporary Employability Skills Needed for Learners to Succeed in the Civil Technology Field in the 4IR Era," *Journal of Technical Education and Training* 12, no. 3 (2020): 29–40.

[12] StatSA, "Mid-Year Population Estimates," Statistics South Africa, July 2018.

[13] OECD, *Education at a Glance 2013* (OECD, 2013), https://doi.org/10.1787/eag-2013-en.

[14] S. Lund et al., "Jobs Lost, Jobs Gained: What the Future of Work Will Mean for Jobs, Skills, and Wages," McKinsey & Company, 2022, https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs- %09gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages.

[15] Vass J.R. and Raidani P., *Facts and Figures in Skills in Manufacturing Information Brief* (Pretoria: The Department of Trade and Industry, 2015).

[16] StatSA, "Quarterly Labour Force Survey (QLFS) Q2:2022," Statistics South Africa, August 22, 2022, https://www.statssa.gov.za/?p=15685.

[17] StatSA, "Quarterly Labour Force Survey (QLFS) Q2:2022."

[18] Jarin Tasnim Tasfi and Shafi Md Mostofa, "Understanding Complex Causes of Suicidal Behaviour among Graduates in Bangladesh," *BMC Public Health* 24, no. 1 (February 22, 2024): 560, https://doi.org/10.1186/s12889-024-17989-x.

of the high mathematical content and some abstraction.[19] Moreso, the Large Language Models (LLMs) which are made for processing and generating text have become abstract for students in conceptualising Natural Languages (NL) and Programming Languages (PL). Pereira et al. adds that, cryptography and cloud technologies which are changing how people process and secure digital assets are not prioritized for computer science curriculum.[20] This points to the detattachement of computer science programs in human capital. It must be noted that if these skills are taught to students, they will be able to hold up to a rapidly changing world and grow their confidence to practice cryptography.

Mnisi et al., outlines that ICT based institutions experience greater challenges with their instructional personnel while they are exposed to novel technological development.[21] The fact that universities' curricula still focus more on making sense of the knowledge that is easily available to them, sharing of notes rather than using features of the novel technologies to improve and make the learning environment more interesting is a cause for concern. Mushimiyimana, et. al, emphasise that universities in the 4IR should develop learning opportunities based on learning attributes which highlights improved level of participation, knowledge availability and the use of rich-media to access real-time and on-the-go advanced technologies to keep improving the learning environment.[22] Sibiya and Mtshali advocate for virtual teaching and learning, and a competency-based curriculum that will play a bigger part in enhancing learning opportunities for various groups of students, promoting lifelong learning and continuous professional development aided by cutting-edge ICT.[23] This advocations should indeed extent to the computer science curriculum in universities.

THEORETICAL FRAMEWORK

Ecological System Theory

To understand the compatibility of computer science curriculum in preparing undergraduates for the future of work, this study used Bronfenbrenner's Ecological Systems Theory (EST).[24] According to Bronfenbrenner, the Ecological Systems Theory (EST) looks at the dynamic interplay between humans and their environments. In the case of this study, researchers wanted to understand the interplay between the current university curriculum for computer science and how it assists in preparing undergraduates for the future of work. Brofenbrenner, provides a comprehensive framework for studying human development in the context of various interconnected systems. This theory emphasizes the reciprocal relationships and influences that shape human behaviour and development, concentrating on the dynamic interaction between individuals and their environment.

Based on Bronfenbrenner's EST, there are several constructs that make ecology happen, which include macrosystem, Exosystem, mesosystem, and microsystem. According to Bronfenbrenner, Macrosystem refers to the larger cultural, social, and historical circumstances that influence people's development and experiences. This study will use the macro system to understand how the computer science curriculum responds to world standards. The exosystem includes external surroundings that indirectly influence people, such as government policies, cultural standards, and technical infrastructures. This study looked into these aspects in terms of the infrastructure that universities have in training their computer science students. The Mesosystem refers to the links and interactions between

[19] Nishat Raihan et al., "Large Language Models in Computer Science Education: A Systematic Literature Review," in *Proceedings of the 56th ACM Technical Symposium on Computer Science Education V. 1* (New York, NY, USA: ACM, 2025), 938–44, https://doi.org/10.1145/3641554.3701863.

