Moving the Hackathon Online:
Reimagining Pedagogy for the Digital Age

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Abstract

This article explores the use and potential of hackathons as a pedagogical and curricular innovation for developing student knowledge and important transversal skills through real-world challenges. It briefly reviews the literature on hackathon formats in higher education and then reports two innovative case studies: Hack4Change and DigiEduHack. Firstly, the paper documents the efficacy of a large hackathon event series which was run on-campus over 5-days in an Irish University as part of an enterprise module. Secondly, it reports the experience of a unique online hackathon event hosted across a number of countries as teams develop solutions to hack educational problems. Following a description of each hackathon event and the design of the learning experience, the paper shares a number of reflections and valuable lessons for Chinese educators thinking about adapting this model to their own teaching contexts, especially when exploring new online and hybrid approaches. Although there is no recipe to hosting a successful hackathon, we conclude that when carefully designed with clearly defined learning outcomes they provide an innovative and pedagogically engaging way to develop more creative students, enterprising mind-sets and future work-ready graduates for tomorrow's world, today.

Keywords: Hackathon, Hack4Change, DigiEduhack, Dublin City University

Introduction

Derived from the word 'marathon' wherein participants engage in an intensive run over a long period of time, a hackathon is an event which requires participants to commit significant time and consideration to a project in a short-form intensive working group (Čović & Manojlović, 2019). Initially hackathons were used in the IT community where programmers, project managers, and designers collaborated intensively on software projects to co-create novel solutions (Kienzler & Fontanesi, 2016). Increasingly, they are being used as a method of engaging students in collaborative project events in multiple educational domains, and particularly in creation of start-up concepts in entrepreneurship communities. During such events, participants will come together and form working teams, tasked with the creation of concept solutions during the time allocated. At the end of the hackathon, the solutions are formally presented and evaluated based on feasibility or other criteria (Brenner, 2011).

These events are intended to be experiential, active and with multiple interactions with expert mentors and facilitators. While usually this format of event takes place in more traditional off-line settings, there has been an increasing trend to stage online hackathons, particularly since the start of the COVID-19 pandemic. Irrespective of whether the event is online or off-line, the hackathon format is beneficial in developing student knowledge and engagement with the topic under investigation. Moreover, well-designed hackathons can develop team working and important transversal skills, such as creativity, complex problem solving, and judgment and decision-making, which notably the World Economic Forum (2020) identify in their top 10 skills for 2025.

Universities currently face sincere challenges in their efforts to develop future job-ready graduates who are critical thinkers, capable communicators and are prepared for an evolving employment landscape (Choy & Delahaye, 2009). They must create connections and partnerships with industry to provide authentic learning opportunities for students using real-world challenges (Gentelli, 2015). Hackathons may prove a useful solution for such requirements, and act as a template which can span multiple disciplines of the education sector if formulated with care and effective pedagogical consideration.

This article discusses the usefulness of hackathons as a pedagogical and curricular innovation by reporting two different case studies. Firstly, it documents the efficacy of a large hackathon event series which was run in an Irish University as part of an enterprise module. Within this series of daylong hackathon events, students were presented with a set of issues of global and national importance and challenged to formulate innovative and viable ideas that could address a specific aspect of these problems. Each day over 110 students, in project groups of 5-6 members, spent a full day engaging with the various elements of the theme and formulating innovative methods of realising improvements. The day was structured around keynote addresses, 'lightning talks', mentorship sessions, and interactive idea pitching, and students gained exposure during each phase to subject experts, both internal and external to the university. Course credits were awarded for a reflection exercise that students wrote following their participation in the Hackathon.

Secondly, the paper briefly describes a major hackathon event where the focus is on Education itself as the problem in need of a solution. In this event, participants from Europe, and elsewhere around the globe, join teams and select a specific problem to hack from a number of challenges. The aim is to encourage collaboration, co-creation and real-life change as teams "hack education" to be more engaging and future-fit for the 21st Century. This hackathon is a free event managed by the European Commission and features as a key initiative in the *Digital Education Action Plan 2021-2027* (European Commission, 2020). The event was first offered in 2019 with the main stage based in Helsinki, Finland and hubs in 21 countries. In 2020, due to the challenges of the COVID-19 crisis, the event went online over 36-hours, with over 50 events in Europe, and beyond, and a main stage streaming live lighting talks and panel discussions from Berlin, Germany.

This paper draws on these two cases to discuss the efficacy and use of the hackathon format in higher education. In the backdrop of what has been dubbed the "great onlining" of higher education, it reflects on how such curriculum innovations can be adapted for online and hybrid learning contexts. A number of key recommendations for future hackathon design and use are shared that aim to promote highly engaging learning experiences which exploit the pedagogical affordances of new digital technologies. It is hoped that the insights of this paper are useful for Chinese educators, and those in other countries, intending to replicate hackathons in an online or hybrid format in their own contexts.

