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The Role of Human Centered Design (HCD) and Challenge Driven Education in Enhancing the Innovation Capacity of Africa's Young People: Case of Youth for Children (Y4C) Innovation Hub in Tanzania¹

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Abstract. As the world advances rapidly and economic conditions continue to change, issues such as globalization and changing labour markets are putting a huge pressure on youth worldwide. There is an urgent need for young people to be trained with flexible set of skills that will allow them to take the front seat and actively contribute to initiatives directly affect their development. The first step towards addressing the pressing concerns of today's youth, especially in Africa, involves improving the existing education systems. This paper elaborates curriculum improvement in education systems by adapt a human centered design (HCD) and Challenge-Driven Education (CDE) approaches that encourages students to work on projects that address real challenges solicited from industry partners. Youth for Children (Y4C) innovation hub, a partnership between UDSM college of ICT (CoICT) and UNICEF Tanzania, was established in 2016 to promote child rights and provide the design skills and social context to support students in developing products and solutions with real social value. Y4C Hub provides unique value in its emphasis on HCD and CDE approaches where projects are undertaken for a period of one year and are directly linked to solving real challenges facing the society in collaboration with the challenge owners and mentors. In the year since launching the hub, 173 CoICT students, 36 supervisors, and 50 secondary school girls have been trained on HCD. A Final Year Project course curriculum has been reviewed to reflect a more challenge driven approach, offering a chance for promising projects to be incubated.

Keywords: Human Centered Design, Innovation Ecosystems, Challenge Driven Education.

1 Introduction

For a long period of time, young people have been famously coined as the "future generation", hence unwittingly overlooking their contributions in critical areas such as education, policy making, peace negotiations and leadership. Consequently, as the world progresses, current solutions and innovations are failing to capture the dynamic demands, experiences and perspectives of the young generation.

Meanwhile, as the world advances rapidly and economic conditions continue to change, issues such as globalization, automation, changing labour markets and climate change are putting enormous pressure on youth worldwide. Job markets now demand a set of digital-savvy youth who possess high perseverance and determination to cope with the

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dynamic market shifts. The World Bank president Jim Yong Kim, at the UN Youth2030 strategy launch [9] pointed out that the current population of young people between 15 and 30 is 1.8 billion, and half a billion of the young people that live in developing countries are either underemployed or hold insecure jobs. Moreover, 300 million continue to live with no employment or education

Therefore, there is an urgent need for young people, especially in developing countries, to be trained with a flexible set of skills that will allow them to take the front seat and actively contribute to initiatives that directly affect their development and wellbeing. With 79% of the Tanzania's population under 35 years [8], mainstreaming innovations for youth and supporting youth-led innovation is critical. As the institutions that are training the next generation of leaders, researchers, designers, and policy-makers, public universities are an essential part of this landscape. Especially in ICT fields, rapidly evolving technologies and corresponding market demands are not always reflected into the curriculum, meaning that even among university graduates, a relatively privileged group, there is an employability gap between the skill-level of graduating students and the skills required by many employers in Tanzania.

Most final year university students in Tanzania spend their final year working on a project. Many students do not select projects that address real life challenges, but instead go for "off the shelf projects just for the sake of fulfilling examination requirements. Unfortunately, these projects are often developed in a vacuum, resulting in products and services that do not address a clear market need or social problem and provide little practical experience for students.

The first step towards addressing the pressing concerns of today's youth, especially in Africa, involves improving the existing education systems. Education systems should adapt a challenge-driven approach that encourages students to work on projects that address real challenges solicited from industry partners. Students, especially in higher learning institutions, may build on promising projects from graduating students in order to turn projects in to solutions while fostering sustainability. Human-centered design and design thinking are critical process frameworks to guide these challenge-driven projects. Designing and innovating with the human in mind enforces students to apply design methods to conduct rigorous research and transform insights into products and services that meet user needs and market demand particularly in ICT, low-resource/low-infrastructure settings.