[20] Nielsen Pereira et al., "A Multitiered Approach to Computer Science Talent Development," *Gifted Child Quarterly* 69, no. 2 (April 16, 2025): 130–46, https://doi.org/10.1177/00169862241307662.

[21] Barutoa Ruth Mnisi, Thokozani Isaac Mtshali, and Makgato Moses, "Moving beyond the Challenges of Learning through Technologies: The Current Status of ICT Integration in South African Schools.," *Journal of Education and E-Learning Research* 11, no. 1 (2024): 128–34.

[22] Jean Baptiste Mushimiyimana, Gabriel Bazimaziki, and Dieudonné Tuyishime, "ICT Integration in Educational Curriculum in Higher Education: Challenges and Opportunities in the University of Rwanda-College of Education," *International Journal of Humanities and Education Development (IJHED)* 4, no. 2 (2022): 118–37.

[23] Mlondie Thlokomelo Sibiya and Thokozani Isaac Mtshali, "Teaching Graphic Communication and Techniques to Senior Phase Technology Learners: A Guide for Teachers," *International Journal of Education and Teaching Zone* 4, no. 2 (June 16, 2025): 195–207, https://doi.org/10.57092/ijetz.v4i2.390.

[24] Urie Bronfenbrenner, *The Ecology of Human Development: Experiments by Nature and Design* (Cambridge, MA: Harvard University Press, 1979).

various microsystems, such as the relationship between the home and school environments. In this study, the mesosystem looked at how the curriculum bridges the gap between the world and the context where the course is offered. The microsystem refers to the immediate surroundings in which people interact, such as classrooms, schools, and online learning platforms. This study looked into the learning management systems that universities have that could help transform the curriculum delivery of computer science.

METHODOLOGY

The purpose of this study was to determine how well computer science curricula prepare undergraduates for the workforce of the future through a qualitative research inquiry. This would help to determine the relevance of the undergraduate computer science curriculum and the need for its improvement in this regard.[25] Therefore, a qualitative approach was opted for over other approaches. This approach was deemed more reliable and appropriate in understanding experiences and thought patterns in undergraduate computer science curriculum lecturers. An exploratory case of lecturers in two universities was studied to address research focus in line with Yin's point of view.[26] Actually, case studies have the advantage of gathering data directly from the case through observation and interviews with participants presenting "what it is like" to be in a specific situation, allowing for the close-up reality, rich detail, and "thick description" of the participants' lived experiences, thoughts about, and feelings towards a situation. In situations where a complete grasp is required to fairly present the case, it enables the researcher to discover causes and witness effects in a real context.[27]

This study considered two populations, namely computer science lecturers and professional infrastructure support staff. The computer science lecturers were chosen because they are experts in this content. The professional infrastructure support was chosen because of their knowledge of the learning management system. As per Turner's assertion, sampling is a method of choosing specific individuals from a large population that is of interest in a research study.[28] As part of the inclusion criteria, this study focuses on two universities from the demographics of rural settings rather than cities, this was important as little is known about those universities with respect to computer science training. A total of 10 computer science lecturers who were members of the department had at least seven years' experience in teaching computer science, held master's or PhD degrees, and participated in some curriculum review activities for the department. All city-based universities and their personnel were excluded from this sampling.

In this study, non-participant observation, semi-structured interviews and document analysis were the three methods employed to collect data. For semi-structured interviews, the researchers used both closed- and open-ended questions (questions that spark debate) within a predetermined topic framework, supplemented by follow-up "why" or "how" questions to gather qualitative data from the participants.[29] The non-participant observation method was used in this study to gain insights into how students are being taught in the computer science classroom.[30] A structured observation checklist was developed in accordance with predetermined criteria as the values of variables had been clearly defined. This technique was helpful in this study since it allowed the researcher to interact with the participants and get actual experiences.[31]

---

[25] Louis J. Cohen, Lawrence Manion, and Keith Morrison, *Research Methods in Education*, 8th ed. (New York: Routledge, 2018).

[26] Yin R. K., *Case Study Research and Applications: Design and Methods* (Thousand Oaks, CA: Sage Publications, 2017).