Use of Hackathon Models in Higher Education

Similar to any curricular or pedagogical approach, it is crucial that the rationale for a hackathon be known before the logistics be considered. At their most effective, these curricular innovations are hoped to be an opportunity for experiential learning, wherein the student as learner undergoes an intentional process of active experimentation, experienced action and reflective thought, said to develop new knowledge and skills (Lewis & Williams, 1994). This type of "innovation pedagogy" (Suominen, et. al., 2018) promotes teams of learners to engage in multi-disciplinary problem-solving which may better prepare them as work-ready graduates and life-long learners for a rapidly changing future. Hackathons which are formally integrated into the curriculum will need to consider their learning intentions and align their outcome expectations accordingly. Highlighted by Cobham et al. (2017) below and also echoed by Wilson, Bender and DeChants (2019), it may be wishful thinking that such interventions

embedded in the curriculum for Enterprise modules would naturally lead to feasible start-up ventures. However, they are useful in priming student teams for this future potential:

> *"Using a Hackathon to initiate a student enterprise has the benefit of bringing together a number of students from a range of backgrounds to start an enterprise together and to make the essential bonds that will help the team to stay together through the challenges that lie ahead. It is naïve to think that this alone will bring about success"* (Cobham et al., 2017, p.6).

Porras et al. (2019) suggest the format of a typical hackathon can be divided into three parts; pre-event, event and post-event. Pre-event activities might consist of some preparatory activities like reading of background material or pre-lectures, idea generation or team building. These elements may be executed before the event or at the initial stages of the hackathon itself. In some formats, idea generation is at the individual level, where participants then 'pitch' their early concept to others in the hopes of recruiting team members. Other formats may select and create the teams more arbitrarily and promote idea generation at the team level.

During the hackathon, team collaboration and team-working will be the main focus, with some themed presentations in the beginning and team demonstrations in the end. In competition-based events the final demonstrations are evaluated to award the winning teams (Porras et al., 2019). The duration of these hackathons is noted to be varied in the literature, with many being run in one day or a weekend. While Cobham et al. (2017) recommends that hackathons be timed as a 48-hour event spread over 3 days. Due to the lack of consensus in the literature on the most appropriate model by which to formulate the ideal hackathon, the most effective timeline for this curricular approach is not well known. Others may be longer, for example the Global Health Hackathon detailed by Kienzler and Fontanesi (2016) was held 10 weeks into the semester. Within this example, the undergraduate students formed working groups to construct their challenge concept at the pre-event stage four weeks before the event itself. In terms of timeline, Nolte et al. (2020) noted that short-form hackathon events may be conducive to engagement and hackathon success/winning, they had a lower likelihood of long-term project continuation.

The key point is that Hackathons are intended to be high-energy events, devised to create engagement and develop inspiration for participants, but there is little knowledge of the specific benefits to learning to date. A three day hackathon focusing on fashion-tech products by Vellesalu et al., (2019) noted an increase of 12.6% in perceived competence assessments in areas of research, conceptual ideation, technical realisation and entrepreneurship noted by participants. Wilson, Bender and DeChants (2019) investigated the feasibility of hosting a university-based homelessness hackathon which consisted of a 7-hour event, involving expert panels, rapid iteration, and solution pitches. Studying the effects on their student participants through pre- and post-test surveys, they noted an improvement in knowledge and attitudes related to homelessness as well as civic responsibility.

The efficacy of hackathons is still attaining research consensus, with Porras et al. (2019) noting the majority of scholarly work emerging after 2012. In the national study of entrepreneurial competencies related to the international GUESSS project, it was noted that only a minimal of Irish courses utilised hackathons in their curriculum (Clinton & Lyons, 2019). However, anecdotal evidence suggests there is growing interest in hackathons across many European institutions. Although there remains a dearth of international research on the hackathon format, in order for an event of this nature to be effective for its participants, including both the team staging the event and for learners, it needs to be planned meticulously and embraced with energy and a spirit of innovation. We believe the two innovative case examples described herein provide valuable insights and ample guidance on aspects to consider when devising a hackathon. While one case is focussed on business students as part of a social enterprise assignment, and the other is designed from an interdisciplinary perspective to generate new educational solutions, it is believed that many components from

the format of these two events are replicable across contexts. They also help to illustrate how the hackathon format with design adaptations and careful planning can support hybrid learning or even go fully online.

Case Study 1: The DCU Hack4Change Social Innovation Series

The case study herein relates to students in the Dublin City University Business School (DCUBS) participating in an enterprise module in their first year. The lead author plays a key role in the design of this module, which prior to the COVID-19 crisis was available to students studying on-campus. The situation in Ireland is now very different and the question is how could this transformative learning experience be replicated or even enhanced in an online or hybrid learning environment. The term hybrid is used here to mean a combination of online and offline learning that leads to a better overall experience.

As a broader version of entrepreneurship education, enterprise education aims to develop a self-reliance and enterprising mind-set in its students, regardless of their intended career path (Gibb, 1993; Lewis & Massey, 2003), thus benefits a wide range of stakeholders (Jones & Iredale, 2010). Lackéus (2017) suggests that Enterprise Education allows a student to become more creative and innovative, and the subject is based on a conceptualisation of entrepreneurship as opportunity-based recognition and action. Enterprise Education is discussed noted in the QAA guidelines (2018, p.7) as:

> *"the generation and application of ideas, which are set within practical situations during a project or undertaking. This is a generic concept that can be applied across all areas of education and professional life. It combines creativity, originality, initiative, idea generation, design thinking, adaptability and reflexivity with problem identification, problem solving, innovation, expression, communication and practical action".*

As such, the incorporation of a hackathon into the curriculum of this yearlong DCUBS module was considered well-suited. The module itself is broken up into thematic areas of entrepreneurship, corporate enterprise, family enterprise and social enterprise. The hackathons were used as the major component of the social enterprise section.

