Future Technology Lab: A Plug-in Campus as an Agent of Change for Computing Education Research in the Global South

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1 Introduction

Computing Education (CE) and Computing Education Research (CER) at universities in the Global South (GS) continue to fall behind their counterparts despite the advancement in Information Communication Technologies (ICT). This could be attributed to the adaptation of universal computing curricula which were not developed for the realities in the GS. The imported curricula were not designed to suit the local context of underinvestment and under-resourcing of higher education in the GS [1], nor to fit the societal or business context in the GS and its demands, which are different from those in the Global North (GN). The contextual challenges often mean that the supposedly generic curricula by professional global associations such as the Institute of Electrical and Electronics Engineers (IEEE) and the Association for Computing Machinery (ACM), typically applied in developed countries, do not work well in the GS [1].

For a successful implementation of CE and CER, there is a need to rethink CE and CER in the context of the GS [2]. Universities are therefore adopting open innovation strategies to access and integrate external sources of knowledge for better collaboration opportunities to revitalise their education, research, or societal impact [3]. Researchers and practitioners are collaborating to gain an understanding of multiple aspects of teaching and learning processes of various topics in the computing curriculum to build generalizable evidence about problems in students'

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learning, to understand the efficacy of new teaching approaches to solve these problems which might be context-dependent [4].

CE is often characterised as a field that draws on approaches and methods from cognitive psychology, education, and computer science [4], thus there are no specific methods and approaches for teaching computer education.

For CE to reshape based on the expectations of the GS, cross-border activities are taking place through studying abroad and via online exchange programmes [5]. Cross-border refers to teachers, students, institutions, or course materials crossing national jurisdictional borders [5], and this form of education has evolved in which established universities expand their services through the establishment of satellite campuses also known as branch or offshore campuses [5].

While these campuses are self-contained and fully functional, parent universities retain full autonomy to run these satellite campuses [3], attracting experienced professors, researchers and funding, thus contributing to their host country's economic and human capital development [5]. Satellite campuses however entail the risks of crowding-out local universities, which may result in those universities receiving less public funding, consequently facing greater challenges and difficulties in attracting the best academics, researchers, and students [6]. Calling for collaboration between universities instead of competition is thus of prime importance for mutual learning and reform.

A plug-in campus is an alternative to a satellite campus, introduced by a university in the GN as a catalyst to accelerate research, innovation, and development in a host university in the GS [3]. In our case, the Future Tech Laboratory (FTLab) is a concrete example of a plug-in campus of the University of Turku (UTU), which was established to accelerate educational practice and related CER for the University of Namibia (UNAM). UTU and UNAM have a mutual understanding and a bidirectional relationship of collaboration, growth, and cross-inspiration. This chapter provides a case study of how CE, research, and innovation are being reshaped through the FTLab and draws lessons to transform CE in Namibia. The chapter presents a range of contributions that the FTLab has made in Namibia by engaging in different missions: teaching, research, and community engagement. It is worth noting that all initiatives adopted from Finland were contextualized to suit the Namibia context, as they were developed for Finland rather than for the Namibian realities. The present study adopted the design reality gap framework to analyse, comprehend, evaluate and improve the implementation of the FTLab initiative. This research is the first to study the contribution of a plug-in campus to improve CER in Namibia.

This chapter is structured as follows: Section 2 presents how Hevner's [7] Design Science Research (DSR) was presented in this study to identify demands that better fit to contextualise CER in the GS. Section 3 presents the results, discussing the Relevance of the environment, which is the Namibian society, focusing on the expectations of CE, especially as identified by the activities of the FTLab. Section 4 presents the results on the Rigor (based on literature), where the Design Reality Gap (DRG) model [7] was introduced as a tool to show the discrepancy of a European plug-in campus in the GS. In Sect. 5, results of the Design cycle are presented, suggesting solutions to the requirements identified in Sect. 3. Section 6 presents the discussion and recommendation. Conclusions and future work are presented in Sect. 7.

2 Research Design

To contextualise CE and CER to better fit the demands identified in the GS, DSR was applied in this study [7]. DSR is a pragmatic and constructive research approach that makes use of research to design a solution, called an artefact, to an identified problem, as expressed in a given environment, in a way that considers the contemporary knowledge base.

Thus, DSR applies in parallel three threads, called relevance, rigor, and design cycles, as depicted in Fig. 1. The relevance cycle ensures that the design process is based on the real demands of the given environment, the rigor cycle identifies and integrates the key aspects of the contemporary knowledge base and updates the knowledge base by the input of the DSR instance, and the design cycle integrates design and evaluation iterations for constructing the solution [7].

