

Stimulating and maintaining students' interest in Computer Science using the hackathon model

Jabu Mtsweni, Council of Scientific and Industrial Research (CSIR) & University of South Africa, South Africa
Hanifa Abdullah, University of South Africa, South Africa

ABSTRACT

Computer Science (CS) enrolments at higher education institutions across the globe remain low in comparison to other disciplines. The low interest in CS is often attributed to students' misconceptions about the discipline, such as CS being construed as complex, asocial, and only for computer wizards. Consequently, hackathons, which are self-organised programmes that bring together different stakeholders to collaborate in rapidly building software prototypes, are emerging as one potential solution to address some of the students' misconceptions about the CS field. Using an exploratory case study and activity theory for data analysis; this research article presents substantive research findings that posit hackathons as an approach that could stimulate and maintain students' interest in CS. The key elements of the hackathon model are collaborations, networking, mentoring, hands-on engagement in socially-relevant computing projects, and community involvement. The model was evaluated using expert reviews in terms of its relevance, impact, complexity, and sustainability.

Keywords: Computer Science, Hackathons, Open Distance Learning, Socially Relevant Computing, Community Engagement

1. INTRODUCTION

There is a general concern that the number of students who opt to study Science, Engineering, Technology, and Mathematics (STEM) is low across the globe. In South Africa, for instance, various reports suggest that interest in maths and science amongst learners has dropped by 20% over the recent years (Firth, 2014). The World Economic Forum report suggests that the quality of maths and science education in South Africa is amongst the lowest when compared to other countries (World Economic Forum, 2012). Earlier studies also suggest that between genders, Computer Science (CS) as a discipline is not well represented across the globe (i.e. there is a low number of female students pursuing CS) (Anderson, Lankshear, Timms, & Courtney, 2008; Hill, Corbett & St. Rose, 2009; Papastergiou, 2008).

A number of reasons for the low interest in CS have been studied, some of them including teaching and learning strategies, social relevance of CS, and student awareness and understanding of computing courses (Buckley, Nordlinger, & Subramanian, 2008a; Galpin & Sanders, 2007; Mtsweni & Abdullah,

2013; Papastergiou, 2008). According to Buckley (2009), the low CS enrolments at higher education institutions could be attributed to the notion that CS is not offered by educators as an idea that is socially relevant, important and caring. It is further postulated that real-world problems are lacking in undergraduate computing disciplines, thereby, making CS not a priority alternative for undergraduate students, especially those who are altruistic and socially aware (Buckley, Nordlinger, & Subramanian, 2008b; Hecht & Werner, 2014).

At Open Distance Learning (ODL) institutions, such as the University of South Africa (UNISA), enrolment statistics with regards to interest in CS courses are not so different to traditional universities (Galpin & Sanders, 2007; University of South Africa, 2014). However, ODL universities are unique, especially because of the mode of instruction and delivery; which is complicated by the notion of anytime, anywhere, equitable, flexible and open access (University of South Africa, 2014). Students at such institutions are bound at some point to consider the misconceptions that computing courses are tedious and asocial, since they have limited opportunities to engage directly with their lecturers and communities in practical projects that offer real-world experiences and engaging challenges (Abdullah & Mtsweni, 2013).

It is therefore imperative that research-oriented solutions are put forth in order to tackle the challenges that affect students' interest in CS. The solutions to such challenges are essential for purposes of averting the negative economic, brain drain, political, pedagogical, and social impacts that such low interest in computing discipline could have in our communities at large. In South Africa, it has also been noted that low enrolments and completion of qualifications in computing courses is even leading to IT skills shortage in the business environment (Firth, 2014).

As a result, a number of strategies are being sought by researchers to stimulate interest in the CS discipline, including initiatives such as Socially Relevant Computing (Buckley et al., 2008b; Hecht & Werner, 2014; Richard & Kafai, 2015), which have their own challenges when it comes to being implemented in an ODL environment (Mtsweni & Abdullah, 2013). Conversely, hackathons (Wiggins, Gurzick, Goggins, & Butler, 2014), which are extensively discussed in the background section of this article, are also emerging as a potential solution to the identified problem. However, thus far, no extensive research has been done to investigate their relevance and potential in changing the perceptions and addressing low interest in CS amongst students at higher learning institutions. This article attempts to contribute by addressing some of these research gaps by following an exploratory case study approach conducted over a period of 36 months within a community engagement project at an ODL institution.

The remainder of this article is structured as follows. Section 2 provides background information relating to Socially Relevant Computing (SRC), the current ODL environment, and the concept of hackathons and hacking culture. Section 3 highlights the research aims and research methodology employed for the research presented in this article. Section 4 describes the Computing Pro Bono project, which was the basis of the case study. In Section 5, the results of the case study are discussed. Section 6 presents and describes the hackathon model and its implication in stimulating students' interest in computing disciplines. Section 7 concludes the research by highlighting the essential findings and further research work.

