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Harnessing information communication and technology in enhancing One Health interventions among the university students in Kenya

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Abstract

Multidisciplinary One Health (OH) collaboration coupled with information communication and technology provides an avenue for combating and avoiding emerging and reemerging diseases. In 2020, AFROHUN-Kenya organized a OH App development hackathon to build an application for frontline community health workers to respond to OH challenges. This article describes the purpose, process, benefits and challenges of this hackathon. Forty-nine participants, divided into eight groups took part in the hackathon. The teams ranged from four to eight members, with 55% female. A total of eight applications were developed during the hackathon all of which are in the process of patenting, before deployment as open-source applications. In the post-hackathon survey, 95% of participants indicated that they had a better grasp of the topic because of the team members' diverse perspectives and that working in multidisciplinary teams had resulted in new friendships and partnerships. In total, 72% of respondents indicated they would be interested in participating in another hackathon. However, 65% of the respondents suggested that the training time be lengthened. This study demonstrates that multidisciplinary hackathons effectively enhance learning, significantly impact communities and improve students' soft skills, including project and time management, interpersonal communication, motivational strategies and problem-solving.

Introduction

At least thirty new infectious diseases have emerged in the last thirty years, posing a serious threat to the health of millions of people around the world (Mukherjee, 2017). Many of these infectious diseases, from severe acute respiratory syndrome to HIV/AIDS and COVID-19, have serious public health implications. These severe public health problems have significant socioeconomic consequences, particularly in developing nations (WHO 2013). The One Health (OH) approach has been suggested as an important way in which multidisciplinary teams could innovatively detect, manage and ultimately prevent these outbreaks. The use of information and communication technologies (ICT) offer great support to implementation of OH approach including predicting events, supporting surveillance and monitoring effectiveness of interventions (Ossebaard, 2013).

Several applications have been developed to address OH challenges. In Africa, notable examples include WeFarm, a free peer-to-peer service that allows farmers to share information via SMS without needing internet access (The Record, 2014). Another example is VetAfrica, a disease surveillance tool that helps farmers quickly diagnose livestock diseases and find suitable medications (One, 2016). Additionally, AfyaData is an innovative OH disease surveillance app that facilitates the reporting and monitoring of diseases from community to national levels (Karimuribo et al., 2017). Outside Africa, Kim et al. (2022) developed a mobile application for community-based surveys to assess risks related to OH challenges in rural Philippines. These mobile applications have greatly revolutionized the OH architecture. However, most of them lack a problem-oriented approach that encourages developers to consider all aspects of a problem (Ramatowski et al., 2017). To address this, the Africa One Health University Network (AFROHUN) Kenya, part of the international AFROHUN Network, which includes nineteen universities across ten African countries focused on OH Workforce capacity building, identified participatory programs as particularly effective in advancing technology-based OH solutions. AFROHUN-Kenya identified the hackathon model, which uses ICT to develop innovative OH solutions, as especially well-suited for this purpose (DePasse et al., 2014).

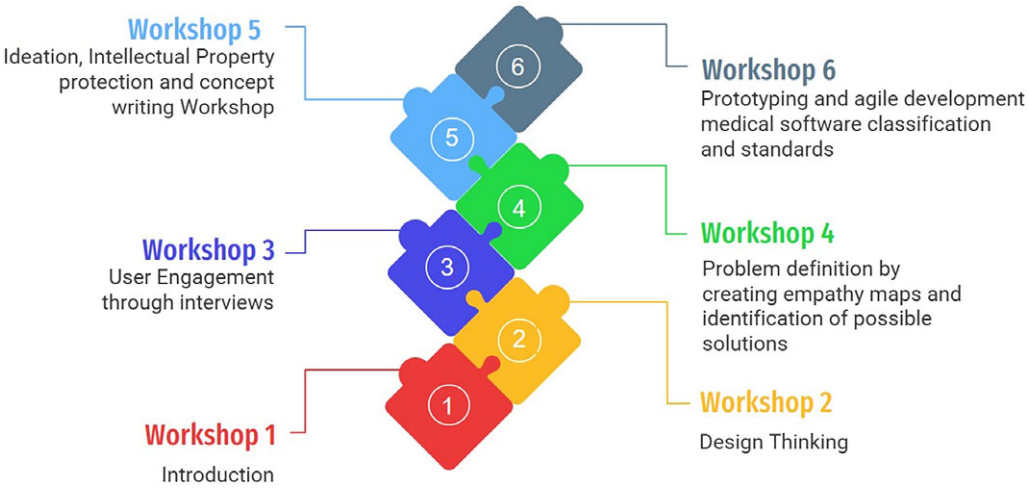

Figure 1. Illustration of the workshops held during the hackathon.