The DRG will be applied on how to make CE and CER relevant in the GS, instead of being no more than an imported product. In our case, the cycles are instantiated in Sects. 3, 4, and 5.

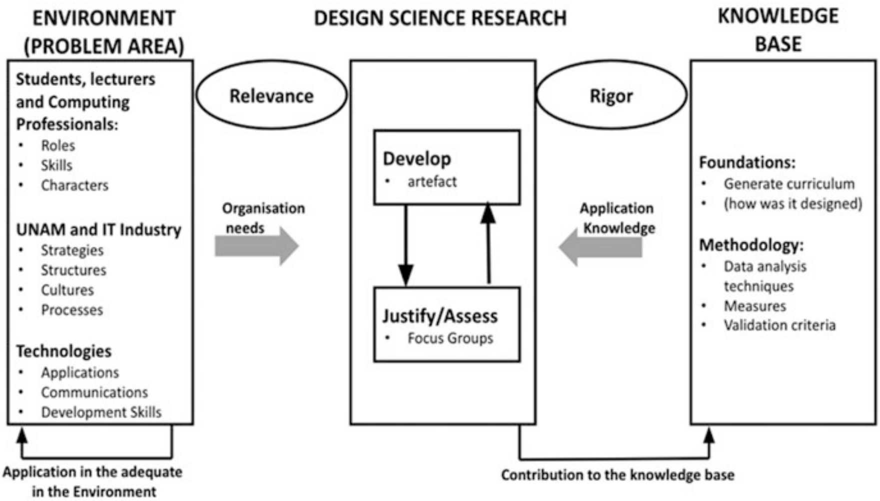

Fig. 1 DSR as used in this study. (Adapted from Ref. [7])

3 Relevance

The relevance cycle is based on the expectations for CE and, hence, CER, expressed by the Namibian society and exemplified by the observations in the FTLab activities.

3.1 CE and CER Requirements in Namibia

Computing Education is a much younger field than other branches of science education in Namibia. As such, CE is primarily taught at university level and mostly as an elective in private schools. Lately, a few public schools have introduced computing education. There are however no specific requirements to enroll for CE in primary and secondary school in Namibia. Also, the computing curricula at secondary school and at university level in Namibia are disconnected as the university does not continue with what was taught in secondary school. Hence, students who apply for computing-related degrees at universities in Namibia do not need to have prior computing knowledge.

Computing Education has gathered momentum over the past years, focusing on teaching programming and teaching methods in computing. However, missing or limited infrastructure, power systems delivering electricity access, as well as internet access, computing teaching efficacy, and the bureaucratically heavy process of updating CE curricula in both secondary and higher education in Namibia are among the challenges hindering the progress of CE. Research on how to teach programming using robotics in Namibia is at the forefront of educational institutions [8]. Research on computing education is notable in Namibia [8], for example, in studies aimed at narrowing the gap between academia and industry [9].

3.2 The Concept of the FTLab Plug-in Campus

To accelerate computing research, innovation, and development in Namibia, the FTLab was implemented at the UNAM. The FTLab is an example of a plug-in campus, an alternative to a full-scale branch or satellite campus that makes use of the host university's infrastructure by renting a small space from its host [3]. The term plug-in refers to the campus's flexibility to its students and making use of the host university's services. A plug-in campus concept evolved from an arrangement between UTU and UNAM whereby UTU wanted to reshape itself to the challenges of another geographical and demographic context and UNAM wanted to renew its education, research, or societal impact [3]. The flexible nature of the plug-in campus allows students to work from anywhere at any time as they are not bound to its physicality. Apart from being plugged into a host university, it can also be plugged into a professional life or an individual life, as illustrated in Fig. 2.