2. BACKGROUND

This section provides background information on the core concepts that underpin the research study, namely Socially Relevant Computing (SRC), Open Distance Learning (ODL), particularly in relation to Computer Science (CS), hacking culture, and hackathons. The concepts are not directly interconnected, but to some extent related. SRC is included in the background, since it has similar aspects (e.g. social aspect) found in the hackathon model, albeit not enjoying the same traction as hackathons across the globe (Briscoe & Mulligan, 2014). In turn, the hacking culture is practised in most hackathons and SRC

projects. Lastly, ODL is discussed in this background section as an alternative environment where the hackathon approach could be implemented for stimulating students' interest in CS. These concepts were mainly derived through rigorous document analyses and participant observations during the case study.

Socially Relevant Computing

To address the importance of incorporating real-world experience in CS, Buckley et al. (2008b), introduced the concept of Socially Relevant Computing (SRC). This is an approach, whereby students are presented with problems of societal and interpersonal relevance, the emphasis being on learning computing for a cause. The central idea is to entice students who ordinarily may not see CS as an alternative to social sciences and the humanities (Pauca & Guy, 2012).

However, SRC requires a different approach to CS instruction ranging from problem representation and modelling, addressing the key concepts of CS (Buckley et al. 2008b). According to Buckley et al. (2008b), SRC is purported to enable students to learn about new domains, work effectively in teams as well as evaluate the social or ethical aspects of their solutions. This is very important because students should in addition to possessing technical skills also be able to assess the societal impact of their work, commit to standards of professional ethics and obtain the life skills necessary to undertake on-going professional development and maintain interest in their discipline. Adding a social relevance dimension to the CS curriculum addresses the common complaint that students are not sufficiently prepared for design challenges in their careers in industry (Buckley et al., 2008b; Hecht & Werner, 2014).

SRC solutions have been implemented successfully under different use cases (Buckley, 2009). However, despite the noticeable benefits of SRC emanating from the case studies conducted by respectable universities (e.g. University of Buffalo) and industry stakeholders, the panoptic implementation of SRC within universities across the world is deficient, mainly because there are no standardised guidelines or models to aid its implementation. Thus, the focus in this study is on a hackathon model, which could be used as an approach for stimulating and maintain students' interest in CS disciplines, especially within and ODL environment.

ODL environment: opportunities and challenges

The University of South Africa (UNISA) is the largest dedicated Open Distance Learning (ODL) organisation in South Africa. The institution is structured into six (6) colleges offering a wide range of academic and vocational programmes, including computer science and information systems (Wessels, 2012). The average number of students enrolled at UNISA was over 300 000 in 2012. The College of Science, Engineering, and Technology (CSET) accounted for only 6.3% of the overall student enrolments (University of South Africa, 2014). On a yearly basis, about 12% of the students complete their qualifications, and this is attributed to the fact that most of the students study part-time, thus would normally take longer to complete their qualifications.

The overall objective of computer science and information systems courses at UNISA is to prepare students to be socially responsible, knowledgeable and proficient in a computing-related profession. However, due to the distance teaching mode, face-to-face contact between academic staff and students is mostly limited. In addition, some students also face challenges of work-integrated learning, where they do not get the opportunity to apply what they have learned in a real-life environment, unless they are employed. Nevertheless, other initiatives to address some of these problems are being sought including community engagement, e-tutoring and extensive use of Information and Communication Technologies (ICTs) (Abdullah & Mtsweni, 2014). In this article, the focus is on the CS discipline, and the intervention that is proposed to address the low interest in CS and to change some of the misconceptions is the hackathon approach, which is discussed in the following subsection.

Hacking Culture

Although the term 'hacking' tends to be interpreted differently under different contexts, it still carries a negative connotation (Briscoe & Mulligan, 2014; Watters, 2012), particularly within the information security domain. A hacker is often referred to as a computer intruder who commits computer-related criminal activities, such as surreptitiously accessing computer systems for malicious reasons (Warren & Leitch, 2010). However, in this article, a different perspective and meaning is adopted. A clear distinction is made between a hacker and a cracker. For instance, an individual who breaks into computer systems to commit illegal activities is referred to as a *cracker*. On the other hand, a *hacker* is defined as an individual who is technically adept and has passion for solving problems within a community environment (Raymond, 2001).

The hacking philosophy adopted in this article has been exploited in a number of environments (Briscoe & Mulligan, 2014; RHoK, 2009; Vivacqua & Borges, 2012; Wiggins et al., 2014). It is important to note that the hacking philosophy is not only limited to computers or software, but could be applied in a number of domains, such as music, electronics, or any level of 'science or art' (Raymond, 2001). This culture spawns from the open source approach of developing technological solutions within a community, where everyone, irrespective of background or expertise, is encouraged to contribute towards addressing existing real-life challenges. Hence, the hacking culture is not only about programming or software coding, but involves a number of iterative steps (e.g. research, design, and analysis) to address complex and simple computing challenges. The hacking culture is closely linked to a number of computer science principles. For instance: hackers strive for realising their passion of computers by working with others to solve real problems for real people. The main motivation behind the hacking culture is about participation, contribution, and learning. In various instances, the hacking culture is practised during the hackathon events, which are discussed in the next section.