[27] Anjelika Huseyinzade Simsek, "Re: What Are the Main Differences between Case Study and Phenomenological Study? ," 2020, https://www.researchgate.net/post/What-are-the-main-differences-between-case-study-and-phenomenological-study/5e30151da4714b1ccf0c0918/citation/download.

[28] Dana P. Turner, "Sampling Methods in Research Design," *Headache: The Journal of Head and Face Pain* 60, no. 1 (January 8, 2020): 8–12, https://doi.org/10.1111/head.13707.

[29] Melissa DeJonckheere and Lisa M Vaughn, "Semistructured Interviewing in Primary Care Research: A Balance of Relationship and Rigour," *Family Medicine and Community Health* 7, no. 2 (2019): e000057.

[30] F. Liu and S. Maitlis, " Nonparticipant Observation," in *Encyclopedia of Case Study Research*, ed. Albert J. Mills, G. Durepos, and E. Wiebe (Thousand Oaks, CA: SAGE Publications, 2010), 610–12.

[31] John W Creswell and Cheryl N Poth, *Qualitative Inquiry and Research Design: Choosing among Five Approaches* (Sage publications, 2016).

Since the data collected in this study was qualitative in nature, thematic data analysis was used to interpret the verbal and aural data acquired from interview sessions. According to Peel, thematic analysis is a qualitative data analysis technique that entails reading over a data set (such as transcripts from semi-structured interviews or document analysis), organising data into themes and sub-themes, and finding patterns in meaning as defined and explained by participants across the data to extract themes.[32] Semi-structured interviews yielded raw data in the form of video recordings, which were verbatim transcribed and then converted into a readable text format.[33] Ethical clearance was sought from the institution affiliated with the author to ensure that data collection happens under the premises of lawful data collection.

PRESENTATION OF FINDINGS AND DISCUSSION

When studying how compatible is the curriculum for computer science in preparing undergraduates for the future of work, this study discovered that the compatibility depended on factors such as:

- Packaging of undergraduate computer science curriculum
- New knowledge area
- Curriculum accreditation, and
- Multidisciplinary modules

The above-mentioned themes are unpacked succinctly below:

Packaging of undergraduate computer science curriculum

According to the CC2020 Task Force, the undergraduate computer science curriculum must incorporate the following components in order to stay relevant to the 4IR era: the curriculum must transition to

- competency-based learning from knowledge-based learning;
- package curriculum knowledge content using a specialised approach;
- broaden curricular disciplines to include cybersecurity and data science;
- include novel trends and demands from industry, research and 'grass-roots' developments and
- support current, emerging and future computing programmes globally.[34]

The analysis shows that the undergraduate computer science curriculum in the participating universities was undergoing cycle review with the objective of disbanding some modules to create specialisation modules. The modules, like programming, project-based system development, network practical and operating systems practical, were embedded in other modules. The fact that these modules did not show up on students' transcripts, proving they did not complete them, disadvantages them. These contribute to the industry's reluctance to employ these students because they believe they must first equip themselves with the relevant skill set, which is additional work for them.[35] This was attested by Participant C who stated:

> *"…The computer science curriculum in the university seems like a generic qualification not a specialised. That is one thing if it is not a specialized curriculum."*

In concurrence, Participant D said:

> *"The way it is structured right now is that when we look from first year up to third year, we don't have specific programming language as a standalone module, so they are bundled together in other modules like computer science, like artificial intelligence and database…"*

---

[32] Karen L Peel, "A Beginner's Guide to Applied Educational Research Using Thematic Analysis," *Practical Assessment Research and Evaluation* 25, no. 1 (2020).

[33] Theophilus Azungah, "Qualitative Research: Deductive and Inductive Approaches to Data Analysis," *Qualitative Research Journal* 18, no. 4 (2018): 383–400.

[34] CC2020 Task Force, *Computing Curricula 2020: Paradigms for Global Computing Education. Association for Computing Machinery.* (New York: ACM, 2020), https://doi.org/10.1145/3467967.