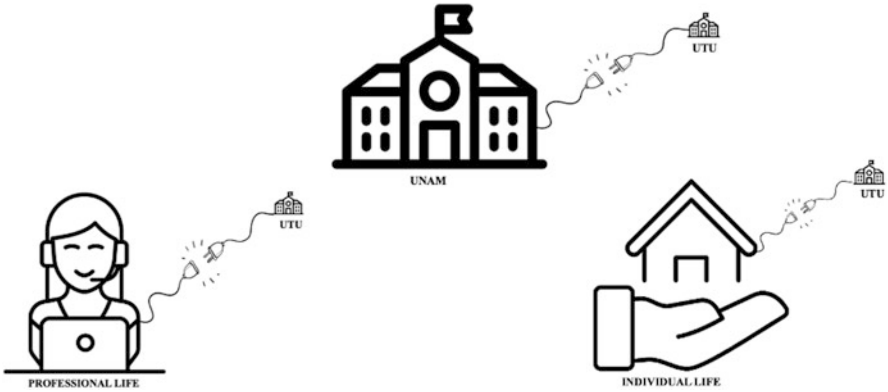

Fig. 2 Concept of the plug-in campus

Through various initiatives such as learning and teaching, projects, research, and innovation happening at the FTLab, required skills can be stimulated. According to [9], the competencies requirements in the SE industry and postgraduate studies in Namibia do not match the skill sets of graduates. Various activities are therefore introduced at the FTLab to assist with narrowing the gap between the SE industry and academia in Namibia. Moreover, strategies are developed to accelerate CER in Namibia and the GS. Those initiatives at the FTLab are being accelerated with the assistance of all involved universities, and external stakeholders: public sector or government, private sector, and other employers, start-up community, and the Non-Governmental Organisations or civil society. The foundation and products of the FTLab are depicted in Fig. 3 using the concept tree.

The roots of the tree illustrate the attributes such as values and resources etc. that the plug-in campus was built for. The trunk of the tree illustrates the activities to be enhanced, the branches illustrate activities happening while the fruits are the end products (achievements) such as degrees, partnerships, etc. of the FTLab.

3.3 Expectations from CE and CER as Identified by the Research, Development, and Innovation Projects at the FTLab

Projects at the FTLab provide new CER opportunities that need to be addressed. The main project at the FTLab is the establishment of the remote presence project that aims to design and develop the use of remote presence technologies to create a greater sense of togetherness for its community [10]. Projects at the FTLab involve local communities in co-designing and co-developing applications to suit the context of those communities, such as the projects on climate services for small-scale farmers [9].

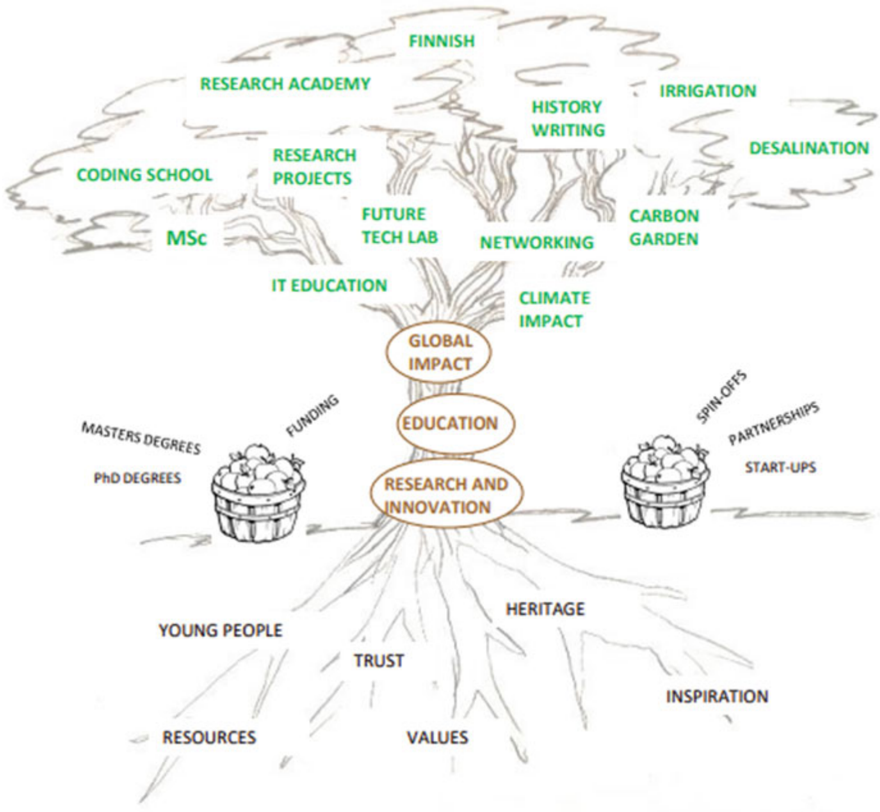

Fig. 3 Concept tree of the plug-in campus

Since the inception of the FTLab in 2019, more than 40 research articles have been published based on joint research projects [10], that resulted from collaborations mostly between Finnish and Namibian researchers. Finland is known for its high-quality education and research which Namibia could benefit from and learn from some of its approaches.

3.4 Accelerating CE in Namibia Via the FTLab

According to the original plans, the FTLab aimed to offer opportunities to students in Namibia through its coding school, micro-credentials or short courses, a master's degree in SE, and a doctoral degree in Computer Science [10]. Both degree programmes offered at the FTLab are adapted from the UTU main campus and contain contextual elements in projects and demonstrations [10]. The MSE programme is structured in a way that would allow students to design, develop, implement, and evaluate software solutions and understand IT-related challenges in the GS to meet local and international requirements [10]. Graduates from the doctoral programme will be able to conduct both independent and collaborative research and possess leadership competencies.