Hackathons are events that bring together both experienced and inexperienced multidisciplinary teams to collaborate intensely over a short period of time to define a problem, devise affordable innovative solutions to complex health problems, and design a working prototype (Ramatowski et al., 2017). Since their inception, hackathon models have been used to stimulate and accelerate innovation in a variety of disciplines, including public health (Ostrovsky and Barnett, 2014; Groen and Calderhead, 2015; Walker and Ko, 2016). A fundamental principle unique to the hackathon model is experts from several fields offer real-time feedback and assistance to teams, resulting in instantaneous project adjustments (DePasse et al., 2014). Additionally, participants were encouraged to voice their opinions and contribute their experiences to devise solutions that are applicable across numerous barriers.

To this end, AFROHUN-Kenya organized a OH hackathon whose objectives were: i) enhancement of multidisciplinary approach in solving OH challenges faced by frontline health workers, ii) building capacity in innovation among undergraduate students, both at the individual and group level, and iii) development of a OH Application that could be used in solving challenges at the Human, Animal and Environmental interface. This case study analyzes the preparation and performance of a multidisciplinary OH hackathon conducted by AFROHUN-Kenya. By assessing participant feedback, the study develops recommendations for future OH hackathons.

Methods

Study setting and hackathon resources

The hackathon was conducted virtually over a six-week period in 2020. The organizing team included five core members (two AFROHUN-Kenya administrators and three AFROHUN-Kenya faculty mentors), supported by three facilitators from the University of Nairobi's Makerspace Science and Technological Park (STP). The AFROHUN-Kenya and Makerspace SPT team provided the real-time feedback and assistance to students during the hackathon.

Our most valuable resource was the large number of well-trained, enthusiastic and tech-savvy students from various universities in Kenya. Additionally, the AFROHUN-Kenya country office played a crucial role in coordinating and organizing the hackathon, with support from faculty mentors selected from academic staff within AFROHUN-Kenya participating institutions. Another significant resource was the Makerspace Science and Technology Park (STP), which provided a creation space equipped with digital fabrication tools and equipment for student use, enhancing their learning through a hands-on approach and fostering multidisciplinary collaboration. The hackathon was part of the AFROHUN-Kenya applied learning and training workstream.

Hackathon preparation

AFROHUN-Kenya issued a hackathon call, which was distributed through partner institutions' websites, notice boards and social media platforms like WhatsApp. Applicants needed to form multidisciplinary teams that went beyond traditional One Health disciplines (human, animal and environment), as to include at least one computer science student. Participants were required to develop an original, free, open-source app, in compliance with applicable policies. Teams were encouraged to be gender-sensitive and create innovations addressing a one health challenge. Each team applied via an online questionnaire, providing a brief description of their motivation, team composition and proposed innovation. Proposals were reviewed by a panel of experts from Makerspace STP, evaluating them based on novelty, feasibility, impact and team composition.

Hackathon event

The five-day hackathon was structured into workshops that were held over six weeks (Figure 1). Each week, students attended a one-day Zoom conference workshop. After the workshop, they had the remainder of the week to collaborate within their groups to review the workshop material and complete their assignments. Throughout the hackathon, all teams had access to Makerspace STP trainers and a dedicated AFROHUN-Kenya faculty mentor.