The DCU Hack4Change Social Innovation Series was a series of five day-long hackathons hosted for students of the LIFE module (1st year DCUBS) during what is known as Reading Week of Semester 2 (March 9-13 2020). Each day had a designated theme (Mental Health & Wellbeing, Fast Fashion, Smarter Travel and Climate Action & Sustainability) with students self-selecting to the theme that interested them most, resulting in a fresh crop of more than 110 students choosing a different theme each day. Students were tasked, in teams of 5 or 6 members, to develop viable ideas that could address a specific aspect of the larger problem.

Academic and practicing specialists were brought in to provide the students with expert insight into each respective theme; over the course of each day, these participants delivered keynote and 'lightning' talks, provided small-group mentoring to help the student teams develop and refine their ideas, and offered feedback at presentation sessions held at the end of each day. In between each round of engagement with the academic and industry specialists, the student teams worked on research and ideation, assisted by a set of informative prompts provided to them in the form of specific problem statements at the beginning of the day.

Staffing and Planning Timeline

To run such an interactive event, there was a requirement for multiple roles and intensive planning. In terms of staffing, during the weeklong event there were:

- 3 Managers – 1 module coordinator and 2 student managers
- 1 Logistics support personnel
- 3 Rotating Core Staff – teachers on the module assisting
- 30 Postgraduate student facilitators (broken up to attend for one day only each)

The two student managers were hired on a part-time basis one month in advance to assist in the preparatory work, attaining speakers and planning the logistics elements. These individuals were indispensable in preparing for the event. The postgraduate student helpers were given an introductory workshop one week prior to the event and were emailed detailed instructions. In the morning of the event prior to commencement, they were also given a briefing (and at breaks during the day). These students helped to facilitate the events and engage with the students, receiving event management experience in the process. They were also enabled to reflect on the experience as part of their management module, thus was incorporated into their academic structure also.

Figure 1: Photo of Hack4Change event

A sponsorship package was created for the event and a number of companies were approached. Sponsorship was required for the lunch costs for participants, some printing and material needs, and for prizes for participants. Due to the low waste concept permeating the event, material costs were kept to a minimum.

Resourcing and Curriculum Development

As stated, each day was devoted to a specific theme. An array of key societal challenges were presented to students in a poll several months before the hackathon, and five were selected from the responses (Mental Health & Wellbeing, Fast Fashion, Smarter Travel, Climate Action, Diversity & Inclusivity). Within each day, a number of theme mini-challenge statements were created by the teaching staff, for student participants to select to work on within their teams (See Table 1 for an overview of challenge statements for Day 1). Rather than allow students and teams to devise their own idea from such a broad concept, it was considered that this offered a more scaffolded approach, while still allowing them to ideate. Discussing their hackathon event, Kienzler and Fontanesi (2016) noted that allowing teams to formulate their own challenges produced extremely broad and unmanageable research problems, so this was considered to be a more effective approach in the time allotted to students in our event.

Each day there were keynote speakers, group ideation, inspirational (lightning) talks, mentorship, and a pitching competition at the end. As it was considered too onerous to create a new concept without any assistance in one day, student teams were given prompts. A selection of up to 20 sub-topics were provided to students, based on the overall challenge of the day, as outlined in Table 1.

Table 1: Challenge Statements for Monday (Mental Health & Wellbeing topic)

Dealing with presentation/public speaking anxiety	The stigma around depression	Keeping an exercise regime is hard!
Dealing with climate anxiety	Stress reduction	Exercise and emotional wellbeing
Coping with social media	Body dysmorphia	Addiction
Fake news distress	Understanding nutritional information	Cooking over Ordering-in
Understanding mindfulness	Sleep disorders	Anger Management.
Going vegan!	Eating disorders	Childhood obesity
More people should buy organic food	Suicidal thoughts and self-harm	Cyber-bullying

Following the keynote presentation and introduction to the day provided by the Master of Ceremonies (MC), students were encouraged to find the challenge statement they were most interested in, as posted on pages around the seminar room. This was a high energy team-working activity where students rushed to find their respective page, affix their name to it and once five names were added, the team was formed.

The format of each day was divided into three discrete sections, to correspond with the Hack Impact Canvas. These were: Problem, Solution and Validation (See Table 2). Schedules and the canvas were colour-coded to correspond with this notation, to aid students in their understanding of the day. Each student was provided a large poster of the Hack Impact Canvas and were instructed at various stages, to engage with the questions posed on it. As such, this was the main output which students created during the day. This canvas proved to be extremely useful in getting students to focus on the tasks and situate their ideas.