[35] Faith Oluwajodu et al., "Graduate Unemployment in South Africa: Perspectives from the Banking Sector," *SA Journal of Human Resource Management* 13, no. 1 (2015): 1–9.

The above passage reflects that the curriculum disadvantages students due to the programming bundling, which results in the lack of modules intended for novel skill sets. This claim was also seconded by Participant H who said that:

> *"What we are doing disadvantage students. In terms of competency, our students are not competent enough within the practical, they are good with theory. Some gap needs to be closed."*

In agreement, Participants B and E said respectively:

> *"Yes, currently the problem is our curriculum on the project as it does not show what they are doing exactly."*
>
> *"The current packaging of the generic BSC lacks a lot of programming language and this is caused by unupdated service license.*

According to these observations, the current curriculum at the institution tends to be generic and needs to be more relevant to the requirements of 4IR. It is important that the curriculum specialises, considering the requirements of 4IR, where technology and people are combined to create new possibilities.[36] In addition, this will encourage students to acquire not only the necessary knowledge but also the competencies to recognise the resources from which they might obtain these materials.

New Knowledge Area

For a course programme built at the heart of rapid technological development, the undergraduate computer science curriculum should be constantly evaluated if it includes enough new knowledge content as recommended by the 2017 and 2020 Computer Science Curricula Guidelines. The new knowledge content should include, among others, interactive technologies, ambient computing, cognitive technology, robotics, data science, cybersecurity, the internet of things, programming on network nodes, cloud computing, and Al design and programming.[37] The extract below showcases modules that make up the undergraduate computer science curriculum with their knowledge content.

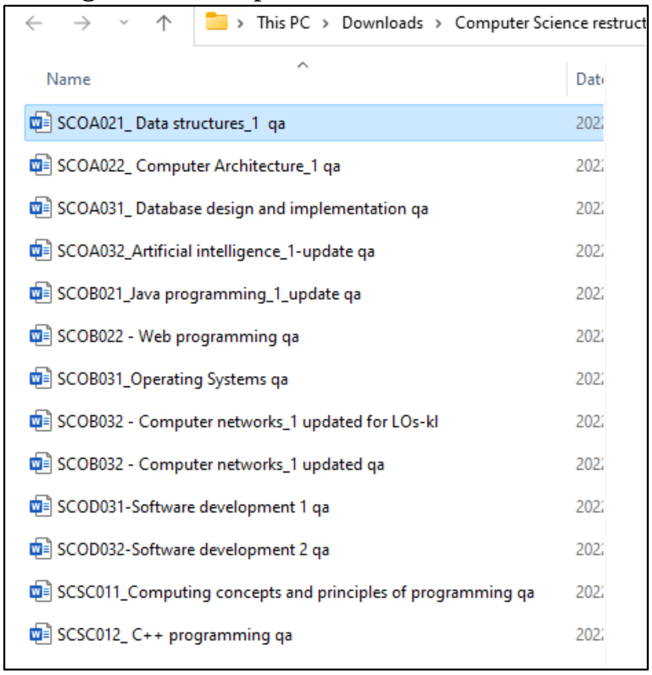

Figure 1: Screen print of modules that make up undergraduate computer science curriculum with their knowledge content.

[36] Christian Kayembe and Danielle Nel, "Challenges and Opportunities for Education in the Fourth Industrial Revolution," *African Journal of Public Affairs* 11, no. 3 (2019): 79–94.

[37] Rakhmonkulov Feruz Pardaboyevich, Usarov Sardor Abdunazirovich, and Shabutayev Quvondiq Saydullayevich, "Teaching Computer Science at School-Current Challenges and Prospects," *JournalNX* 6, no. 11 (2020): 217–21.

Due to the current pace of technological advancement and industrial demands, it was anticipated that the curriculum review would concentrate on aligning the curriculum content with ACM and IEEE curricula recommendations and integrating new knowledge domains in terms of new modules. Among the new knowledge content are cybersecurity, cloud computing, the Internet of Things (IoT), quantum computing, network point programming, robot programming, data analytics and data science.[38] Professional organisations for computer science, ACM, and IEEE, are recommending new curriculum content and updating them every ten years to make them more universally applicable.