Youth for Children (Y4C) innovation hub was established in 2016 to promote child rights and provide the design skills and social context to support students in developing products and solutions with real social value. Y4C Hub is housed in a dedicated space at University of Dar es Salaam (UDSM), College of Information and Communication Technology (CoICT). Recognizing that over half of Tanzania's population is under the age of 18, University of Dar es Salaam (UDSM), College of Information and Communication Technology (CoICT) and UNICEF Tanzania have jointly established the Youth for Children (Y4C) Innovation Hub on CoICT campus to promote child rights and invest in human-centered, open innovation that contributes real social value. This initiative is committed to mainstreaming innovations for children and young people and supporting youth-led innovations in Tanzania, offering a hub space for design and prototyping alongside courses, trainings, and seminars as illustrated in Fig. 1. Students are guided based on a HCD process to develop early-stage, open source, products, services, and research that address community challenges.

Y4C Hub is an innovative model of partnership between development actors (in this case, UNICEF) and local universities (in this case, UDSM) for enhancing the critical thinking and innovation capacity of young people and inspiring them to create public goods and generate positive social value.

Y4C Hub provides unique value in its emphasis on human centered design and challenge-driven approaches where projects are undertaken for a period of one year and are directly linked to solving real challenges facing the industry/society in collaboration

with the challenge owners and mentors. In the year since launching the hub, the primary focus has been on developing HCD courses and training programmes for CoICT undergraduate students, with the goal of ensuring that the 120+ technology-enabled projects coming out of College of ICT each year are developed with an understanding of user needs and market demand. The process is underway to fully-integrate Y4C Hub within UDSM curriculum where it can feed a pipeline of open-source products and services for Tanzanian children and youth. The first cohort of students completed the final year project (FYP) course and pitched their projects in July 2018.

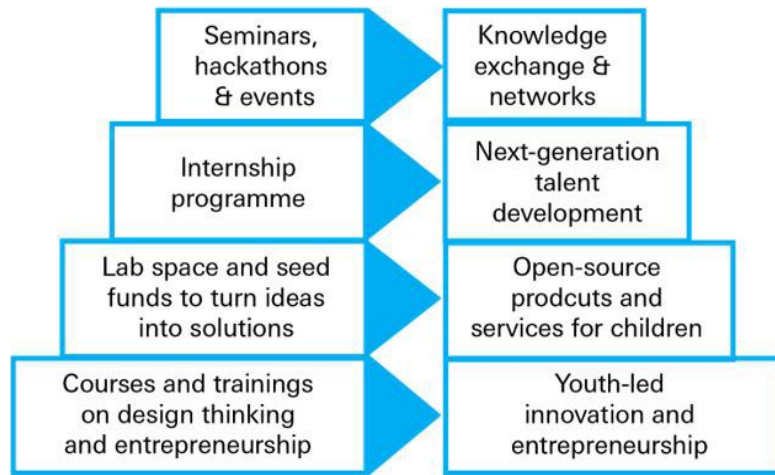


Fig. 1. Y4C Hub Activities and Expected Outputs

It is imperative to mention that the innovation ecosystem in Tanzania has many actors and is rapidly growing. In 2017, UK Aid funded research on the innovation ecosystem in Tanzania and the report reveals that there are currently 33 innovation hubs (22 incubators and 11 labs) in Tanzania mainly focusing on health, agriculture, energy, data collaboration, education, technology, gender issues, research and political science [1]. Y4C Hub stands out from the rest of existing innovation hubs because it is housed within a public university, allowing Hub programs to be fully integrated into departments' core curricula and ensuring long-term sustainability. Y4C Hub is also differentiated by its emphasis on capacity building. Landscape analysis and observation indicate that many innovation actors focus primarily on supporting innovation outputs, such as ideas, products, and business concepts, while Y4C Hub focuses more on innovation process, beginning with design research, problem framing, and understanding user needs. Equipping young people with these innovation skills will serve them beyond the scope of any particular product or business they develop.

2 Related Work

2.1 Human Centered Design & Design Principles

Human centered design begins with the user and moves towards the solution, and throughout the development process, the user remains as the focal point. The human centered design approach, as depicted by IDEO's design process [14] in Fig. 2 requires designers to be aware of assumptions about the problem and suspend any prior thoughts of what the solution to the problem might be, and instead rely on conducting research to fully explore and understand the needs, desires, behaviors, attitudes and beliefs of the

users in order to formulate a problem statement based on the research rather than designer's prior knowledge and assumptions.