Hackathons

Hackathons can be loosely defined as marathon coding events that bring together different stakeholders to build rapidly or hack prototypes that could address technological challenges within a particular domain (Briscoe & Mulligan, 2014; NASA, 2010; Watters, 2012; Wiggins et al., 2014). The emergence of hackathons dates back to 1960 (Levy, 2010). However, their extensive use within the software development domain started to emerge in the 1990s when the use of computer software became significant. Today, hackathons are a norm in large organisations such as Facebook, Yahoo, Google, and Microsoft (Briscoe & Mulligan, 2014). These events are hosted in these large organisations for many reasons, such as to build new solutions, to empower a community of developers, to entice developers to embrace latest technologies, and to recruit bright software developers into these organisations (Briscoe & Mulligan, 2014; Calco & Veeck, 2015).

The general focus of these events is on 'rapid and iterative software development', where a community of developers, analysts, researchers, subject-matter experts, local communities, and related stakeholders collaborate to design, code, and build testable software prototypes (Briscoe & Mulligan, 2014; Chowdhury, 2012).

3. RESEARCH AIMS AND RESEARCH METHODOLOGY

The following subsections discuss the research objectives and the research methods used to arrive at the research findings that are presented in Section 5.

Research Aim

The main aim of the research reported in this article was to investigate and understand the hackathon approach and determine if it was suitable in stimulating and maintaining students' interest in computing.

Secondary objectives included an investigation to determine if approaches such as the hackathon programmes could change the 'false' students' perceptions about CS. The potential impact of hackathons in supporting students via mentoring, networking, and collaboration with external stakeholders was also investigated.

Research Methodology

An exploratory case study approach (Yin, 2009), supported by document analyses, participant observations (Guest, Namey & Mitchell, 2013), and open-ended interviews, was used for this research study. The case study method was chosen and preferred as it provides opportunities to collect data using multiple sources of data (Tellis, 1997; Yin, 2009). In addition, the case study method was chosen because of its 'ability to examine in-depth' a phenomenon within a real-life setting (Yin, 2009). A single case study was then designed within an existing community engagement project, called Computing Pro Bono (cf. Section 4). The case study was conducted and administered over a period of 36 months, spanning six (6) formal hackathon events. The major component of the case study focused on participant observations, open-ended interviews, and expert evaluations of the prototypical solutions, which are not discussed in this article due to space limitations.

The participants who formed part of the case study were mainly software developers, subject-matter experts, computing students, learners, community representatives, problem owners, and business owners. Data collection was accomplished through different phases. In Phase 1, a thorough searching through the Web for hackathons-related online news reports, personal blogs, and hackathon events pages was done. This was done so as to understand fully the purpose of the hackathons from different perspectives. It was also important to understand why these hackathon events have rapidly found their way even in larger organisations (Briscoe & Mulligan, 2014; Wiggins et al., 2014), such as Google. Phase 1 was also crucial for understanding the impact that these types of programmes have on those who participate in them, particularly computing students.

In Phase 2, data was continuously collected and analysed during the six (6) different hackathons that formed part of the case study. During Phase 2, data was collected through open-ended interviews with randomly selected participants and field notes were recorded during participant observations. A total of 30 interviews were conducted during the period of the study, with about five (5) interviews conducted at each of the events. The interviewees were mainly with software developers, subject-matter experts, students, and community members. Participant observation was chosen because it enabled the researchers not to be bystanders, but to be directly involved in all the activities that formed part of the case study (Guest et al., 2013: 79).

The case study evidence was analysed using thematic analysis and activity theory (De Souza & Redmiles, 2003; Joffe, 2011; Vakkayil, 2010). Thematic analysis 'focuses on identifiable themes and patterns' of activities from research data (Joffe, 2011), whilst activity theory provides elements that make it possible to understand and analyse the relevance of collaborative work (Hashim & Jones, 2007). In addition, activity theory provides aspects that are useful for understanding human activities within a specific environment

community engagement project). In Phase 3, the proposed model was evaluated by involving expert reviews made up of five (5) experts, mainly from academia, private and public sector. The expert reviews were only conducted during the last hackathon that formed part of this study. The experts evaluated the model based on the following aspects:

- **Impact:** the impact that the model could have in stimulating students' interest in CS
- **Complexity:** the complexity of the model when considering different aspects, such as involvement of multi-disciplinary stakeholders

- **Relevance:** the relevance of the model within the ODL environment and in addressing challenges of low enrolment in CS.
- **Sustainability:** the sustainability of the model in achieving the desired results now and in the future.

A simple 1 (Poor)–5 (Excellent) scale was used to quantitatively evaluate the model and experts' comments and suggestions were used to qualitatively evaluate the model.