Micro-credentials or short courses are offered on a need basis, and currently the Sustainability Engineering module of 20 ECTS credit points received funding and will be offered at the FTLab. Co-teaching also happens at the FTLab, for example, an Artificial Intelligence course registered under the Department of Computing, Mathematics and Statistical Sciences (DCMSS) at UNAM was co-taught by a lecturer from the DCMSS, a professor from the FTLab, and professionals from the industry [11]. Short, concise, and hands-on courses based on domain-specific programming languages are also offered at the FTLab, see [10].

Although one of the aims of the FTLab was for students enrolled in the PhD and MSE programme to work closely with students from UTU's main campus and both local and international SE companies, unfortunately, the FTLab only managed to attract students for the PhD programme.

3.5 Community Outreach at the FTLab

The FTLab has assisted in the acceleration of CER in Namibia through both online and physical events and workshops over the years since its establishment [3]. Both projects carried out at the FTLab contributed to the enhancement of CER in Namibia. In 2021, the FTLab hosted a one-day event that introduced learners from the C.I.D.S Centre to the basics of robotics to spark the learners' interest in Science, Technology, Engineering, and Mathematics (STEM) [10]. In addition, a crash course on the Finnish language was offered at the FTLab to spark interest in the Finnish language. The FTLab has also been on the wheels, towards being a mobile plug-in campus shaping as a metaversity [12], offering robotic lessons at different institutions such as Nakayale in Ruacana, De Duine High School, and Walvisbay Primary school, as well as at the UNAM Engineering campus in Ongwediva.

4 Rigor Cycle

The rigor cycle summarises the relevant knowledge of satellite campuses – of which the FTLab is an example – and presents Heeks' design-reality gap [1] as an analysis tool for identifying, understanding, and correcting the shortcomings of direct imports of design from the GN so that they could work in the GS.

4.1 Satellite Campuses as Agents of Change for CER in the Global South

Satellite campuses have become important dimensions of higher education as their establishments are often motivated by institutions' willingness to increase their quality of teaching and research activities, visibility, and attraction to public funding [13]. These campuses are normally set up in areas previously lacking a university or where local universities are under-resourced to meet the high demand of their localities by engaging in all their missions: teaching, research, and business and community engagement [14]. Satellite campuses are outcomes of either regional institutions that are merged into larger universities or are related to strategies of territorial diversification of large universities [15] and are likely to attract the best students, staff, and visitors such as guests, institutional visitors, seminars, congress, and event attendees [16]. According to Miller-Idriss and Hanauer [5], most satellite campuses are found in the Middle East. Other satellite campuses include Carnegie Mellon University, a US university in Kigali, Rwanda [17]. Monash University also has a satellite campus in South Africa [18]. Similarly, satellite campuses are being set up in countries in the GN as well, for example, the Limkokwing University of Creative Technology, a Malaysian-based university has a branch campus in London [19]. In Namibia, Limkokwing University of Creative Technology is busy setting up a satellite campus in Windhoek. Botho University [20] is another international university with a branch campus in Namibia.

Satellite campuses belonging to international companies bring competition to public universities instead of collaborations. These universities also experience challenges – cultural diffusion, governance, enrollment, establishment and operation risks, and quality education – that need to be addressed when setting up satellite campuses [14].

There is no doubt that satellite campuses yield benefits for the host country, but the success of these campuses depends on consulting local stakeholders to identify local strengths. Since the FTLab is similar to satellite campuses (see differences between the plug-in campus and satellite campus [3]) the beneficiaries are of different socio-economic and cultural dimensions, hence those designs might not fit the local realities. Heek's design reality gap model [1] was then adopted to evaluate the implementation of the FTLab to assess the gap that might have occurred in the design expectation and the realities of the FTLab.

4.2 Evaluating Progress and Challenges Via Design-Reality Gap (DRG) Analysis

The Design-Reality Gap (DRG) model was developed to analyse organisational change and the risk associated with it, and argues that the design expectations of an organisation may match or mismatch the real situation found in the context of