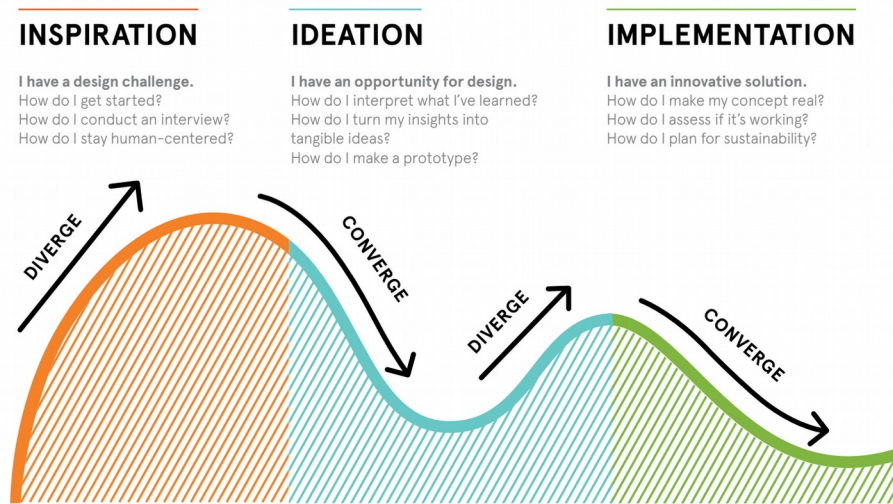


Fig. 2. Human Centered Design Process

Y4C Hub aims to introduce modern design practices as an indispensable part of 21st century digital development. In this, it joins a large and growing number of schools and organizations globally that teach human-centered design as the preferred process for creative problem solving and strategic management.

At CoICT, human-centered design is integrated as a complement to a technical discipline, with a strong emphasis on design research and problem framing. ICT disciplines were identified as being particularly well-suited for this type of integration, both because of the partner's (UNICEF Tanzania) expanding portfolio of ICT-enabled products and services, as well as because of the affinity between contemporary practices of human-centered design and modern development practices such as lean and agile.

Equally important in institutionalizing these practices are the Principles for Digital Development [15], which are high-level guidelines developed by a community of international organizations for leveraging digital tools in development contexts. These principles intersect with principles of HCD, while laying out best-practices such as working in the open to foster collaboration and facilitate scale and building for sustainability rather than simply maximizing growth.

Donald Norman [11], Ben Shneiderman [13] and Jakob Nielsen [10] highlight design principles and foundational concepts that are essential for facilitating the designer's task. Designers should focus on making things visible to the users, maintain simplicity and consistency in their designs, and use visuals and graphics to map between intentions and the required actions; between actions and the resulting effect; and between the information that is visible and the interpretation of the system state.

2.2 Challenge Driven Education

Challenge Driven Education (CDE) is an innovation framework that accelerated traditional innovation outcomes by leveraging open innovation [and co-creation] along with defined methodology, process and tools to help organizations develop and implement actionable solutions to their challenges [5]. Innovation is defined as an event characterized by an act of creation or invention followed by successful implementation and deployment so that the benefits of that creation may be widely enjoyed [4]. The innovation process does not start from the point of view of a digital platform or

technology but rather from an actual need or challenge. A challenge can be considered as a clearly and accurately defined problem whose resulting solution has value to the society or company [5]. Once a problem is accurately defined as a challenge is distributed to an appropriate channel for innovating an appropriate solution. Human resources can be considered as the most valuable asset for innovation activities. However, teamwork is considered more important for innovation than individuals alone since teams have more knowledge, skills, and experience than individuals do [6]. Especially as challenges become more complex, solutions benefit from cross-functional teams representing different domains of expertise

Open innovation and co-creation concepts are used for managing innovation process. Open innovation engages a multi-disciplinary teamwork to digest and analyze complex challenges, and openly contribute knowledge, experience, and skills to create mutually beneficial relevant solutions. Co-creation is an active, creative, and social process based on collaboration team work [12] to exchange knowledge and resources. CDE focuses the entire innovation process on carefully defined challenges that target the society or stakeholders.