It also emerged that students were not given precise instructions on the selection criteria for the curriculum's knowledge areas. The module's purpose and rationale were not explained. In the curriculum template, the rationale section explains why the knowledge is significant and should be taught to students.[39] This is where the narrative can explain the necessity of addressing the national skills gap in order to promote economic participation on a national scale.

Curriculum Accreditation

Curriculum accreditation in South Africa is done by the South African Qualifications Authority (SAQA), a professional body whose members are typically persons who are experts in their field and who are engaging in a profession or occupation.[40] These bodies typically have control over the specific profession's knowledge areas, skill sets, support, conduct and practice. Additionally, they help with continuous professional development (CPD), networks for professionals to connect and discuss their areas of specialisation and opportunities for students, recent graduates and professionals in the field to advance their careers. The Institute of Information Technology Professionals South Africa (IITPSA), the South African Institute for Computer Scientists and Information Technologists (SAICSIT), the Institute of Chartered IT Professionals (ICITP-SA) and the Information Technology Association (ITA) are all professional organisations in the field of computer science and are recognised by South African Qualifications Authority (SAQA).

It seems there is no recognised professional body to monitor curriculum activities which may disadvantage students because of the curriculum’s potential for obsolete material and skill sets that are less needed by industry. As such this means that undergraduates will face difficulties finding employment in the industry when there are gaps in monitoring bodies on all activities of training computer science undergraduates.

Multidisciplinary Modules

Multidisciplinary modules supplement the requirements of the computer science profession that are not included in the undergraduate computer science curriculum. According to ACM Code Task Force and CSC2020 Task Force, there is knowledge content that deals with ethics and professional conduct and with cultural sensitivity and diversity, such as cybernetics, ethics in information technology, laws and policies for privacy and computing ethics as well as professional conduct.[41] Participant F notes that:

> *“Unfortunately in our computer science program, we don’t have multidisciplinary module, perhaps the information systems program would probably have that kind of module.”*

This indicates that the majority of students take in general knowledge from the curriculum, which does not support the idea of 4IR. A study by Paterson and Lueher, discussed how a 4IR approach supports multidisciplinary.[42] The study shed light on how the undergraduate computer science

---

[38] Mritunjay Shall Peelam, Anjaney Asreet Rout, and Vinay Chamola, “Quantum Computing Applications for Internet of Things,” *IET Quantum Communication* 5, no. 2 (2024): 103–12.

[39] South African Qualifications Authority (SAQA)., “Policy and Criteria for Recognising a Professional Body and Registering a Professional Designation for the Purposes of the National Qualifications Framework Act” (2018).

[40] South African Qualifications Authority (SAQA)., Policy and Criteria for Recognising a Professional Body and Registering a Professional Designation for the Purposes of the National Qualifications Framework Act.

[41] ACM Code 2018 Task Force, “ The Code Affirms an Obligation of Computing Professionals to Use Their Skills for the Benefit of Society,” ACM, 2018, https://www.acm.org/code-of-ethics; CC2020 Task Force, *Computing Curricula 2020: Paradigms for Global Computing Education. Association for Computing Machinery.*

[42] M. Paterson and T. M. Luesher, “African HE Can Be More Competitive through 4IR Technologies,” University World News, October 26, 2022, https://www.universityworldnews.com/post.php?story=20221025083907664.

curriculum could include crucial cultural, social, legal and ethical aspects relevant to the subject of computing.

As a result of the present pace of technological advancement and industrial demands, undergraduate computer science knowledge has a high potential to integrate with different learning fields, thus medicine, accounting, and aviation, to name a few. Therefore, curriculum review must include multidiscipline modules including professional values, ethics, and conduct in order to prepare students to be relevant in solving contemporary challenges.