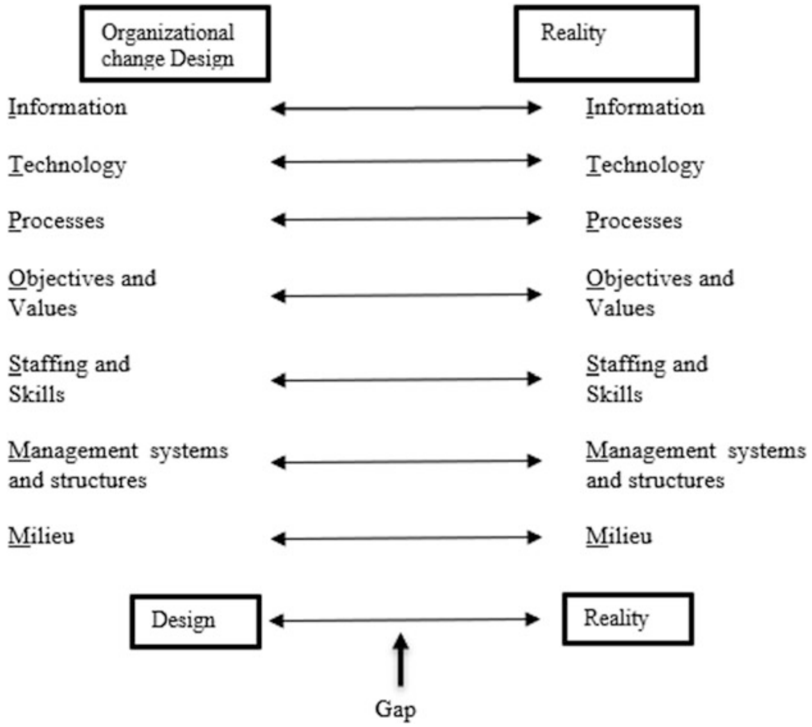

Fig. 4 The DRG model for analysing change [1]

the implementation [1]. There are eight extensions of the DRG, and they can be summarised with the OPTIMISM mnemonic as illustrated in Fig. 4 [1].

The DRG model can be applied as either a risk analysis tool or a project evaluation tool [2]. When the DRG model is used as a risk analysis tool, the design and reality are assessed cross-sectionally at a particular moment in time to assess the gap. The larger the gap, the greater the risk of project failure and vice versa [1]. On the other hand, when the DRG model is used as a project evaluation tool, the design and reality are assessed longitudinally; with the expectations within the design compared to the reality sometime later after implementation (though recognising that implementation is often an ongoing process that can rarely be seen as completed) [2]. This study adopted the latter to enable us to assess the extent of success or failure of the implementation of the FTLab since its inception in 2019. Moreover, areas in which further changes are required are identified for further improvements. Two staff members of the FTLab who are based in Windhoek were interviewed and the results are presented in Sect. 5.

5 Design Results

The design cycle collects the process as a solution for removing the gap in the tension between design (a universal model of CE and CER) and reality (contextual demands of CE and CER in the GS). The progress of the implementation of the FTLab is examined by adopting the DRG model with the assumption that there will be gaps in the design of the ideal FTLab as initially proposed, and the reality observed in its current implementation.

5.1 Identifying and Analysing the Design-Reality Gap at the FTLab

According to Bass and Heeks [1], the success and failure of a system are multifactorial, hence the importance of considering the environment where an initiative is implemented. We present the gaps using each of the eight OPTIMISM dimensions of DRG in turn [1]. Besides the DRG in the FTLab itself, we also enlist gaps identified by the activities run at the FTLab.

Objectives and values (both formal strategies and culture, and informal goals)

Design Expectations

The FTLab aims to catalyse and accelerate CE and in turn CER at UNAM with the emphasis on contextual innovation, collaboration, and mutual interaction between UTU, UNAM, Finnish–Namibian industrial partners, and local communities [3]. The objective is to be met through co-working on projects, co-designing applications, and co-learning different technologies. To realise its objectives, the FTLab was designed to include the implementation of state-of-the-art remote presence technologies for online learning of short courses, a masters, and PhD degree programmes [21]. Since degree programmes have the same requirements as the main campus of UTU, students in Namibia and Finland need to attain equal ECTS (European Credit Transfer System) credit points and complete a thesis to graduate with both masters and PhD degrees.

Reality

Co-creation of applications and co-working on projects is ongoing at the FTLab. Currently, both local and international students are enrolled in the PhD programme. Although there have been calls for applications for the master's degree, there are no students enrolled in the master's programme. This could be attributed to the English language test entry and the cost of the master's programme. Also, activities at the FTLab slowed down during the Covid-19 pandemic.

Design-Reality gap

The observation in the study shows that there appears to be a relatively good match between the design expectation and reality in terms of objectives and values at the FTLab. However, an ethnocomputing-based approach in ICT-related education could be implemented, based on an indigenous community's context-driven principles [22]. We therefore recommend collaboration between students and lecturers to work together to contexualize the curriculum. The FTLab could harness software development to develop an online digital library to motivate users to contribute "resource-scarce languages" on a Web-based portal, as similarly done in a study in South Africa [23].