4. CASE STUDY – COMPUTING PRO BONO

The case study that informed this research was undertaken within a project called Computing Pro Bono. The project has been running since 2012. The project is a community engagement and outreach initiative in the School of Computing at UNISA. It is purported to exploit the computing and research expertise of the computing academics, students, and external stakeholders to develop or hack Open Information and Communitarian Technologies (ICTs) solutions that could address social and humanitarian challenges. Community engagement typically finds expression in a variety of forms, ranging from informal and relatively unstructured activities to formal and structured academic programmes addressed at particular community needs. Some of the activities might be conducive towards the creation of a better environment for community engagement and others might be directly related to teaching and research (UNISA, 2008). Community engagement is also one of three core responsibilities of higher education, together with research and teaching, even though it seems to have been neglected (Council of Higher Education, 2010).

The main objective of this specific project is to foster collaborations between students, staff, and external stakeholders in addressing some of the social challenges using computing. The other aim is to provide a work-integrated learning environment for computing students, who are often neglected when it comes to industry exposure.

Approximately, a total of 400 participants, including computing students, learners, subject-matter experts, researchers, business analysts, developers, and representatives of local communities gathered and collaborated to tackle different social challenges in various domains over the six (6) hackathon events that formed part of the case study from 2012 until the end of 2014. Each hackathon was hosted over a two-day period (from Saturday until Sunday) spanning over 40 hours. Participants had an option to attend the events physically or virtually participate using tools, such as Google Plus or Skype.

The participation was voluntary and opened to everyone who had the interest to contribute in the identified projects. Challenges or projects that were tackled by the volunteers mainly originated from communities, schools, non-profit organisations, experts, and in some instances, from computing students. At the end of each session, all the projects were evaluated against set criteria by a team of subject-matter experts. The evaluation of these projects is beyond the scope of the research results presented in this article.

5. CASE STUDY FINDINGS

In this section, we present and discuss the research findings that emerged from the case study using thematic analysis and activity theory as explained in Section 3. In terms of thematic analysis, a number of common themes were derived from the research data and these are discussed in conjunction with the same data that was analysed using activity theory. It is worth noting that data collection, analysis, and reporting in this study was guided by the research ethics code of the university (University of South Africa, 2015), and for purposes of ensuring confidentiality and anonymity of respondents, including experts, no direct names of the respondents are exposed in this report. Respondents' answers during the interviewed are referenced using R1, R2,...Rn and experts are referenced using E1, E2, and so forth.

Briefly, activity theory focuses on six elements when analysing human activity, and these are (1) objects, (2) subjects, (3) community, (4) division of labour (5) rules, and (6) tools (Constantine, 2009; Vakkayil, 2010). The results are discussed according to the derived themes and based on the elements defined by the activity theory.

Challenges

In all hackathons under the aforementioned case study, the main activity was about delivering computing solutions within a short period of time focusing on addressing identified social challenges. Based on the activity theory, *objects* are equivalent to challenges. These are the intended activities that role players engage with to achieve a particular outcome (Hashim & Jones, 2007). Some of the challenges or projects that were tackled during the hackathons included projects, such as social informant, water detective, water pump monitor, micro worker, donate-my-school-stuff, smart-citizens, and many others. Details on some of these projects can be found in these reports (CSET, 2012, 2013; RHoK, 2012). These projects were initiated by different stakeholders, such as non-governmental organisations, private and public schools, and subject-matter experts. The challenges presented integrated a number of computer science concepts, such as searching algorithms, graph theories, and others.

During all the hackathons, it was also observed that although the main activity was about software development, other sub-activities were also performed by non-technical or novice participants, such as researching the presented challenge, gathering requirements from subject-matter experts, managing the to-do tasks list, and designing of user interfaces. Most of the challenges presented offered students opportunities to apply what has been learned in class in practice, do further research on computer science and information systems concepts, reflect on various concepts in practice, and in some way confront social good issues in a collaborative environment.

Participants

The challenges presented in the hackathons were normally addressed in teams of about two to eight members. The participants, which are referred to as *subjects* in the activity theory (Vakkayil, 2010), came from different fields and had different skills sets; which were not only limited to technical programming. From the data collected, it became apparent that the subjects were instrumental in making the hackathons successful, particularly the subject-matter experts, developers, and organisers. It was observed that students engaged heavily with experts in the beginning, mainly for purposes of understanding the social challenges and possible approaches to addressing the challenge. These students brought a lot of dynamics into different challenges as they were open-minded and attended these events to 'learn, and also practically apply what [we] have learnt in the classroom' said one student (R23). Most of the students interviewed find the whole concept of hackathons very useful, giving them a chance to learn and 'network with expert developers' (R10), but also an opportunity to be part of project teams that are capable of delivering solutions within a short space of time, using a number of open source technologies.

Collaborations

In all the hackathons that formed part of the case study, the aspect of *community* and collaborative work was central. In a number of instances, communities were formed before the events, either for problem finding and formulation or for identifying stakeholders that might benefit from the proposed solution(s). The challenges (i.e. projects), although many required technical solutions; were tackled by appreciating all the contributions of individuals who participated. In this instance, students found the opportunity of addressing some of these challenges with others rewarding. One expert asserted:

students not only get the opportunity to understand the value of computer science in terms of social good, but they also get the opportunity to engage with industry professionals and subject-matter experts, who have already passed the road that they are currently travelling (E5).