In the first workshop, students were introduced to frontline health work in the Kenyan context and learned about the multidisciplinary approach to innovation and problem-solving. That week, students were assigned to collect firsthand information by interviewing frontline workers about their experiences. Faculty mentors identified these frontline workers and sent invitations to those who agreed to participate in the short interviews. Zoom meetings were scheduled, providing each frontline worker with thirty minutes to describe their work. Faculty mentors facilitated these interview sessions. After each presentation, students had the opportunity to ask relevant questions about the challenges faced by

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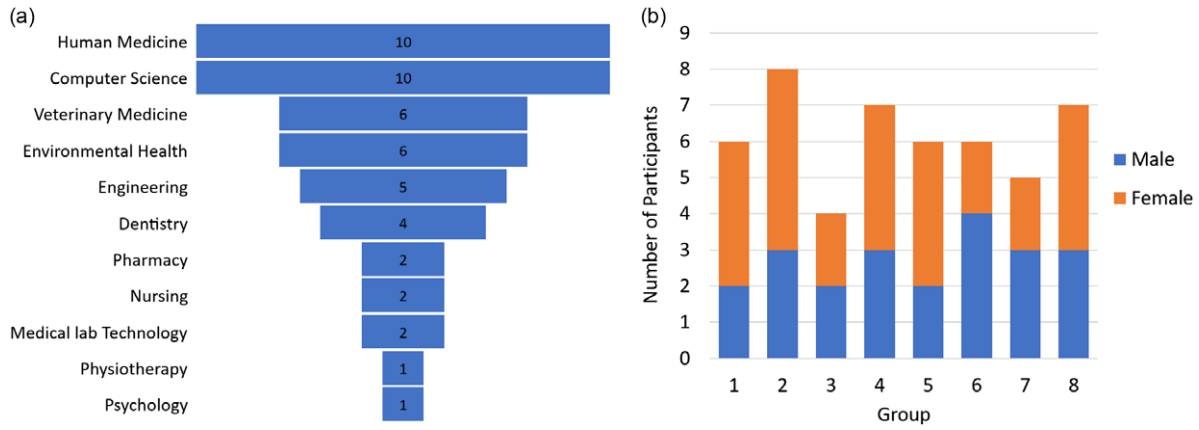

Figure 2. (a). Number of participants in all disciplines that attended the hackathon, (b). Gender distribution of participants in each group.

the frontline workers and how they could be assisted in their duties. The frontline workers also shared their contact information so students could reach out for further information related to their projects. A total of eleven frontline workers from various disciplines were contacted. Detailed information about the interviewees can be found in Supplementary Table 1. In addition, students were introduced to design thinking, with a focus on 'empathy' and empathy mapping. Empathy, the ability to understand and share the feelings of others, is crucial for developing products or services that best suit the needs of those experiencing specific situations. By emphasizing empathy, the workshop aimed to highlight the daily realities, emotions and challenges faced by health workers. This approach guided app development towards user-centric designs, enabling quick and effective responses. Through fostering empathy, students were not just creating technical solutions; they were crafting tools that resonate with the needs and emotions of frontline health workers. The workshop also included activities such as team formation, naming and setting general expectations for all participating groups.

During the second to fourth workshops, students interviewed various frontline workers to identify gaps and challenges using a One Health (OH) approach. They learned to create empathy maps, refine users' needs and insights, develop personas, formulate problem statements and identify possible solutions. Additionally, students were introduced to Intellectual Property protection. Workshops five and six covered ideation, solution generation, selection, concept writing, prototyping, agile development and medical software classification and standards.

After all the workshops, on 2nd September 2020, the hackathon concluded with a 20–30-minute presentation that identified the problem the team was going to address (through the One Health lens), the primary user (persona), the solution they were presenting and a demonstration of the application. An expert jury panel voted to select three winning teams. The multidisciplinary jury consisted of two OH service providers, a representative from the non-governmental organizations, and an IT expert. At the end of each presentation, judges sought clarifications and made suggested improvements to the application. At the end of the hackathon, Makerspace STP offered all participants, who had attained a 90% participation and above during the hackathon, access to their space for their current and future innovations. In addition, child development foundation-UK offered all participants facilitation and mentorship on among other areas, the internet of things, big data and actualization and deployment of the innovations.