Universities have a large pool of young and creative students undertaking different degree programs. These young learners are required to apply knowledge gained from various classroom teaching and learning activities in solving societal challenges and in so doing they can obtain technical oriented skills and experience needed to increase their capabilities and employability.

2.3 Innovation Ecosystems

An innovation ecosystem is defined as the complex relationships formed between actors and entities whose objective is to enable technology development and innovation thereby contributing to economic growth by creating new business, and employment opportunities [3], [7]. CoICT was established in 2011 to address the increasing demand of ICT experts and employers? by strengthening the University's teaching, research, and innovation in various disciplines (Computer Science, Information Systems, Applied Informatics, Data Science, Business IT, Computer Engineering, Electronics, and Telecommunications). The College integrates scientific, ICT and engineering principles, practical work, and engineering design experiences, culminating into group work projects that use a CDE Learning approach to solve societal/community/industrial challenges.

A growing network of partners and stakeholders from both private and public sectors are engaging directly with Y4C Hub actors (UDSM students and faculty) to collaboratively analyze and address community challenges and test innovative applications of new and emerging technologies.

3 Methodology: Y4C Innovation Ecosystem

To enhance the innovation capacity of young people, innovation ecosystems must ensure appropriate strategies, systems and resources to support the youth as they create ideas, test ideas and scale ideas. As depicted in Fig. 3, Y4C youth-led innovation consists of collaboration of several agents such as funding agents, capacity builders and trainers, and agents that feed challenges and problems to the youth, all working together to push young people to operate beyond academic boundaries, hence transforming knowledge into innovation. Y4C innovation ecosystem and framework seeks to strike a balance between academic theories and industry investment in direct product development.

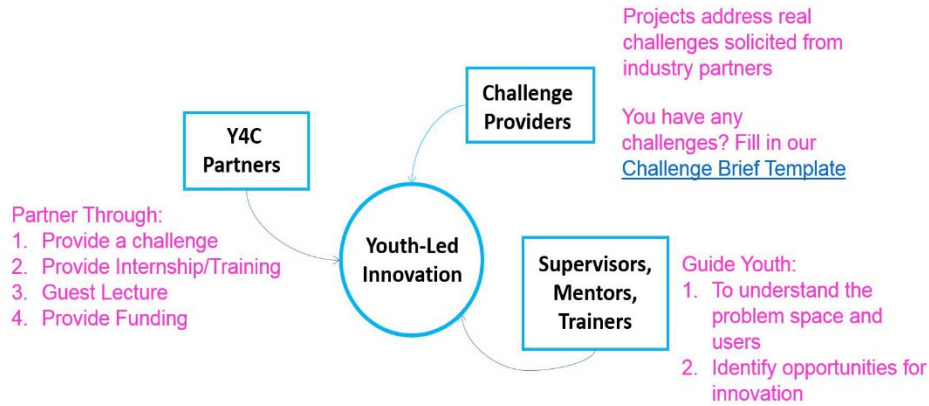


Fig. 3. Y4C Innovation Ecosystem

3.1 Capacity builders

The fundamental objectives of Y4C hub are to enhance youth led innovation and entrepreneurship, foster knowledge exchange, develop next generation talent, and support open source products and services for children. Y4C hub places strong emphasis on building the capacity of innovation ecosystem actors. Mentors, supervisors and trainers guide the students to and train them throughout the innovation process beginning with design research, problem framing, and understanding user needs.

Y4C is housed within a public university with college of ICT having 116 faculty and UDSM at large having 2,068 faculty, presenting a large pool of faculty who can serve as project supervisors and mentors. Y4C hub invests in frequently training university supervisors and currently more than 75 supervisors at College of ICT have received training in HCD principles and challenge driven education. Y4C hub objective is to ensure all faculty at UDSM and other universities in Tanzania that supervise students in projects have received training in HCD and challenge driven education.