Table 2: Representation of the Hack Impact Canvas

Problem	Solution	Validation
What is the problem that you are trying to address? Who experiences this problem? Pick one main group – this is your target group Where/when/how does this problem occur?	Think of some new ways to solve your problem: Using a low tech product Using an online platform Using a community-based initiative Any other way?	Is the problem urgent? How many people have this problem? Who else is trying to solve this problem (i.e. competitors)? What do people think of this solution?

Why does this problem occur? Is this a local or global problem?	How does your solution work for the user/customer? Draw out your storyline of their journey - showing how customers interact with it.	Are they willing to buy/use your solution? Do they think your solution can be made better?

Mentoring sessions were scheduled twice during the day. Mentors were briefed in the guest area prior to the session. The information below was also posted in this area and all were encouraged to read it once signed in. In advance of the mentoring session, mentors were brought to an information area where their respective table numbers (corresponding to specific student groups) were posted on a large whiteboard. Volunteers then walked them to their assigned table/group. Once the mentor had spent their allocated time with the team, they returned to the board and were reassigned. All industry guests and sponsors were announced through social media and their profiles were posted on a rotating screen on each day. Profiles were color coded to coincide with the specific hackathon day.

All judges were given a briefing in advance of the pitch presentations and were instructed to use feedback templates to evaluate the teams. At the end of each round these were scored and discussed by the judges to ensure there was consensus.

What was their impact?

More than 600 students took part in the Hack4Change series. Each day, the event welcomed over 110 student participants, who were supported throughout the day by 20-25 subject specialists from across DCU and industry. In addition, 15 postgraduate business students assisted with the logistics and execution of the event, for which they also received academic credits in event management. As a channel for teaching and assessment, it is likely that few of these students will participate in an event of this kind during the remainder of their time in DCU. The event was experiential and engaging, with periods of ideation, reflection and inspiration. Student feedback on the experience was highly positive as evidenced by the selected quotes in Table 3.

Table 3: Selection of student feedback

Student Feedback – DCU Hack4Change
"The hackathon changed how I think about entrepreneurship. I actually know what entrepreneurship means after spending the day listening to great entrepreneurs."
"This experience has opened my eyes to the process of social innovation and I have learned a lot from it."
"This hackathon was intense, engaging and collaborative where we were inspired to create concepts that could be turned into ventures."
"This hackathon was a fantastic way to meet people with similar views and interests. It brought out my creative side that isn't always enabled in many of my modules and furthermore improved my communication skills and team work ability!"

"It was a very worthwhile experience and one that will stand to me in the long run. I was able to develop many skills over the course of the day such as communicating well with others, creativity, working in a group and public speaking which I was quite nervous about! Overall, the event far exceeded my expectations."

"I am grateful to have been given the opportunity to attend such an eye-opening event centered around a very personal issue of mental health … This was an amazing opportunity to learn more about this topic, find possible solutions to issues I personally struggle with and also receive valuable entrepreneurial advice from experts."

I really enjoyed the interactive experience and will definitely partake in more hackathons. Before attending the social hackathon I always thought being an entrepreneur was unattainable, that you needed to have some sort of expertise in a field to create a product, but after fast fashion I realised how wrong I was. In just five hours my group came up with a product that I can actually see a use for, and there is nothing like it on the market.

"Before this experience, I used to think being an entrepreneur was just having an idea, taking a risk and setting up a business. But there is so much more to it. It is about being innovative and creative. Coming up with new ideas or improved ones. Social entrepreneurship is so important. Hearing from multiple entrepreneurs at the hackathon and how much they have achieved and the impact they have made in society was amazing. This experience made entrepreneurship more intriguing to me, working alongside well-established entrepreneurs and coming up with ideas was an extremely valuable experience. I left DCU that day feeling inspired."

Twitter was the epicentre for social media engagement, as the entrepreneurial community in Ireland is very active on this platform. Twitter was leveraged to:

- Keep students and DCU staff up to date before, during and after the event.
- Enable potential event sponsors and partners to find out about the Hackathons.
- Engage with potential mentors, judges and speakers.
- Provide media coverage of the event, highlighting the stakeholders involved such as DCU business school, and all of the other organizations who generously got involved.
- Promote other initiatives and events that may be of interest to followers.

While the hackathon was designed to incorporate social media and utilize other relevant digital technologies it was never intended to be a fully online event. This is the challenge now facing the lead author and colleagues centrally involved in the Hack4Change initiative. Although we have yet to fully replicate this hackathon in an online format, over 2020 a number of other events were designed due to the COVID-19 crisis which encapsulates both the spirit and intent of this form of pedagogy. We are committed to exploring how to successfully apply the principles of hackathon design to online and hybrid learning environments. Currently, a number of virtual platforms which simulate live interaction are being evaluated - with online corporate tools such as Remo, GatherTown and Virbela all with distinct potential.

Case Study 2: The DigiEduHack Experience

This second case study reports the experience of DigiEduHack [https://digieduhack.com/] which is a major annual hackathon led by EIT Climate-KIC and coordinated by Aalto University in Finland on behalf of the European Commission. The second author has served on the high-level Steering Group since the original inception of this event late in 2018. As mentioned above, DigiEduHack is a key initiative in the *Digital Education Action Plan 2021-2027* and is seen by the European Commission as a powerful way of helping to reimagine education and

develop real-world solutions to advance the goal of developing across Europe an innovative and high performance digital education ecosystem.