Results

Hackathon demographics and flow

Prior to the hackathon, nine teams out of the thirteen that had applied were selected to participate in the competition. In total, forty-nine participants took part in the hackathon. A total of 55% of our participants were female. The participants came from a diverse range of disciplines as shown in Figure 2. One participant noted, "*My team was an excellent mixture of a variety of disciplines – a human doctor, a veterinarian, an environmentalist, a nurse, and a computer science student.*" The average team size was five members, with the smallest team having four and the largest consisting of eight members. All presented projects were mobile apps. Communication during the hackathon was facilitated by Slack integration with Miro (for tasks management and progress tracking) and code developed was pushed to GitHub. As shown in Figure 3, after multidisciplinary team formation, the teams had brainstorming sessions to identify gaps after interviews with a variety of frontline OH workers. Afterward, participants carried on with their hacking and explored solution approaches with the support of information technology and faculty mentors. As a result of this iterative process, the teams developed prototypes demonstrating their ideas and solutions. Often in parallel to hacking, the team members started working on their pitch.

Finally, students presented their solutions to a panel of judges, showing a working prototype.

Hackathon projects

The applications, especially the three winning ones, aimed to tackle One Health problems requiring multidisciplinary solutions, focusing on a single sector persona while exemplifying the One Health concept. The hackathon produced both mobile and web-based projects. The three grand prize-winning projects were:

1. MED-IS: A mobile application for community health volunteers (CHVs) facing inadequate training, paperwork and low motivation. It offers secure data recording and storage for reporting disease incidences, particularly zoonotic diseases. The app facilitates data sharing with higher governance levels, enabling early warning systems and cross-sector information dissemination. It also provides reference materials, health event information and a digital follow-up calendar.

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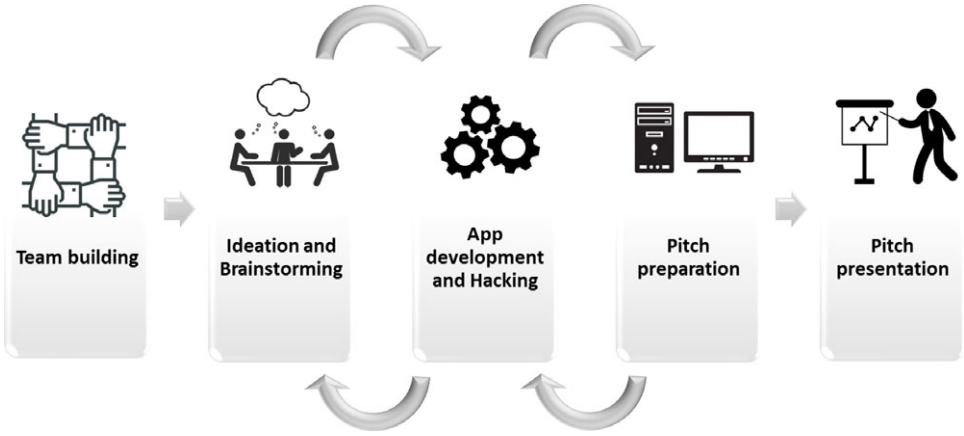

Figure 3. Five steps of the hackathon model. Arrows point towards the flow of the process.

2. e-OneHealth: A mobile application for veterinary officers dealing with challenges in information sharing, transmission and disease reporting. It allows veterinary and medical doctors to report zoonotic diseases and antimicrobial resistance (AMR) from their laboratories. The app analyzes reports, generates alerts and sends notifications, including environmental alerts related to increased disease risk factors.
3. ComuKol: A mobile and web-based digital platform for disease surveillance coordinators addressing weak inter-organizational communication and collaboration breakdowns during disease outbreaks. It facilitates communication and coordination among multidisciplinary response teams, ensuring smooth information flow and timely field interventions.

Table 1 lists all the applications developed during this hackathon. Some of these applications developed in this hackathon were sector specific and can be utilized to address specific sector challenges.

Hackathon evaluation

To evaluate the hackathon and overall course experience, an anonymous online feedback form was administered at the end of the hackathon to gain insight into student satisfaction and learning and to modify teaching practices if necessary. The form included a mix of open ended and quantitative questions. Out of forty-nine students who participated in the hackathon, where 65% responded. While this was a small sample size, several observations were made based on these responses.