Y4C welcomes and encourages industry experts to mentor and train students in specific topical areas of their projects. On a dedicated day of the week, industry persons are invited to offer guest lectures and trainings. Students at the hub have so far received mentorship in areas such as project budgeting, big data programming frameworks, blockchain, drone technology, privacy and network security assessment.

Training and building capacity of our students at higher learning institutions, prepares them to become trainers and mentors to their peers and basic secondary schools' students. Currently more than 10 Y4C students are volunteering as mentors and trainers in a gender equality and inclusiveness project [2] where they train secondary school girls from more than 10 public schools in HCD principles while the young girls use innovation to address real challenges such as early pregnancies, school dropouts and gender violence.

3.2 Challenge providers

All projects and tasks that students work on in Y4C hub must address real challenges solicited from industry partners. Since the launch of Y4C hub, we have solicited challenge briefs from more than 35 agencies ranging from academia, industry, development, private and public sector. The Y4C approach as depicted in Fig. 4 aims to grow a pool of continuously-updated challenges from which interns, final year students, practical trainees, academic researchers and any other designer can browse and work on real societal challenges while engaging challenge providers throughout the process.

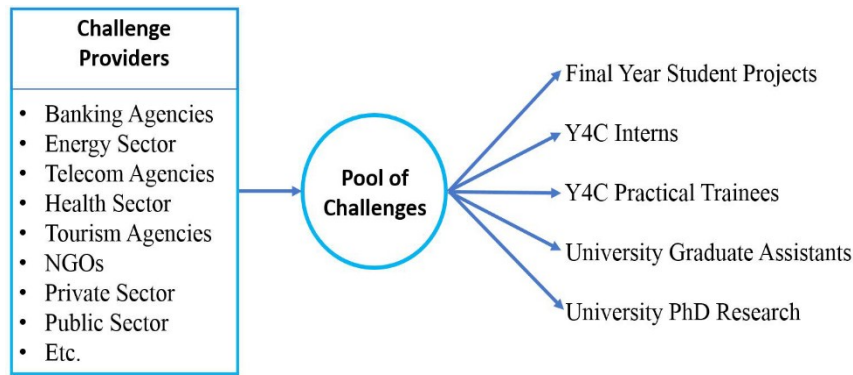


Fig. 4. Y4C Challenge Driven Innovation

3.3 Funding agents

We believe that numerous student innovations die due to lack of financial support needed to transition prototypes to products and solutions where industries and investors can foresee commercial potential. Y4C is not for profit, in-line with the organizational mandates of the project partners. However, it will support young people in scoping market potential and commercializing their products through existing commercialization resources at UDSM as well as through private-sector partnerships.

Y4C innovation ecosystem seeks to collaborate with and maintain a pool of Y4C partners as funding agents through striking nondisclosure agreements and memoranda of understanding. Y4C promotes interaction with Y4C funding partners by offering opportunities where students can circulate among respective partners as interns, mentors, volunteers and consultants. Y4C organizes seminars, guest lectures, hackathons, workshops and exhibitions where we invite Y4C partners to either pass skills to the students or witness a range of ideas and prototypes that can later be transitioned to products.

In order to support transparency and sustainability in parallel to project implementations, Y4C established a governance structure in 2018. A steering Committee representing private and public sector was identified to oversee the Y4C Seed Fund and contribute to long-term resource mobilization for the pooled fund. The steering committee members explore innovative ways to monetize hub resources in order to balance out overhead costs for operations, for example through faculty-led design workshops or Y4C consulting for private sector.

4 Implementation and Results: Y4C hub progress

4.1. HCD Activities to Field Students

The Y4C Hub has enrolled CoICT students during annual practical training (PT) periods to engage in developing innovative products and solutions with real social value, and as a means to prototype the design curriculum and challenge-driven model prior in a well-defined environment. Since its launch, the Hub has enrolled 17 students for PT cohort of 2016/17 and 27 students for 2017/18 academic year with a focus of enabling the students to use human-centered design (HCD) methods for ICT innovation for challenges facing children and women in Tanzania. As stipulated in Table 4.1, the 17 enrolled students enrolled into PT-cohort of 2016/17 academic year were given 5 challenges from three stakeholders, whereby at the end of the program each team managed to produce a prototype solution that was pitched to respected challenge provider.