Processes (from individual tasks up to broader business processes)

Design Expectations

There are ongoing collaborations between the Finnish-Namibia community, universities, and industry. The processes are supported via writing, grants, sponsorships, and community services. The emphasis at the plug-in campus relies on graduating students who understand IT-related challenges to meet local and international requirements.

Reality

These initiatives are effective to support these processes. Students at the FTLab work closely with industry and there are ongoing collaborations across different disciplines. For example, the UNESCO summer school received sponsorship from international industry, see [24], community projects [25], and co-writing of grant proposals amongst both Finnish-Namibian communities are ongoing. However, no grant has been successful thus far. The FTLab has been successful in research, and this is evident in articles published by researches from the FTLab, see [10]. There is however a need to come up with initiatives to stimulate industry-academia collaboration as there is a disconnect between academia and industry in Namibia. Neither party seems to see the relevance of collaborations or a need to strengthen existing ties.

Design-Reality gap

There has not been an observation in terms of the masters degree programme. For the PhD programme, the FTLab did not attract a lot of students. However, other initiatives are a success, so the study shows that there appears to be a relatively good match in other initiatives and an unmatched in the masters and PhD programmes.

Technology (ICTs and other relevant technologies)

Design Expectations

The FTLab has a project that aims to remove the critical research hurdles holding back the use of sensory immersive 3D video as an alternative to ordinary videoconferencing. The state-of-the-art immersive telepresence entails the design and development of a custom live 3D capture system for a higher fidelity immersive experience, targeting local and remote collaboration of small groups of two (2) to six (6) [26]. Also, there is stable Internet connectivity at the FTLab. These technologies are to enable collaborations from Finland in a remote presence. Other technologies like printers, projectors and robotics sets are also available at the FTLab. Current students have access to the online library and classes at the main campus of UTU.

Reality

The state-of-the-art immersive telepresence to support the practical and collaborative group work element in the remotely taught degrees as initially proposed was not implemented but is under development in the Academy of Finland funded project in 2021–25. However, the internet connectivity is stable, and learning is still possible at the FTLab.

Design-Reality gap

The observation in the study shows that there appears to be a mismatch between the design expectation and reality in terms of technology at the FTLab. The immersive telepresence as initially proposed was not implemented and is under development but could be better integrated to CER. There is however basic technology to operate at the FTLab.

Information and access to it (data stores, data flows, etc.)

Design Expectations

Effective implementation of the FTLab depends on effective information flows between stakeholders: students, staff, local and international communities, and industry.

Reality

- *Access to the Lab*

  Students and local communities and industry can make use of the FTLab to co-design and co-develop projects. There is a campus coordinator, and students can always get the keys to the FTLab when they want to use the facilities to host workshops, teach or study.

- *Access to the lecturers*

  Most courses are offered online from the base university and for short courses offered physically, students and other participants can either email lecturers or set up meetings physically or online.

- *Access to industry*

  One of the objectives of the FTLab is to enhance collaboration with external stakeholders, both locally and internationally. The FTLab also provides space for member partners to use the FTLab. Also, there have been webinars for industry-academia interaction [10].

Design-Reality gap

The observation in the study shows that there appears to be a match between the design expectation and reality in terms of information (data stores, data flows, etc) at the FTLab. There are expectations of open data being available to be used outside or inside of the FTLab. These data include but are not limited to data from research articles published or climate data from developed climate applications. There is however a need to increase the involvement of local industry to guide activities at the FTLab.

Management structures and systems

Design Expectations

Since the FTLab is an offshore campus of the UTU, its management and structure, and faculties are of the base university.

Reality

The majority of staff members are based at UTU's main campus. There are however two full-time staff: a professor and the campus coordinator based at the FTLab. When the need arises, UNAM offers its staff members to assist with activities at the FTLab. The flexible nature of the FTLab allows for UNAM staff to assist in co-design and co-working with the Namibian community. The management structure and systems are those of the base university.

Design-Reality gap

The observation in the study shows that there appears to be a mismatch between the design expectation and reality in terms of management structures and systems at the plug-in campus. Although there is mutual collaboration between UNAM and UTU, the FTLab faces a challenge in offering co-courses with UNAM as the integration of courses is difficult due to different accreditation systems. For example, UTU offered courses such as tiny machine learning to UNAM students, but these students cannot use credits from such courses for their studies at UNAM. Joint courses and joint professorship between both institutions could be initiated.

Financial Investment

Design Expectations

Financial support comes from heterogeneous, mutually independent sources: industry of the base, host and third countries, grants, participants attending workshops, summer schools, or alike, and students registered for degree programmes [3].