The primary motivation for participating in the OH App Development hackathon, cited by 59% of respondents, was the mentorship and learning opportunities provided. This indicates that a lack of prior experience was not seen as a barrier to participation. The second most common reason, given by 42% of respondents, was the desire to create tangible solutions. Additionally, 22% of respondents were motivated by the opportunity to work in a team environment. 88% of the respondents indicated that the hackathon had been useful and that they had gained new skills. Regarding how useful the hackathon exercise was to participants' training, one participant commented in an anonymous survey: "*This training enhanced my leadership skills, as I was the team leader of my group; I learned how to manage a team; coordinate tasks; and foster collaboration within my team.*" Another respondent commented, *"I have been having many ideas but have not implemented any because I lacked disciplined thinking. The training on design thinking and empathy has taught me how to think in a disciplined way and approach existing challenges in a way that helps me solve them."*

One aim of the hackathon was to promote a multidisciplinary approach to problem-solving. Students were asked about their experience learning alongside peers from other disciplines and whether this multidisciplinary training enhanced their learning. A significant majority (95%) reported a better understanding of the content due to the broader perspectives of their team members. Additionally, they noted that working in multidisciplinary teams fostered new friendships and relationships. Furthermore, 60% said they intended to keep collaborating with persons they met at other events. Some remarks from participants were, "*It has been one big learning experience, "Riding the tail of a comet ". I have learnt a lot, how different each of our disciplines train us to think. How tech guys focus on data to the expense of empathy and how medics might focus too much on empathy since our field of work is tailored to that end. It's been about unlearning some of the things we've believed. One thing I got away with is I would rather have a team of 7 different disciplines than 7 medics. Ideas are rich in a multidisciplinary team.*" Another participant responded, "*I have begun to appreciate that knowledge generation can come from sectors entirely unrelated to your own and that it pays to have perspectives from different backgrounds when it comes to solving problems."*

Furthermore, 60% of the participants expressed their intention to continue collaborating with people they met at the event. Some remarks from participants were, "*It has been one big learning experience, "Riding the tail of a comet ". I have learnt a lot, how different each of our disciplines train us to think."* Another participant responded, "*I have begun to appreciate that knowledge generation can come from sectors entirely unrelated to your own and that it pays to have perspectives from different backgrounds when it comes to solving problems."*

When asked what other discipline or disciplines they thought should have been part of the hackathon, and why they felt those disciplines were needed in the hackathon, students gave an array of disciplines as shown in Figure 4. Most respondents (19%) suggested inclusion of students from economics because of the cost implications involved in development of the application. In addition, 13% of the respondents suggested inclusion of journalism and mass communication students to aid in publicity of the developed innovations. Some of the comments about the mentors

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Table 1. Summary of the eight projects developed at the One Health App development hackathon

App Name	Persona (Primary user)	Problem	Solution in App
e-OneHealth	Veterinary Officer	Information sharing, transmission and disease reporting	A mobile app with veterinary and medical doctors' zoonotic disease reporting platform through submission of reports for confirmed zoonotic diseases and AMR from laboratories. Application performs analysis of reports, generation of alerts and sends notifications to uses and environmental alerts relating to increased disease risk factors to the users
MED-IS	Community Health Volunteer	Inadequate training, massive paperwork and low motivation	Mobile application for digital data recording, secure data storage and sharing. Application also provides reference materials, information to community health workers on health events, and digital follow-ups
Afya-Yetu	Pregnant Mothers	Complications associated with pregnancy	Mobile digital system for empowering pregnant women, keeping their hospital booking and empowering the community health volunteers to monitor and check up on pregnant mothers
pataVet	Veterinary officer	Manual record keeping for public service veterinary sector, making it challenging to track zoonotic diseases	A web-based platform that connects animal health practitioners with farmers/ community members within a locality. Application records, store data and aid in creating awareness of animal/zoonotic diseases in the community through customized alerts
LindaToto	Pregnant teenager	Complications and the burden associated with puberty and teenage pregnancy	A mobile application that provides sexual and reproductive health education, menstrual hygiene, psychological support, toll-free call numbers, maps, learning videos and precautions to teenage girls
ONE HEALTH	Medical doctor	Doctor and patient communication problems	Web-based data portal that allows information sharing, online appointments to doctors, statistical data analysis and data sharing to government
Afya Mtaani	Community Health worker	Inaccessibility of reliable information and tedious documentation process	A mobile app that acts as a data input portal, documents region-specific disease burden, automatic data sharing to facilities after referrals, and provides reference numbers for referral hospitals
ComuKol	Disease surveillance coordinator	Weak inter-organizational communication and collaboration during disease outbreaks	A mobile and desktop web-based digital platform for communication and coordination among multidisciplinary outbreak response teams for enhanced information transfer and decision making