Table 4.1. Matrix of Challenges and HCD-based Solutions from 2016/17 PT-cohort.

S/ no.	Challenge	Challenge Provider	Ideation and Output
1.	Children Nutrition problem.	UNICEF - Tanzania (Nutrition)	<ul style="list-style-type: none"> ● SMS-based social media platform for nutrition awareness and sensitization campaign ● Tested prototype of the platform ● Showcase the product on University exhibition
2.	Maternal and Newborn Health problems.	UNICEF – Tanzania (Health)	<ul style="list-style-type: none"> ● Digital platform for clinical procedures ● Enrolled for incubation at Y4C
3.	Education stakeholders' communication problem	Kinondoni Municipality	<ul style="list-style-type: none"> ● Prototype of mobile application for education stakeholders' communication
4.	Collection and transmission of data on water supply services.	Dar-es-salaam Water Supply Company	<ul style="list-style-type: none"> ● Digital system prototype comprising of USSD and web platform
5.	Abuse of street children	UNICEF Tanzania (Child Protection)	<ul style="list-style-type: none"> ● Mobile application for Investigation and Assessment of Child Abuse ● Internship opportunity to finish the project

Likewise, as stipulated in Table 4.2, the 27 students enrolled into PT-cohort of 2017/18 academic-year were given 6 challenges from five stakeholders, whereby at the end of the programme each team managed to produce a prototype solution that was pitched to the respective challenge provider.

Table 4.2. Matrix of Challenges and HCD-based Solutions from 2017/18 PT-cohort.

S/ no.	Challenge	Challenge Provider	Ideation and Output
1.	Water, sanitation and hygiene (WASH) in schools	UNICEF - Tanzania (WASH Unit)	<ul style="list-style-type: none"> ● Prototype of low-cost WASH facility ● Internship opportunity to finish the project
2.	Life skills gap in formal and informal education system	UNICEF- Tanzania (Education Unit)	<ul style="list-style-type: none"> ● Prototyped mobile application that extend delivery ● Enrolled for incubation at Y4C
z	Kids' educational materials delivery challenges	Ubongo Kids	<ul style="list-style-type: none"> ● Web application for kids' educational cartoons
4.	Family planning challenges	Apps & Girls	<ul style="list-style-type: none"> ● Prototyped digital platform for family planning awareness
5.	Ineffective volunteering platform to address shortage of teachers	UNICEF - Tanzania (Education Unit)	<ul style="list-style-type: none"> ● Prototyped digital platform for effective volunteering ● Enrolled for incubation at Y4C

6.	Cyber security challenge and Y4C virtual lab challenge	CoICT	<ul style="list-style-type: none"> ● Y4C Virtual Lab Prototype for secured virtualization tool for resource access ● CoICT security assessment document
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4.2 Integration of Human-Centered Design in FYP Curriculum

The Y4C Hub collaborated with the (CoICT) of University of Dar es Salaam (UDSM) to revise a training curriculum of final year projects (FYP) programme. The FYP is a mandatory course for all final year students of CoICT with objective to simulate outgoing students with post graduate job environment. The purpose of revision was to integrate a human-centered design (HCD) lens and curriculum modules into the programme. As stipulated in Table 4.3, before integration the course delivery mode involved self-reading and individual lab-works, on which students pursued lengthy projects while confined to consult supervisors for advice only.

Table 4.3. Curriculum of FYP programme before/after Y4C Intervention.