A review of the curriculum for 4IR must use the same jargon that the industry is using for a smooth understanding and transition from universities. Regular accreditation of programmes, including all subjects where practical skills are developed, is recommended. The researchers conclude that curriculum review must be competency-based with the intention to supply the skill set demanded by the industry. The curriculum must deliberately include soft, technical and entrepreneurial skill sets in multidisciplinary knowledge content. It must introduce emerging novel technologies as knowledge areas that may be organised into modules. Competencies are characteristics that a person must exhibit to be successful in a given position, role, function, task, or obligation. These characteristics include technical knowledge/skills, which is what a person demonstrates regarding facts; motivation, which is how a person feels about a job; and job-relevant behaviour, which is what a person says or does that results in good or poor performance.[43] An analysis of jobs and roles reveals the competencies that are required. Therefore, competency closely resembles behaviour and performance relating to a profession. It is a person-centred notion that necessitates the presentation of both technical knowledge and abilities, as well as human behaviour.

The collective finding in this study is that universities' leadership must define its ICT strategic plans in the finest detail and cascade them down through a lecturer in a classroom with the purpose of promoting an information technology-savvy university that uses cutting-edge technologies to enhance all its core process, including providing new and innovative ways of engaging students and lectures in academic activities. The researchers found that the Department of Computer Science rarely forges collaboration with key technology partners that can offer future trends, current technologies and strategies to use technology to prepare students to be relevant for the era of the 4IR.

Discussion Summary

The study's findings show that an undergraduate computer science curriculum has difficulties in being relevant to 4IR while fostering lifelong learning. Instead of using interactive approaches that encourage the critical and independent thinking required in today's innovation-driven technology. The curriculum relies on passive teaching and learning styles that are centred on direct instructions and memorisation. The learning environments are more static than dynamic because of diverse technologies with many application features. The demands and reality of national economies and societies around the world have become more and more disassociated with this situation, instead of teaching, students need to be trained.

RECOMMENDATIONS

Based on the findings and discussion, it is recommended that universities use more of their learning management systems (LMS) which have features and processing capabilities that are able to support online platforms for the greater good of computer science students.

CONCLUSION

As this study sought to explore how compatible is the curriculum for computer science in preparing undergraduates for the future of work, his study concludes that universities curriculum have not made visible strides to prepare its computer science graduates to win in this evolving AI saturated world. Rural universities' lecturers are still battling to upgrade their knowledge of the discipline. It rests upon

[43] CC2020 Task Force, *Computing Curricula 2020: Paradigms for Global Computing Education. Association for Computing Machinery.*

them to upgrade curriculum and consult with their sister universities who are excelling in training computer engineering students to assist in skilling, reskilling and upskilling their students.

Limitations

The opinions shared by the participants in the study do not accurately reflect those of the broader status of computer engineering lecturers in rural universities.

ACKNOWLEDGEMENTS

The authors would like to acknowledge all respondents who participated in this study.

BIBLIOGRAPHY

ACM Code 2018 Task Force. " The Code Affirms an Obligation of Computing Professionals to Use Their Skills for the Benefit of Society." ACM, 2018. https://www.acm.org/code-of-ethics.

Arntz, Melanie, Terry Gregory, and Ulrich Zierahn. "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis," 2016.

Azungah, Theophilus. "Qualitative Research: Deductive and Inductive Approaches to Data Analysis." *Qualitative Research Journal* 18, no. 4 (2018): 383–400.

Bronfenbrenner, Urie. *The Ecology of Human Development: Experiments by Nature and Design*. Cambridge, MA: Harvard University Press, 1979.

CC2020 Task Force. *Computing Curricula 2020: Paradigms for Global Computing Education. Association for Computing Machinery.* New York: ACM, 2020. https://doi.org/10.1145/3467967.

Cohen, Louis J., Lawrence Manion, and Keith Morrison. *Research Methods in Education*. 8th ed. New York: Routledge, 2018.

Creswell, John W, and Cheryl N Poth. *Qualitative Inquiry and Research Design: Choosing among Five Approaches*. Sage publications, 2016.

DeJonckheere, Melissa, and Lisa M Vaughn. "Semistructured Interviewing in Primary Care Research: A Balance of Relationship and Rigour." *Family Medicine and Community Health* 7, no. 2 (2019): e000057.

García-Morales, Víctor J., Aurora Garrido-Moreno, and Rodrigo Martín-Rojas. "The Transformation of Higher Education After the COVID Disruption: Emerging Challenges in an Online Learning Scenario." *Frontiers in Psychology* 12 (February 11, 2021). https://doi.org/10.3389/fpsyg.2021.616059.