It should also be emphasised that by being part of collaborative teams, students are also exposed to 'mentoring and work-integrated learning opportunities; which are sometimes limited within an ODL environment' (E2).

It was also observed throughout the different events that hackathons do encourage the notion of 'working together to achieve more' (R18) and it is believed that students' participation in such projects is vital for their social and practical understanding of computer science concepts, and for maintaining their interest in CS.

Structure, Rules, and Technologies

From the case study, it became apparent that activities within the projects are somehow semi-structured, with participants, especially students deciding where they would want to be involved. In many instances, most of the participants were involved in the hackathon for social coding, thus most of the attendees are software developers. In addition, there are normally some unwritten rules that govern how teams engage in activities. Typically, subject-matter experts would drive the requirements of the social solution meant to address the identified challenge. Conversely, seasoned developers would lead the manner in which the development of the solution will be approached, such as what software development methodologies are used and which technologies are useful and relevant for the identified challenges.

Computing students would normally be tasked with setting up the environment, such as the relational database, designing simple user interfaces, and performing project management duties. However, depending on the technical skills of the student, more challenging tasks could also be allocated. However, it should be noted that for all the hackathons within the case study, the main objective of involving computing students, mostly from the ODL environment, was to investigate and understand the value of hackathons in stimulating and maintaining their interest in the CS field.

Activity theory postulates that *subjects* engage with the *object(s)* by using different types of tools (Jonassen & Rohrer-Murphy, 1999). Open and mobile technologies were dominant, mainly due to the fact that they are easily accessible, easy to use, and normally receive wide support from the open source communities. It is also worth noting that mobile devices are quite efficient as experimental tools for rapidly testing various computer science concepts. This is because they have similar capabilities as traditional computers, such as network access, processing and storage.

Nevertheless, it became apparent during the interviews with some students that a technology choice was based on previous experience, awareness of the tool, and availability of online resources about the technology (e.g. documentation and tutorials). In some instances, it was also based on what the team deemed as appropriate. In some cases, teams chose a technology on which they had little working experience. This as explained by one software developer interviewed, was for purposes of 'trying and learning something new' (R11).

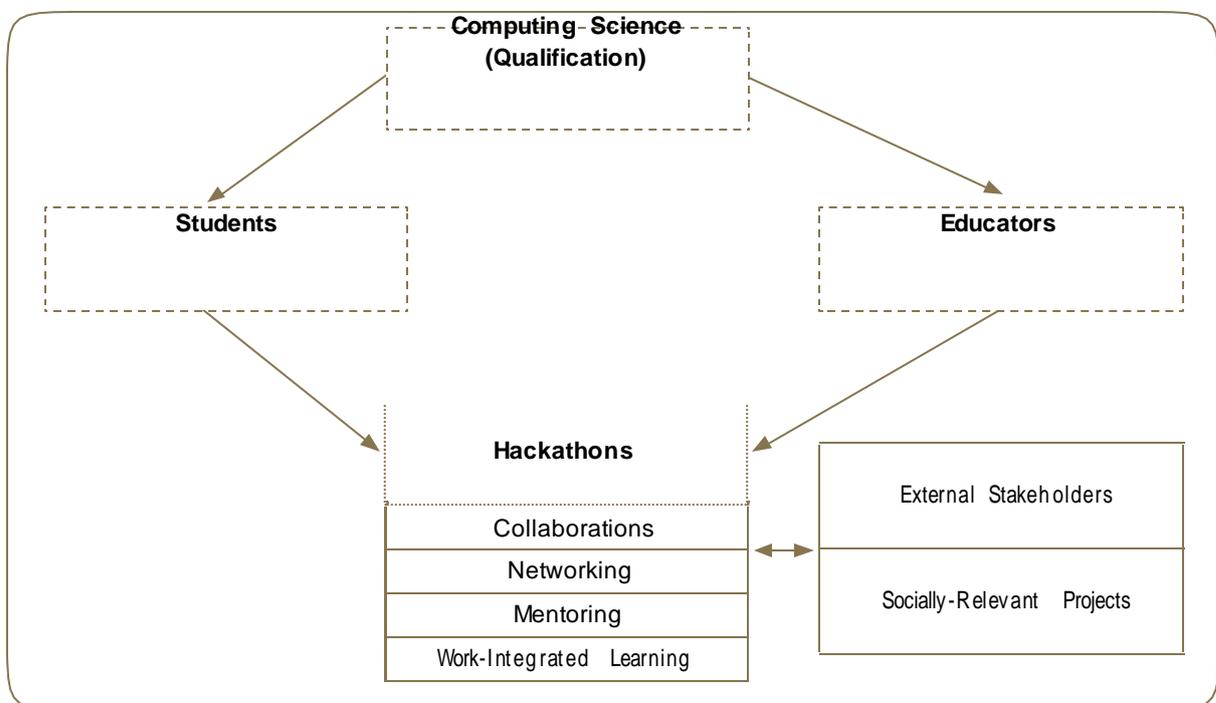
From the research findings, it is apparent that hackathons have the potential to stimulate and maintain students' interest in computer science. At the same time, the hackathon approach provides a suitable environment where students could easily understand the social relevance of CS. The research findings also suggest that if students are able to see the value of what they are learning in class within a real-life setting, their passion and participation in the field increases. This was observed throughout the different hackathon events that formed part of the case study. Lastly, it was also observed that during the first attendance of a hackathon, many students had wrong perceptions of what the whole programme is all about. Some students interviewed during the first two (2) hackathons thought that it was about 'breaking into bank systems' (R3, R8), and after the first event, particularly when their projects are evaluated by the experts, their thinking completely transformed.