Reality

There have not been intakes of master's students and no grants application has been successful so far. Funds at the FTLab come from the base university and industry of the base country who pay membership fees, and from participants attending workshops, and summer schools. The master's degree programme is expensive compared to masters degrees programmes offered by local universities. Also, companies did not send their employees for studies as anticipated.

Design-Reality gap

The observation in the study shows that there appears to be a relative mismatch between the design expectation and reality in terms of financial investment at the plug-in campus. Companies did not send their employees or sponsor students who will work on real research projects for those companies in return. Although there were industry members who would pay membership fees, the FTLab did not attract enough members, especially locally. Local companies do not see the benefit of applying for joint projects funded by external sources as they see UTU primarily as a customer or a donor. The FTLab mostly depends on financial support from its base university. Hence there is a need for the FTLab to create initiatives to generate revenue to complement resources provided by the base university.

Staffing and skills

Design Expectations

The FTLab focuses on ensuring the quality of its main campus is met but in the context of the satellite campus [14]. PhD courses are taught by lecturers from the base university as well as the supervision of the thesis. For workshops, UNAM offers its staff members to assist in collaboration with UTU or industry practitioners.

Reality

There is a full-time professor at the plug-in campus, supervising PhD students. These students also have co-supervisors based in Finland or elsewhere. Most of these professors are affiliated with UTU. There is also a campus coordinator who is responsible for all issues at the FTLab. Staff members at UNAM also assist by co-teaching workshops and are involved in community projects. Local and international industry partners also give seminars at the FTLab.

Design-Reality gap

The observation in the study shows that there appears to be a good match between the design expectation and reality in terms of staffing and skills at the FTLab given the number of students currently registered. However, there is a need for more lecturers to join if the number of students increases.

Milieu (the external political, economic, socio-cultural, technological, and legal environment)

Design Expectations

The qualification offered at the FTLab is offered following the European standards. Legal and political contexts in Namibia are not violated.

Reality

The success of the FTLab is multifactorial, and the financial, cultural, and environmental factors are discussed in [3]. For the legal and political context, the government of Namibia supports the implementation of satellite campuses and collaborations between foreign and Namibian universities. Since these degrees will be accorded by the base university, there is no need to involve the national accreditation body in Namibia to accredit the degree programmes. However, upon completion, students are expected to submit their qualifications for evaluation with the Namibia Qualification Authority, a body responsible for accrediting foreign qualifications [27].

Design-Reality gap

The design expectation and reality in terms of the milieu of the FTLab are met. There are no graduates of the plug-in campus yet. CER for designing CE solutions for the economic and digital freedom of computing graduates needs to be stimulated to serve the communities better. In our view, we perceive Africanization, e.g. in CER, as an enriching approach, rather than designing applications that are not for the African reality, as sometimes has been happening.

6 Discussion

Computing education at most African universities follows the IEEE and ACM curriculum, a curriculum developed to solve problems for developed countries [1]. With the way computing education is currently taught at universities in the GS, there is a need to reform the curriculum to train graduates who will get inspiration from local challenges and learn to solve problems using the best expertise available worldwide [28]. We adopted DSR to find a solution that better fits to contextualise CE and in turn enhance CER in the GS. We also adopted the DRG model to provide lessons learned during the first 3 years since the establishment of the FTLab. We can observe a cornucopia of new challenges and opportunities which – when attended to with imagination, curiosity but also hard work over decades of cross-cultural collaboration – can transfer the field of CER onto a new level of relevance, also globally, inspired and cross-fertilized by the dialogue between the CER communities in the Global South and the Global North. We summarise the agenda below.

Contextualization One of the key lessons we have learned is the importance of contextualization of Computing education. While the theory of computing is universal and context-independent, the users of the artefacts created by computer scientists are local with their related requirements and demands, based on their everyday milieu. This is the reason that the imported Computing curricula, especially when they are not rethought of in the context, do not work, but rather lead to queues of unemployable computing graduates. The conventional process of first importing (I) a Global North curriculum to the South, then transferring (T) it to a given place, applying (A) the learning contents by localising, and last and usually least contextualising (C) whenever there is time and resources left [29] could be considered. The main effort is in the I phase, also called education export, and the least is left for the C stage. Vesisenaho (2006) [29] has turned the concept around into his CATI model, where the primary emphasis is on contextualization. Only two universities in southern Africa: the University of Pretoria and the University of Johannesburg have adopted the CATI model while the rest of the universities follow the traditional approaches [12].

In Namibia and the rest of the continent, contextualization can be called Africanization [30]. But unlike the occasional, dismissive use of the concept, leading for example to reducing requirements and teaching programming in Africa in a superficial way, Africanization means taking the continent's exceptional while still much-hidden talent pool seriously and, thus, extending, deepening, and reforming CER by the challenges and potential of Africa, its people, and cultures. A process of Africanizing CE might also involve ethnocomputing [22], or finding an alternative entry point to computing, without sacrificing the discipline's core.