Gillis, G. " SA's Education System Needs a Radical Overhaul for the Fourth Industrial Revolution." Daily Maverick, 2018. https://www.dailymaverick.co.za/opinionista/2018-11-26-sas-education-system-needs-a-radical-overhaul-for-the-fourth-industrial-revolution/.

Huseyinzade Simsek, Anjelika. "Re: What Are the Main Differences between Case Study and Phenomenological Study? ," 2020. https://www.researchgate.net/post/What-are-the-main-differences-between-case-study-and-phenomenological-study/5e30151da4714b1ccf0c0918/citation/download.

Independent Evaluation Group. " Higher Education for Development: An Evaluation of the World Bank Group's Support," 2017. https://openknowledge.worldbank.org/handle/10986/26486.

Kayembe, Christian, and Danielle Nel. "Challenges and Opportunities for Education in the Fourth Industrial Revolution." *African Journal of Public Affairs* 11, no. 3 (2019): 79–94.

Langa, Ranta Patrick, and Damtew Teferra. "An Exploration of the Relevance of the Undergraduate Computer Science Curriculum in Preparation of the Fourth Industrial Revolution in One of South Africa's Universities." University of KwaZulu Natal, 2022.

Leicht, A., J. Heiss, and W. J. Byun. *Issues and Trends in Education for Sustainable Development* . Vol. 5. UNESCO Publishing, 2018.

Liu, F., and S. Maitlis. " Nonparticipant Observation." In *Encyclopedia of Case Study Research*, edited by Albert J. Mills, G. Durepos, and E. Wiebe, 610–12. Thousand Oaks, CA: SAGE Publications, 2010.

Lund, S., M. Chui, J. Bughin, J. Woetzel, P. Batra, R. Ko, and S. Sanghvi. "Jobs Lost, Jobs Gained: What the Future of Work Will Mean for Jobs, Skills, and Wages." McKinsey & Company, 2022. https://www.mckinsey.com/featured-insights/future-of-work/jobs-lost-jobs-%09gained-what-the-future-of-work-will-mean-for-jobs-skills-and-wages.

Menon, Kirti, and Gloria Castrillón. "Reimagining Curricula for the Fourth Industrial Revolution." *The Independent Journal of Teaching and Learning* 14, no. 2 (2019): 6–19.

Mnisi, Barutoa Ruth, Thokozani Isaac Mtshali, and Makgato Moses. "Moving beyond the Challenges of Learning through Technologies: The Current Status of ICT Integration in South African Schools." *Journal of Education and E-Learning Research* 11, no. 1 (2024): 128–34.

Moueddene, Karim, Michela Coppola, Patrick Wauters, Maya Ivanova, Valeria Ansaloni, and Joanie Paquette. "Expected Skills Needs for the Future of Work: Understanding the Expectations of the European Workforce." *UK: Deloitte*, 2019, 1–20.

Mtshali, Thokozani Isaac, and Sylvia Manto Ramaligela. "Contemporary Employability Skills Needed for Learners to Succeed in the Civil Technology Field in the 4IR Era." *Journal of Technical Education and Training* 12, no. 3 (2020): 29–40.

Mushimiyimana, Jean Baptiste, Gabriel Bazimaziki, and Dieudonné Tuyishime. "ICT Integration in Educational Curriculum in Higher Education: Challenges and Opportunities in the University of Rwanda-College of Education." *International Journal of Humanities and Education Development (IJHED)* 4, no. 2 (2022): 118–37.

Mzekandaba, S. " SA Universities Must Lead Industry 4.0 Curriculum." Business Technology Media Company, March 22, 2019. https://www.itweb.co.za/content/PmxVE7KXLopMQY85.

OECD. *Education at a Glance 2013*. OECD, 2013. https://doi.org/10.1787/eag-2013-en.

Ohei, Kenneth Nwanua, and Roelien Brink. "Investigating the Prevailing Issues Surrounding ICT Graduate Employability in South Africa: A Case Study of a South African University." *The Independent Journal of Teaching and Learning* 14, no. 2 (2019): 29–42.