Course Aspect	Before Y4C Intervention	After Y4C Intervention
Deliver Mode	Consultation = 6 Hrs/Wk Self-reading/Labwork = 10 Hrs/Wk	Consultation = 2 Hrs/Wk Inspirational Seminars = 2 Hrs/Wk Workshops = 2 Hrs/Wk Self-reading/Lab-work = 10 Hrs/Wk
Assessment Mode	Documentation (30%), Presentation (20%), Demonstration (50%).	Design Research (20%) Documentation (30%) Demo + presentation to college (30%) Demo + presentation to challenge providers and stakeholders (20%)
Course Contents	The student pursues a lengthy project in an area of informatics with top level advice only being provided by the supervisor.	Unit I: Introduction to Design Research Unit II: Research Synthesis and Ideation Unit III: Prototyping & Iteration Unit IV: Business Model development
Reference Readings	Not Applicable	<ul style="list-style-type: none"> ● HCD Library created at Y4C Hub with more than 8 books on design tools and methods, in addition to a number of open online resources
Team Work	Only supported by Computer Science Department	<ul style="list-style-type: none"> ● All departments at CoICT to support students project Team work [not more than 5 students]
Challenge Driven	Not necessary	<ul style="list-style-type: none"> ● Project must address a societal challenge and student must do field research with users and use data as input to their design and prototypes
Incubation Support	Not applicable	<ul style="list-style-type: none"> ● Criteria formalized for incubation support

Accordingly, the curriculum revision process proposed changes in delivery mode of FYP programme by introducing seminars and workshops on innovation skills and HCD techniques. This measure intended to enable FYP students to apply human-centered design on identifying opportunities for innovation and utilize replicable design research

methods to conduct rigorous research and transform insights into projects with economic, social, cultural, or environmental value.

Table 4.4. Status of HCD Deliverance during a Pilot Implementation of Proposed Integrated Curriculum.

Aspect of HCD Delivery	Number of Sessions	Total Number of Hours	Number of Students Benefited
Workshops	12	24	120+
Seminars	3	6	60

The integration of HCD methods into FYP curriculum were first prototyped during an 8-week practical training (PT) program in 2017 and completed in October 2017. The completion paved a way for the FYP coordination team to conduct pilot implementation in 2017/18 academic year that commenced on November 2017. As stipulated in Table 4.4, a total of 24 hours of workshops were delivered, covering broader knowledge of human-centered design and innovation skills. Moreover, a total of 6 hours of seminars were delivered which involved inspirational talks from speakers with notable working experience in information and communication technologies (ICT) industry. Each workshop engaged an average number of 120 students pursuing final year project programme while an average of 20 students attended each inspirational talk delivered during seminars.

Table 4.3. Performance improvement in FYP after HCD intervention.

Performance Parameter	Results	
	2016/2017	2017/2018
Number of FYP projects	43	35
Maximum Score	73.69	77.06
Minimum Score	29.50	50.91
Average Score	59.24	61.88
Standard Deviation	8.17	5.86

Although it is too early to account for the impact of curriculum integration of HCD techniques into FYP programme in one year of pilot implementation, but there has been a clear improvement in students' presentation skills and documentation, where students' reports included a design research and user engagement component. The college has observed a slight improvement in results of FYP course among students. As stipulated in Table 4.3 that compared FYP results for 2016/17 and 2017/18 cohort of Computer Science students, the average performance of course assessment has slightly improved. There is clear harmonization of performance whereby the overall maximum score has lifted from 73.69 to 77.06, while the overall minimum score lifted from 29.50 to 50.91. Moreover, the overall standard deviation has lowered from 8.17 to 5.86, which implies positive effect on harmonization of FYP performance among projects.

5 Conclusion

This paper presents Y4C Hub, which is an innovative model of partnership between development actors and local universities for enhancing the critical thinking and

innovation capacity of young people and inspiring them to create public goods and generate positive social value. The innovation ecosystem and implementation progress of Y4C hub affirms the role of HCD and CDE in enhancing the innovation capacity of youth. Y4C youth-led innovation consists of collaboration of several agents such as funding agents, capacity builders, and agents that feed challenges and problems to the youth, all working together to push young people to operate beyond academic boundaries, hence transforming knowledge into innovation.

In the year since launching the hub, 173 CoICT students, 36 supervisors, and 50 secondary school girls have been trained on HCD. Y4C hub has offered more than 15 internships to undergraduate students. A Final Year Project course curriculum has been reviewed to reflect a more challenge driven approach, offering a chance for promising projects to be incubated. The process is underway to fully-integrate Y4C Hub within UDSM curriculum where it can feed a pipeline of open-source products and services for Tanzanian children and youth.

6 Acknowledgement

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