The hackathon was first run over 24-hours in October 2019 following what could be described as a "hub and spoke" model. The hub or main stage was physically located in Helsinki with other hackathon teams participating in around 60 different education challenges spread across 21 countries. While live events were streamed from the main stage over the 24 hours to help connect and inspire the distributed hubs, the work of each team was primarily off-line. There were opportunities however to consult with relevant experts in the field through online platforms. In total, the hackathon involved over 1,700 participants with the 130 solutions coming from a diverse range of teams, including in some cases a mix of students, educators and other people just with an interest in education. In this respect, DigiEduHack aims to be inclusive, although as a general observation the 2019 event tended to attract more males than females.

Ten finalists were selected from the 130 uploaded solutions with three teams crowned as global winners each receiving €5000 to help go towards developing their educational solution. This funding reflects the spirit of DigiEduHack as the intention is for teams to take action and contribute to solving an actual challenge. Finalists were also acknowledged as Global DigiEduHack Ambassadors.

A decision was made relatively early in 2020 to develop a hybrid or fully online format due to the impact of the COVID-19 crisis. After considerable planning and preparation, and a series of webinars during the year to generate interest along with a MOOC on the FutureLearn platform to help support the development of challenges and successful team engagement, the 2020 version of the hackathon was staged over 36-hours on 12-13 November (see Figure 2). A main stage event once again brought together a diverse array of live speakers and panel discussions from Berlin as part of Germany's Presidency of the Council of the European Union.

Figure 2: Example of 2020 DigiEduHack website

Panel topics included:

- Lessons learned from the covid-19 crisis with implications for policy-making
- Collaboration and global exchange and finding solutions together
- The role of digital and green skills in delivering system innovation
- Future of learning and the Innovation potential of hackathons
- Future skills and life-long learning

- Putting ideas Into practice

This core feature of the revised online hackathon format was organised by Hochschulforum Digitalisierung (HFD), the German Academic Exchange Service (DAAD) and Technical University Berlin (TU Berlin).

The 2020 DigiEduHack attracted over 50 events spread around the world, although most of the 250+ teams and 2,600 participants were located in Europe, as illustrated below in Figure 3. Also it should be noted the main language used throughout the event was English, which probably limited more global uptake. Teams tackled a diverse range of challenges, including:

- Future campus
- Pimp my course
- Learning with AI
- Rethinking science labs
- Access to quality education
- The great online education pivot
- Improving learning through robotics
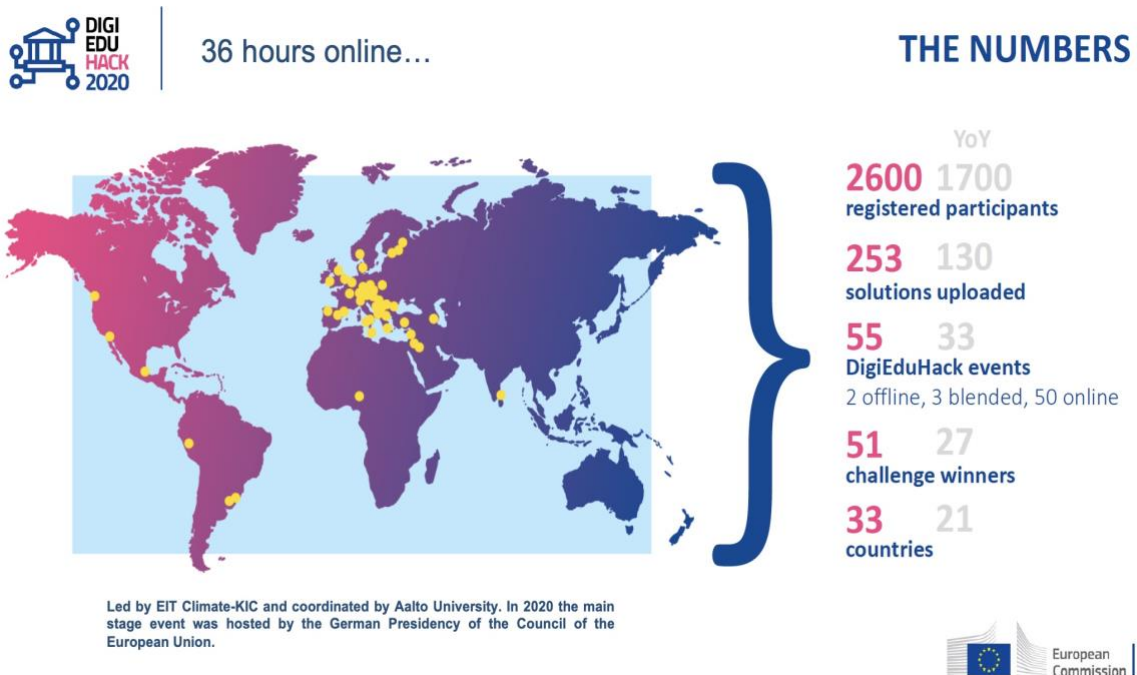- Education in the post-pandemic world