The following section presents a hackathon model that emanated from the case study and could be used as a foundation to stimulating and maintaining students' interest in CS within an ODL environment. The evaluation of the model is also discussed.

6. HACKATHON MODEL

From the results of the case study conducted as described in Section 5, the hackathon model as depicted in Figure 1 was formulated. The purpose of the model is to capture key elements that are essential toward stimulating and maintaining students' interest in CS. The model is composed of various integrated elements, with the root element being the CS qualification.

Figure 1:
Suggested hackathon model



As it may be noted in Figure 1, the facilitation of the CS qualification is managed by educators with students being the key participants. On average, the five (5) experts (E1 – E5) rated the complexity of the model at 3.6, which is classified between Good and Great. It was noted that the involvement of different stakeholders should be synergistic, where students and educators continuously engage through various pedagogical strategies for purposes of promoting better learning and understanding. Within this element, it is also important to start reflecting on the social importance and impact of CS, possibly through small and social class-based projects.

A direct connection between theory and practice need to be formulated, using programmes (e.g. *hackathons*) that encourage students and educators working together with external stakeholders (e.g. communities and subject-matter experts) in socially relevant projects. The projects need to be scoped such that some of the computing principles taught in class could be implemented in practice, thus 'enabling current and prospective students to better understand the relevance of CS in the real-world settings'(E3). The process of aligning the CS curriculum with hackathons is a process that needs to be given enough attention, and improved over time through experience and participation by both students and academics. All the experts evaluated the proposed model to be of the higher impact (score of 4), and having a great

potential to address some of the challenges faced by computing students (e.g. work-integrated learning). The potential impact is elaborated as follows: The hackathon approach could also be incorporated in the CS qualification to provide students progressively with opportunities *for collaborations* with the community and industry experts, thus enriching their perceptions about CS. *Networking* opportunities with other individuals in the same field (e.g. software developers) could also clarify a number of concerns for CS students, particularly when networking with those who are already applying what was taught in class in a real world. The environment (i.e. hackathon approach) could also enable experienced professionals who are already in industry to 'mentor and engage' (E1) students on various aspects related to computing. Another important aspect that could be tackled with the hackathon approach is the 'work-integrated learning' (E1, E4), which is possible to implement and complete over multiple hackathon sessions and where deliverables could be social projects that are ready to be deployed with the selected community.

The ultimate goal of the hackathon model should be to ensure that students' interest in CS is stimulated and maintained, and that students' perceptions about CS as being complex and asocial are transformed. On average, the experts evaluated the sustainability of the proposed model at 4.5. They mostly cited its implication on addressing social challenges in the communities using technology and alignment with the education sector, where practical work is essential for students to be prepared for the real world.

Lastly, the implementation of the model could differ from one setting to the next. For instance: in an ODL environment where students are mainly distributed across different locations, virtual hackathons or even different hackathon chapters in different locations or regions could be considered. In order to also ensure seamless integration of such an approach into the CS qualification, it might be useful to assess students on the deliverables that emanate from different events. With regards to the relevance aspect, experts agreed that such a model is relevant, and not only to the ODL environment, but to other traditional universities, businesses, and the public sector. However, care should be taken that projects that are started are completed, and students take time to understand the environment where the developed solutions are meant to be deployed. Experts also warned that it might be difficult for the model to stimulate directly students' (especially those not in the system already) interest in CS, but mostly agree that it is relevant for maintaining students' interest in computing qualifications.

7. CONCLUSION

In this study, we have demonstrated the possibilities of using the hackathon approach as a means to stimulate and maintain students' interest in computer science. Through an exploratory case study, we have highlighted that community engagement projects, such as Computing Pro Bono, when implemented within the context of hackathons, can enable computing students to collaborate with communities, subject-matter experts, and most importantly industry professionals in order to better understand the relevance of CS in a real-world setting. The potential of hackathons in delivering socially-relevant solutions within a short space of time is self-evident from the case study conducted, and this provides a good platform for students to apply what they have learned. From the research findings, it was discovered that most students who participated in the hackathons that formed part of the case study found the hackathon environment to be useful for their learning and above all for changing their perceptions about computing.