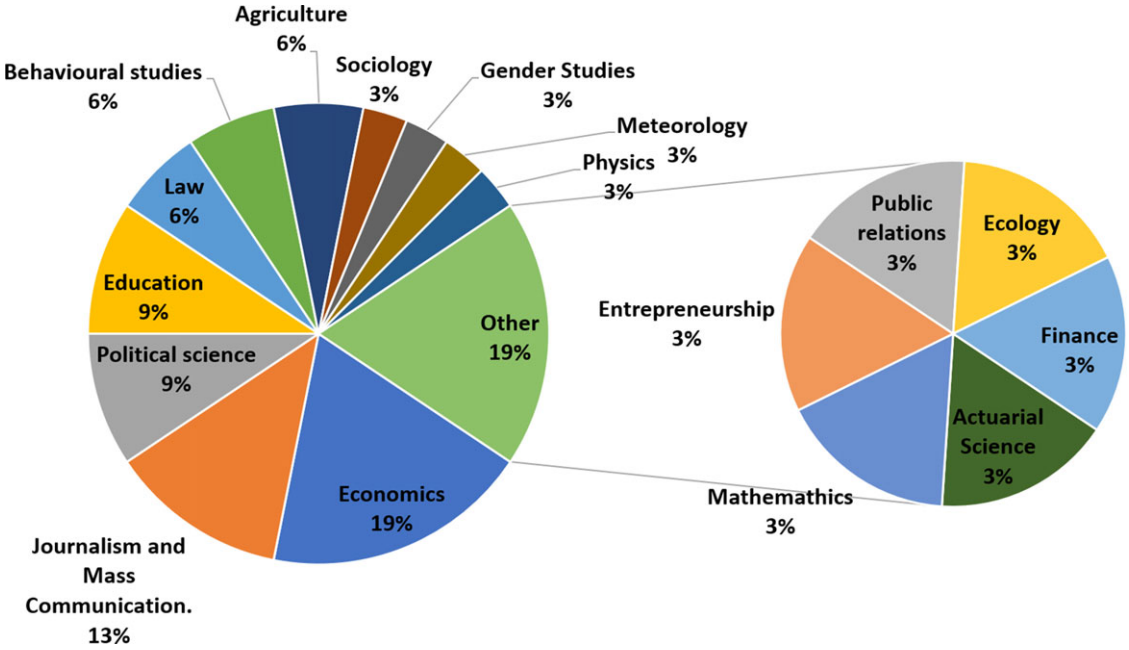

Figure 4. Pie chart showing disciplines that participants felt should have been part of the hackathon.

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were: "*Political science students can give us insights on how to develop solutions and engage with the political leaders who at times can be the biggest determinant to deployment of such solutions.*" and "*I would have appreciated having somebody form law or something to do with policies. There are a lot of bureaucratic processes that hinder innovation in the country.*"

The three things that respondents liked the most were: the mentorship by faculty and facilitators (33%), the facilitation in terms of airtime and internet data, provided by AFROHUN-Kenya country office, to enable them attend the hackathon (21%) and the team working environment (15%). Concerning the perception of participants to the helpfulness of the mentorship, 97% of respondents stated that the mentors were very helpful. Respondents used words like "*excellent*," "*patient*," "*supportive*" and "*extremely good*" to characterize their mentors.