Figure 3: Participants in 2020 DigiEduHack

Over the 36-hour online event, a number of technologies and popular social media channels were used to facilitate communication within and across the teams (e.g., Slack, Facebook and Twitter). Live main stage events were hosted in Zoom and streamed using YouTube, with WhatsApp used by the German organisers and Steering Group to help coordinate activities. At the time of writing the three winning teams had yet to be announced as the European Commission is scheduled to release this news at the end of January 2021. It is difficult to know whether some higher education institutions awarded credit for student participation or to assess the wider impact of the two different hackathon formats, over the two years, until a more formal evaluation is conducted by the European Commission. However, it is noteworthy that 100% of hosts who participated in 2020 have indicated they wish to join the 2021 event.

Lessons Learned and Recommendations

This section critically reflects on the Hack4Change and DigiEduHack experience and drawing on relevant literature provides a number of lessons and recommendations for designing successful hackathons. In response to a hackathon event run by Cobham et al. (2017) the following recommendations were proposed for those embarking on similar events, noting that key success factors include:

- An extended timescale (a 48-hour event spread over three days was considered optimal).
- Provision of a team of organisers to supervise the event.
- A creative rather than competitive environment.
- Participation by students from a broad range of academic disciplines.
- A combination of allowing friendship groups with some management of group membership to ensure mixed skill-sets.
- Realistic goals with a focus on design requirements and prototypes over finished coded solutions.

These suggestions remain applicable to hackathon designs regardless of whether the event is off-line, online or in a hybrid format. With the benefit of reflection the second iteration of DigiEduHack certainly benefited from the longer timescale over 36-hours and this might be a lesson for future online events. In a similar vein, there were many benefits spreading the Hack4Change event over five-days, but we believe the optimal length really depends on what you want to achieve and an array of local contextual factors. Too long may make it difficult to sustain the momentum and high energy nature of the hackathon, whereas on the other hand too short a timescale may stifle creativity and enterprising mind-sets.

Both the two cases reported in this paper would not have been possible without a dedicated team of organisers. Planning began months in advance and this is an important lesson to keep in mind. Organising a hackathon is not for the faint-hearted as there are many challenges thrown up along the way. But in our experience they can also be a lot of fun for the organising team, and this is something we encourage Chinese educators to value and really celebrate, especially when all of your hard work and planning successfully comes together by the end of the event. The lesson here is that if your team is enjoying the event, then your participants are also likely to be having a lot of fun. As the saying goes, "the person who distinguishes between learning and fun does not really know much about the learning process".

The question of whether the event should have a competitive element is an interesting one as in the case of DigiEduHack the monetary prize was seen as a way of helping to fund the educational solution arising from the hack rather than being a personal reward for individual team members. Prizes can also help to add to the general buzz or atmosphere of the hackathon without necessarily making the event overly competitive, as we found during Hack4Change. Prizes can be an avenue for innovation also; for example, DigiEduHack had a special prize for the best team photo and most memorable social media post, which does not directly compare one solution to another. In our experience, teams benefit from receiving constructive feedback on their solutions from experts working in the field, and the use of prizes can help to ensure the best hacks or pitches are judged against clear criteria.

How you decide to invite participants to join teams is another example of how the local context is important. It was the case in the first year of DigiEduHack that team composition based on self-selection and existing friendships tended to skew the groups in terms of overrepresentation of males. If the intention is for teams to be creative and to think outside of the box, then diversity is important. However, the issue of diversity goes beyond gender as this includes age, ethnicity, academic discipline, and so on. The key lesson from our experience is to intentionally design your hackathon for diversity right from the outset, which applies also to your choice of challenges.

We concur with Cobham et al. (2017) that you have to be realistic about what is possible in the timeframe and communicate this to your participants. Sharing examples from previous hackathons might be helpful along with providing a timeline and structure for participants so they have a sense of whether the team is on track. In the case of online teams, in particular, we recommend you schedule a number of checkpoints where the team needs to provide a progress up; however, the time assigned for this task should be brief as you want to ensure the maximum amount of time is spent working on the challenge itself. Ensuring sufficient time is allocated at the end for a team debrief as well as a chance to share reflections across all of the groups is crucial if skills and knowledge gained from the hackathon experience are going to transfer to other problem-solving experiences. Such critical reflections are essential to developing "backward reaching" as well as the concepts of "far" and "high road" transfer (Perkins & Salomon, 1992) where learners can apply their newfound skills and understandings in the future.

To evaluate the hackathon and overall course experience, Kienzler and Fontanesi (2016) utilised a feedback message board forum to collect insights and develop a critically reflective community. We endorse the value of designing an online feedback form and other reflective tools to help scaffold participant evaluation. While it was considered that the team managing the enterprise module collected multiple insights from our participants, with the benefit of reflection more quantitative collection tools would allow for more replicable findings and more trustworthy conclusions. In the case of DigiEduHack, when uploading their solutions each participant was asked to provide a personal assessment of their team dynamics and whether everyone's voice was heard as they sought to generate solutions. Assessing the effectiveness of team-work is always difficult and we recommend that during the hackathon design particular attention is given to how you decide to assess team performance over and above the quality, inventiness or originality of the proposed solution.