The main contribution from this article is, therefore, a proposition of a hackathon model as one possible approach for increasing students' interest in computer science and encouraging their involvement in using their computing skills and knowledge in solving social pressing issues affecting their local communities. Further research work points to the replication of the study with more computing students and the evaluation of the model in other environments, such as a traditional university. The efficacy of the proposed model in addressing the low interest in computer science also requires further investigation as noted during the expert reviews.

REFERENCES

- Abdullah, H. & Mtsweni, J.S. (2013) 'A model for Work Integrated Learning (WIL) in an Open Distance Learning (ODL) environment' *Proceedings of the 18th WACE World Conference on Cooperative & Work-Integrated Education*. Durban, South Africa. pp.1-13.
- Abdullah, H. & Mtsweni, J. (2014) 'The role of e-tutors in promoting e-learning using Web 2.0 technologies' In J. Van Niekerk (Ed.) *Proceedings of the African Cyber Citizenship Conference* pp.67-72. Nelson Mandela Metropolitan University, South Africa.
- Anderson, N., Lankshear, C., Timms, C. & Courtney, L. (2008) "'Because it's boring, irrelevant and I don't like computers": Why high school girls avoid professionally-oriented ICT subjects' *Computers & Education* 50(4) pp.1304-1318. doi:10.1016/j.compedu.2006.12.003
- Briscoe, G. & Mulligan, C. (2014) Digital Innovation: The Hackathon Phenomenon (6). <http://www.creativeworkslondon.org.uk/wp-content/uploads/2013/11/Digital-Innovation-The-HackathonPhenomenon1.pdf> (Accessed 13 November 2014).
- Buckley, M. (2009) 'Viewpoint: Computing as social science' *Communications of the ACM* 52 (4) pp.29-30. doi:10.1145/1498765.1498779
- Buckley, M., Nordlinger, J. & Subramanian, D. (2008a) 'Socially relevant computing' *Proceedings of the 39th SIGCSE Technical Symposium on Computer Science Education*. Portland, OR, USA: ACM. doi:10.1145/1352135.1352255
- Buckley, M., Nordlinger, J. & Subramanian, D. (2008b) 'Socially relevant computing' *SIGCSE Bulletin* 40(1) pp.347-351. doi:10.1145/1352322.1352255
- Calco, M. & Veeck, A. (2015) 'The Markathon: Adapting the Hackathon Model for an Introductory Marketing Class Project' *Marketing Education Review* 25(1) pp.33-38. <http://www.tandfonline.com/doi/abs/10.1080/10528008.2015.999600>
- Chowdhury, J. (2012) 'Hacking Health: Bottom-up Innovation for Healthcare' *Technology Innovation Management Review* (July 2012) pp.31–35.
- Constantine, L.L. (2009) 'Human Activity Modeling: Toward A Pragmatic Integration of Activity Theory and Usage-Centered Design Human-Centered Software Engineering' In A. Seffah, J. Vanderdonck & M.C. Desmarais (Eds.) Springer: London. pp.27-51. doi:10.1007/978-1-84800-907-3_3
- Council of Higher Education. (2010) 'Community Engagement in South African Higher Education' http://www.che.ac.za/documents/d000204/Kagisano_No_6_January2010.pdf. (Accessed 12 December 2012).
- CSET. (2012) 'Computing Pro Bono' <http://www.unisa.ac.za/cset/news/index.php/2012/06/computing-pro-bono/> (Accessed 18 May 2013).
- CSET. (2013) 'Computing Pro Bono Hacks for Humanity' <http://www.unisa.ac.za/cset/news/index.php/2013/06/computing-pro-bono-hacks-for-humanity/> (Accessed 22 July 2014).
- De Souza, C.R.B. & Redmiles, D.F. (2003) 'Opportunities for Extending Activity Theory for Studying Collaborative Software Development' *8th European Conference in Computer-Supported Co-operative Work and Social Computing (CSCW) (Workshop in Applying Activity Theory to CSCW Research and Practice)*. Helsinki, Finland.

Firth, R. (2014) 'South Africa needs to get kids interested in computer science, or risk falling badly behind | memeburn' <http://memeburn.com/2014/09/south-africa-needs-get-kids-interested-in-computer-science-or-risk-falling-badly-behind/> (Accessed 11 February 2015).

Galpin, V.C. & Sanders, I.D. (2007) 'Perceptions of Computer Science at a South African university' *Computers & Education* 49(4) pp.1330-1356. doi:10.1016/j.compedu.2006.02.008

Guest, G., Namey, E. & Mitchell, M.L. (2013) *Collecting Qualitative Data: A Field Manual for Applied Research*. London: SAGE Publication, Inc.

Hashim, N. & Jones, M.L. (2007) 'Activity Theory: A framework for qualitative analysis' *4th International Qualitative Research Convention (QRC)*. PJ Hilton, Malaysia.