Curriculum reform The current Computing curricula in most universities in the GS are theory-based adaptations of the universal Computing curriculum, and students' learning outcomes are mostly measured by conventionally written examinations, emphasising memorization. Among other obstacles preventing the much-needed transformation towards problem-based curricula, it seems that the universities' financial challenges, teachers' heavy teaching loads, and latent loyalty to international curricula as well as the massive number of students have made faculty very conservative and resistant toward modern teaching and learning methods. However, based on the observations of the courses offered at the plug-in campus, students learn and get excited when solving real-life problems. This is evident in the courses in robotics [10].

CER in informal and non-formal CE Besides conventional CE degree programmes, the challenges of the highly demanding settings in the GS call for alternatives. Besides professional development courses, various micro-credentials have been suggested as informal and non-formal CE solutions in the GS. Instead of a degree-oriented approach, students can learn competencies that they want in the order they see fit, and, in some cases, the process can end up with a highly individualised degree. Interestingly, due to the fast-growing and fast-changing competencies, micro-credentials have also gained importance in the European Union, indicating the global importance of the CER in the GS. However, in the GS, micro-credentials might be frugal pedagogical innovations, with micro-loans as their financial paragon.

Off-shoring One of the key challenges for CE and CER is the employment of graduates. For example, major international companies increasingly employ software engineers in India; the arrangement is referred to as off-shoring. One of the FTLab PhD students is devising approaches by which Namibia could be an offshoring destination, but for SMEs of the GN.

Fast-tracking learning The luxury of studying K-12 years at pre-primary, primary, and secondary school and attending university for the following 4–10 years is not possible for most young people in Namibia, and even less in most other countries in the GS. The GN model for education does not work, and neither does CER, which assumes the northern educational structures, principles, and practices. At the same time, societies in the global south require well-educated and trained employees, experts, and entrepreneurs to advance the field of CE. This means that the CER community needs to come out from their zones protected by well-funded institutions and radically imagine, invent, and innovate fast-tracked learning for computing.

Devising future technologies The whole concept of the plug-in campus is based on the expectation that a university can grow to an increasingly relevant form when it is located outside its original milieu. The COVID-19 pandemic showed the nonnecessities of a traditional university: much of lecture rooms and other physical facilities were not required but could be replaced by their digital counterparts. These observations and experiences that were imposed by the pandemic chased the university community outside their former comfort zone. Concepts such as the metaverse [12] and remote presence would pave the way toward novel solutions in this direction.

As of the interdisciplinary stage behind CER, the requirements from the GS call for an extension. Relevant and meaningful CE and, hence, CER in the GS requires close collaboration beyond the three current academic fields of Computing, Cognitive science, and Education. Contributions from business studies, social science, and cultural and development studies are critical.

Shortcomings of the study The GS certainly exceeds the boundaries of Namibia and, therefore, our results cannot be generalised to the whole South. However, DSR always starts from an identified but limited environment for ensuring concrete results. In the future, we intend to extend our environment to a set of diverse environments from the Global South, thus also extending the DSR methodology.

Secondly, our design cycle did not include the critical build task, but only came up with a list of suggestions to enhance the contemporary CER agenda, reflecting the requirements of the GN. However, Heeks's tools [1] for the design gave the scheme to integrate evaluation within the design task.

7 Conclusion

We presented how the Future Technology Lab (FTLab), a collaboration between the University of Turku, in the Global North, and the University of Namibia, in the Global South, responded to the computing education and computing education research respectively in the Global South. We applied the research methodology following Hevner's Design Science Research: relevance, rigor, and design cycles without really reaching the design stage to understand the local environment and existing knowledge on computing education and computing education research in the Global South. We applied Heeks's Design Reality Gap as a tool to show the discrepancy between a plug-in campus initiative and the realities in the Global South. Since this was a longitudinal analysis, the process is ongoing and thus cannot be seen as complete. The gap was only identified from activities at the FTLab since its inception in 2019.

Although all eight dimensions of the Design Reality Gap presented challenges in our study, there appears to be a relatively good match between the design expectation and the reality at the FTLab. Based on the results of the study, employment of graduates is one of the key challenges for CE and CER in the Global South, hence a need to move away from importing the curriculum and instead reform and fast-track the curriculum. Metaversity and remote presence concepts could replace traditional universities to pave the way toward novel solutions. Shifting universities online could enhance collaborations between both local and international universities and industry, hence opening collaboration opportunities and exposing students to offshoring.

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