Due to the COVID-19 global pandemic many higher education institutions around the globe had to rapidly pivot to online learning or what became better known as emergency remote teaching. As the saying goes, "in every crisis, there is an opportunity" and in many respects the pandemic has forced educators to think more creatively about how to adapt and develop new pedagogies for such challenging and uncertain times. What the crisis has taught us, as evidenced by the two case studies reported in this paper, is that the underlying pedagogical and curricular innovation of hackathons can be successfully adapted and implemented in both fully online and hybrid formats. The lesson is that we can do so much better than emergency remote teaching in designing active and meaningful online learning experiences.

A legacy of the crisis we hope will be that online learning environments will feature more prominently as productive spaces, places and tools to support more innovative curricular, especially for large classes. Therefore, we concur with Allen (2020) who in the management context encourages educators to embrace the digital mindset, to ensure "...that our curricula will be based on traditional business education fundamentals while keeping an eye on the future" (Allen 2020, p. 384). It is important, however, that we do not get seduced by the attractiveness of new digital learning solutions as a commitment to innovative pedagogy and transformative learning experiences must underpin decisions about hackathon design.

This last point returns us to an earlier discussion concerning the importance of clearly defining your learning outcomes and understanding how you will ensure your learners embrace the opportunities to engage in this type of real-world experience where new knowledge (and skills) is not going to be found or assessed from the traditional textbook. At first students may not be comfortable with this approach, which is why we recommend that you need to think very carefully about the design of your hackathon. Importantly, the most appropriate design will depend on your students, what you want them to learn, how you want them to learn, and what level of experience they already have working as teams on real-world problems and challenges.

The importance of selecting the best technology and online learning platforms for your hackathon is also an important consideration. In our experience the underlying pedagogical design is crucial but so too is the choice of learning technology. The basic principle is that your technology solutions should augment the learning experience and be woven seamlessly throughout the curriculum. Having said that, in the spirit of the hackathon format we encourage experimentation using new innovations such as gamification and augmented and virtual reality. Examples like Netland et al. (2020) who used virtual reality (VR) in an operations management course to give students the experience of being in a manufacturing company, are even more interesting now given that students may not be able to travel or fully engage in on-site visits. A recent systematic review of the literature by Hamilton et. al (2021) argues that immersive virtual reality is beginning to challenge our conceptual definition of what constitutes a learning environment.

Other specialist tools and platforms are emerging to support hackathons and we plan to pilot some of these in future initiatives. For example, Techstars and other companies have conducted online start-up events and hackathons to engage entrepreneurial students and members, using online conference tools like Remo which allow for breakout tables, general announcements and networking. Currently, a number of virtual platforms which simulate live interaction are being evaluated by our DCU team - with online corporate tools such as Remo, GatherTown and Virbela all with distinct potential. Internationally, hackathons continue to be a growing mechanism for innovation, connection and community building. In China, hackathons led by the Merck Innovation Hub, Microsoft for Startups and WeChat have all been facilitated to engage the public in Covid related problem solving. These events across the globe have real potential in developing a cross-cultural experience for students, if leveraged correctly by our educational institutions.

Conclusion

This paper has demonstrated how the hackathon format can be applied in different contexts and through different delivery models for different types of learners. As higher education evolves in the post COVID-19 world there will be greater need for educators to better understand how to harness the pedagogical potential of new online and hybrid learning environments. Moreover, with pressure on funding there is likely to be increased attention given to how new digital technologies can be used to support mass pedagogy and more efficient and automated forms of teaching, learning and assessment. Coupled with these pressures, there is a growing gap between the types of transversal skills and qualities that employers claim they want 21st Century graduates to possess and the more traditional skills and knowledge being developed by universities. While the traditional university degree has served us well for many years the time has come to rethink and reimagine higher education to prepare active citizens for new jobs, unknown careers and the rapidly changing nature of work. Put another way, if you want different results, then you have to try different approaches. Arguably, continuing to do the same thing leading to the same outcomes is no longer an option.

Hackathons provide one solution to ensuring that higher education is more future-fit for the requirements of the 21st Century. They enable educators to place a greater emphasis on collaborative team-teaching, active and participative learning, and innovative approaches to the development of important transversal skills. The efficacy of hackathons is still unresolved in the research literature, particularly in terms of new and emerging online and hybrid formats. However, the appetite for this curricular innovation appears to be growing, especially amongst many Irish students as they willingly volunteer their free time to participate in hackathon events externally supported by industry mentors and affiliate organisations.

While commendable, these student-driven and industry-led events can be a challenge to fully embed in the curriculum, and it is highly desirable they become part of the "next normal"

university experience, particularly as we look to exploit the potential of new digital technologies. While there is no magic template for institutions wishing to design effective hackathon events, whatever the delivery model, based on our experience from the two case studies reported in this paper we encourage educators to experiment with this emerging pedagogy to challenge traditional university norms. In the best traditions of the hackathon concept, there is an opportunity to hack the traditional higher education model to help develop more creative students, enterprising mind-sets and future work-ready graduates for tomorrow's world, today.