Hecht, B. & Werner, J. (2014) 'The KumbhThon technical hackathon for Nashik: A model for STEM education and social entrepreneurship' *IEEE Intergrated STEM Education Conference (ISEC)*. http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=6891024

Hill, C., Corbett, C. & St. Rose, A. (2009) 'Why So Few? Women in Science, Technology, Engineering, and Mathematics' *American Association of University Women*. <http://eric.ed.gov/?id=ED509653>

Joffe, H. (2011) *Thematic analysis*. Chichester, UK: John Wiley & Sons.

Jonassen, D. & Rohrer-Murphy, L. (1999) 'Activity theory as a framework for designing constructivist learning environments' *Educational Technology Research and Development* 47(1) pp.61-79. doi:10.1007/bf02299477

Levy, S. (2010) *Hackers: Heroes of the Computer Revolution - 25th Anniversary Edition*. California: O'Reilly Media, Incorporated. <http://books.google.ca/books?id=mShXzzKtpmEC>

Mtsweni, J. & Abdullah, H. (2013) 'Stimulating Socially Relevant Computing through Community Engagement: an ODeL perspective' *INEER ICEE ICIT Conference*. Cape Town, South Africa.

NASA. (2010) Random Hacks of Kindness (RHoK). http://www.nasa.gov/open/rhok_2010_prt.htm (Accessed 12 May 2013).

Papastergiou, M. (2008) 'Are Computer Science and Information Technology still masculine fields? High school students' perceptions and career choices' *Computers & Education* 51(2) pp.594-608. doi:10.1016/j.compedu.2007.06.009

Pauca, V.P. & Guy, R.T. (2012) 'Mobile apps for the greater good' *Proceedings of the 43rd ACM technical symposium on Computer Science Education - SIGCSE 12* p.535. New York: ACM Press. doi:10.1145/2157136.2157291

Raymond, E.S. (2001). How to become a Hacker. <http://www.catb.org/esr/faqs/hacker-howto.html> (Accessed 18 May 2013).

RHoK. (2009) What is Random Hacks of Kindness? <https://sites.google.com/a/rhok.org/www/home> (Accessed 12 May 2013).

RHoK. (2012) RHoK Pretoria - H20 Detective are the winners! www.rhok.org/blog/rhok-pretoria-h20-detective-are-winners

Richard, G. & Kafai, Y. (2015) 'StitchFest: Diversifying a College Hackathon to Broaden Participation and Perceptions in Computing' *SIGSE '15 Proceedings of the 46th Technical Symposium in Computer Science Education* pp.114-119. <http://dl.acm.org/citation.cfm?id=2677310>

Tellis, W. (1997) 'Application of a Case Study Methodology' *The Qualitative Report* 3 (3) <http://www.nova.edu/ssss/QR/QR3-3/tellis2.html>

UNISA. (2008) Community Engagement and Outreach Policy. http://cm.unisa.ac.za/contents/departments/community/docs/CommEngagemPolicy_toManCom_26an08.pdf (Accessed 18 May 2013).

University of South Africa. (2014) Unisa Online - Facts & figures. <http://www.unisa.ac.za/Default.asp?Cmd=ViewContent&ContentID=18123> (Accessed 10 January 2015).

University of South Africa. (2015) Research ethics. <http://www.unisa.ac.za/Default.asp?Cmd=ViewContent&ContentID=27669> (Accessed 24 July 2015).

Vakkayil, J.D. (2010) 'Activity Theory: A Useful Framework for Analysing Project-Based Organizations' *Vikalpa: The Journal for Decision Makers* 35(3) pp.1-18. doi: <http://www.vikalpa.com/pdf/articles/2010/page-vol-35-1-18.pdf>

Vivacqua, A.S. & Borges, M.R.S. (2012) 'Taking advantage of collective knowledge in emergency response systems' *Journal of Network and Computer Applications* 35(1) pp.189-198. doi:10.1016/j.jnca.2011.03.002

Warren, M. & Leitch, S. (2010) 'Hacker Taggers: A new type of hackers' *Information Systems Frontiers* 12(4) pp.425-431. doi:10.1007/s10796-009-9203-y

Watters, A. (2012) Designing Education Hackathons. <http://hackededucation.com/2012/08/06/education-hackathon/> (Accessed 19 May 2013).

Wessels, R. (2012) 'The reception of satellite broadcasting in public administration teaching at the University of South Africa' *Mediterranean Journal of Social Sciences* 3(12) pp.150.

Wiggins, A., Gurzick, D., Goggins, S. & Butler, B. (2014) 'Quality Hackathon' *Proceedings of the 18th International Conference on Supporting Group Work - GROUP '14* pp.321-323. New York, USA: ACM Press. doi:10.1145/2660398.2660429

World Economic Forum. (2012) The Financial Development Report. http://www3.weforum.org/docs/WEF_FinancialDevelopmentReport_2012.pdf (Accessed 12 February 2015).

Yin, R.K. (2009) *Case Study Research - design and methods* (4th ed.) California: SAGE Publications.