Oluwajodu, Faith, Lorraine Greyling, Derick Blaauw, and Ewert P J Kleynhans. "Graduate Unemployment in South Africa: Perspectives from the Banking Sector." *SA Journal of Human Resource Management* 13, no. 1 (2015): 1–9.

Pardaboyevich, Rakhmonkulov Feruz, Usarov Sardor Abdunazirovich, and Shabutayev Quvondiq Saydullayevich. "Teaching Computer Science at School-Current Challenges and Prospects." *JournalNX* 6, no. 11 (2020): 217–21.

Paterson, M., and T. M. Luesher. "African HE Can Be More Competitive through 4IR Technologies." University World News, October 26, 2022. https://www.universityworldnews.com/post.php?story=20221025083907664.

Peel, Karen L. "A Beginner's Guide to Applied Educational Research Using Thematic Analysis." *Practical Assessment Research and Evaluation* 25, no. 1 (2020).

Peelam, Mritunjay Shall, Anjaney Asreet Rout, and Vinay Chamola. "Quantum Computing Applications for Internet of Things." *IET Quantum Communication* 5, no. 2 (2024): 103–12.

Pereira, Nielsen, Sarah Bright, Zafer Ozen, Shahnaz Safitri, Hernan Castillo-Hermosilla, Brenda C. Matos, Tugce Karatas, and Pedro Fonseca. "A Multitiered Approach to Computer Science Talent Development." *Gifted Child Quarterly* 69, no. 2 (April 16, 2025): 130–46. https://doi.org/10.1177/00169862241307662.

Raihan, Nishat, Mohammed Latif Siddiq, Joanna C.S. Santos, and Marcos Zampieri. "Large Language Models in Computer Science Education: A Systematic Literature Review." In *Proceedings of the 56th ACM Technical Symposium on Computer Science Education V. 1*, 938–44. New York, NY, USA: ACM, 2025. https://doi.org/10.1145/3641554.3701863.

Sibiya, Mlondie Thlokomelo, and Thokozani Isaac Mtshali. "Teaching Graphic Communication and Techniques to Senior Phase Technology Learners: A Guide for Teachers." *International Journal of Education and Teaching Zone* 4, no. 2 (June 16, 2025): 195–207. https://doi.org/10.57092/ijetz.v4i2.390.

South African Qualifications Authority (SAQA). Policy and Criteria for Recognising a Professional Body and Registering a Professional Designation for the Purposes of the National Qualifications

Framework Act (2018).
StatSA. "Mid-Year Population Estimates." Statistics South Africa, July 2018.
———. "Quarterly Labour Force Survey (QLFS) Q2:2022." Statistics South Africa, August 22, 2022. https://www.statssa.gov.za/?p=15685.
Tasfi, Jarin Tasnim, and Shafi Md Mostofa. "Understanding Complex Causes of Suicidal Behaviour among Graduates in Bangladesh." *BMC Public Health* 24, no. 1 (February 22, 2024): 560. https://doi.org/10.1186/s12889-024-17989-x.
Turner, Dana P. "Sampling Methods in Research Design." *Headache: The Journal of Head and Face Pain* 60, no. 1 (January 8, 2020): 8–12. https://doi.org/10.1111/head.13707.
Vass J.R., and Raidani P. *Facts and Figures in Skills in Manufacturing Information Brief*. Pretoria: The Department of Trade and Industry, 2015.
Yin R. K. *Case Study Research and Applications: Design and Methods*. Thousand Oaks, CA: Sage Publications, 2017.

ABOUT AUTHORS

Ranta Patrick Langa is a lecturer at the University of Limpopo in South Africa specializing in Computer Science and Computer Application skills to students studying towards their Bachelor of Education. Mr Langa is also involved in Honours research projects of students in Technology Education in the same university.

Damtew Teferra is a Professor of Higher Education at the University of KwaZulu-Natal, South Africa. He has published extensively in the area of Higher Education and supervised numerous Masters and PhD students to completion.

Thokozani Isaac Mtshali is a senior lecturer and research chair in Technology and Vocational education at Tshwane University of Technology, South Africa. He has published books, book chapters, articles and conference proceeding in various national and international educational platforms. He has delivered various keynote addresses with special focus to TVET Education.