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Appendix 1

Recommended Planning Timeline for Hackathon Series

3 Months out
- Decide whether online or onsite (or hybrid) event
- Prepare budget
- Begin outreach to sponsors
- Identify speakers, mentors, judges and begin outreach
- Secure venue and date(s)
- Identify technology you wish to use
- Set up social media accounts and website

2 Months out
- Have some speakers, mentors and judges locked in. Follow up with those who have not responded and continue outreach to others.
- Initiate wider community outreach
- Volunteers - start putting this team together. Assign head volunteer(s).
- Social media and promo - generate buzz, have constant stream of promo
- Media release
- Follow up with sponsors, get funds locked in
- Catering - get an idea of numbers and costs. Order if in a position to do so
- Organise videographer/ photographer

1 Month out
- Focus on getting sponsors locked in
- Finalise technology tools and platforms
- Follow up with unconfirmed speakers, mentors and judges. Focus on getting any gaps filled
- Social media push - keep the buzz going
- Bios and headshots - begin
- Order promo materials
- Order catering of onsite event
- Create a list of event supplies - make necessary orders eg name tags
- Ensure the necessary bodies know where and when the events will be taking place (online or onsite or hybrid)

2 Weeks out
- Finalize speakers, mentors and judges. Send confirmation email with details of venue, arrival times etc
- Follow up with sponsors who have not yet paid (if any)
- Order food and drinks of onsite event
- Strong marketing push

1 Week Out
- Test technology
- Confirm sponsor details, arrival times, sponsor materials etc.
- Get sponsor logos for deck
- Finalise food and drinks orders
- Confirm all venue arrangements
- Reach out to press/promo team for external promo
- Final marketing push - ensure all sponsor, speaker, mentor and judge headshots and bios have been released on social media.
- Do walk through of the entire event in the venue or online platform - find holes/ issues
- Meet with volunteers and brief them
- Organise the individual topics for teams for each event.

1 Day Out
- Finalise main deck and speaker decks
- Set up venue or online platform, walk through venue, ensure everything is ready
- Organise registration table and lay out name tags
- Have signs on walls
- Have materials out on tables for students
- Organise mentor room
- Set out chairs/ TVs for presentations
- Ensure volunteers know all event details and are well briefed for the even. Assign 2 volunteers to concentrate on social media throughout the events
- Printing - judging materials, mentor packs, schedules, sign in sheets, topic sheets

Morning of Event
- Final technology test
- Arrive early, finish setting up, be ready to greet student and speakers/ mentors
- Team brief, specifically if there are new volunteers. Recap of previous events and any alterations made.
- Be ready for lost/ late/ cancelling mentors/ speakers etc
- Meet volunteers, ensure everyone is confident and ready for the day
- Big promo push all day - ensure media volunteers know what they're doing.
- Registration table ready
- Catering confirmed if onsite or hybrid event
- Rooms set up and volunteers ready to change set up once students move to next section

Afternoon and Beyond
- Judging areas set up
- Gather photos and logos from teams, ensure deck is ready
- Divide judges between judging areas
- Have a debrief after each event. Review what worked and what didn't and make necessary changes for the next day

Biographies

Dr. Roisin Lyons is an Assistant Professor of Entrepreneurship and Innovation at the Dublin City University (DCU) Business School. She holds a B.Sc. of Chemistry/Biology, a Higher Diploma in Education, M.Sc. Business Management and PhD in Entrepreneurship Education. Her research focuses on the effects of entrepreneurship education on student and student team, entrepreneurial tendencies and social entrepreneurship. She currently lectures in both DCU, Dublin and as part of the DCU team in PNU, Riyadh, and has won teaching awards for both posts. She is also part of the GUESSS Ireland team and a faculty advisor for Enactus (social entrepreneurship).

Prof. Mark Brown Mark is Ireland's first Professor of Digital Learning and Director of the National Institute for Digital Learning (NIDL) at Dublin City University (DCU). He serves on the Executive Committee of the European Distance and E-learning Network (EDEN) and is also an EDEN Fellow. Mark is a member of the Supervisory Board of the European Association of Distance Teaching Universities (EADTU) and serves on the Executive Committee of the Open and Distance Learning Association of Australia (ODLAA). In 2017, the Commonwealth of Learning recognised Professor Brown as a world leader in Open and Distance Learning, and he is a recipient of a New Zealand National Award for Sustained Excellence in Tertiary Teaching. In 2019, Mark was Chair of the ICDE World Conference on Online Learning in Dublin.

Dr. Enda Donlon is an Assistant Professor in the school of STEM Education, Innovation and Global Studies at the DCU Institute of Education. He is a former president (2018-2020) and vice-president (2016-2018) of the Educational Studies Association of Ireland (ESAI), and has served on the national executive of the Computers in Education Society of Ireland (CESI) from 2008-2019. He is currently the Irish representative on the Governing Council of the European Educational Research Association (EERA). Enda mainly teaches on the use of ICT in teaching and learning, with a specific interest in the use of digital technologies in and for teacher education.