Since the hackathon targeted undergraduate students, the respondents were given a scenario where they were to fast track themselves to when they were out-of-school or as an in-service professional and asked to give a statement on how this training would come in handy. One respondent said: "*In the future as a doctor, team playing skills and collaboration with other professionals is a key skill to have. This training experience has taught me not only the value of collaboration with other team players but also ways of facilitating the same via collaborative tools e.g. Miro and Slack.*"

About 87% of respondents would recommend someone to join a similar training/activity. Some of the statements put forward by the respondents that they would use to encourage someone to join were: "*It is a great learning experience; you'll be equipped with skills to help you tackle problems that face our community.*" And "*This is the future of medicine; collaboration among different experts to influence health.*" When asked to describe themselves before and after the activity, one respondent commented: "*A young student who had an in-group persona to solving problems transformed to a wiser person who embraces a multi-sectoral approach to solving health problems.*"

On the other hand, 72% of respondents mentioned that they would be interested in participating again next time. However, 65% of the students suggested that the time for the training be increased. Some of the general comments on the hackathon from the students were: "*It was exciting, great experience, great people. I can do this again*" and "*It was a great experience; I have learnt a lot and have met new colleagues with whom we will tackle challenges in healthcare.*"

These findings highlight several key aspects of the OH App development hackathon. First, despite the tight time constraints and the restrictions imposed by the COVID-19 pandemic, students generally had a positive experience. Second, collaborating with frontline health workers allowed students to tackle real-world problems and make significant contributions to the community. Third, working as part of a team in a high-pressure environment was another valuable feature of the hackathon. Fourth, access to mentors boosted the confidence of students, even those who were inexperienced programmers, enabling them to create programs. Fifth, throughout the hackathon, students gained both technical and soft skills. Finally, both students and mentors enhanced their multitasking abilities and skills.

Discussion

Hackathons and other intense programing events have the potential to give a variety of benefits to participants including the chance to expand social networks by meeting new people who share similar interests and learning new techniques and technology (Fowler et al., 2013; Trainer and Herbsleb, 2014). Hackathons offer the added benefit of allowing students to put what they have learnt in class into practice (Calco and Veeck, 2015); gives a sense of belonging to students (Munro, 2015); boosts motivation through by learning from counterparts (Gould, 2014); increasing exposure to the social impact of technology (Linnell et al., 2014); and development of soft skills (Matthews, 2014).

The AFROHUN-Kenya OH App development hackathon was aimed at building multidisciplinary teams that would develop solutions for frontline community health workers when they are responding to OH challenges. Survey results revealed a very pleasant learning experience. Generally, students found working on an authentic project as part of a team to be quite beneficial. Participating in a hackathon helped students improve their soft skills such as project and time management, interpersonal communication, motivational techniques and dealing with unanticipated situations, in addition to their programing skills.

Conclusions & perspectives

Conclusions

To enhance networks to boost organizational capacities in the AFROHUN affiliated institutions, AFROHUN-Kenya organized a OH App development hackathon for students to develop a OH App for use by frontline community workers. Results from this hackathon indicated a very positive learning experience, which can be harnessed to innovatively involve multiple disciplines in developing solutions to health problems faced at the human, animal and environmental nexus. In general, students found it very valuable to have the opportunity to work in an authentic project as part of a team. In addition to improving their programing skills, participating in a hackathon also helped students work on their soft skills such as project and time management, interpersonal communication, motivational strategies and dealing with unexpected issues. After proper documentation and licensing, we intend to pilot these applications to the intended end users to get their feedback before final deployment for use.

Lessons learnt and future work

While hackathons are just one tool for programing education, when executed with thought they can provide both educational opportunities for students and value to community partners. In addition, hackathons can be conducted flexibly to accommodate participants' convenience; for example, this hackathon was held virtually, allowing it to continue despite government restrictions imposed due to the COVID-19 pandemic. However, since participants were not physically together, continuing some tasks after the virtual workshops sometimes became a challenge. Similarly, participants sometimes experienced internet connectivity challenges. Compared to other hackathons, the low number of participants reduced logistical challenges, giving the organizers more flexibility. This is because participants easily managed resources, adapted schedules or activities as needed and received personalized support. Though, the small size of participants could have discouraged participants from having broader transdisciplinary groups.

The future hackathon assessments should include external evaluations, investigate the factors that influence student motivation to participate, their overall experience, the role and experience

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of mentors and the motivation of female students to join the hackathon.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/one.2024.8.

Data availability statement. The source code for applications developed during this hackathon are not publicly available due to license and patent restrictions. Further details on developed applications can be availed upon request to AFROHUN-Kenya country office.

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Author contributions. The concept was agreed by all authors, FK created a first draft, all authors then contributed to adding to and editing the final submitted version.

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