Remote Software Development: A Student-staff Collaboration to Build a Showcase Platform for Non-traditional Digital Artefacts

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Abstract—In today's digital era, the number of digital artefacts produced by students in universities around the world continues to rise. This paper describes a project that developed a digital artefacts platform to showcase students' projects at an international level, aiming to increase the visibility of students' work to global audiences. Due to the COVID-19 pandemic, a large proportion of the software engineering project development took place remotely, with students and staff at University of Nottingham Ningbo China (UNNC), a Sino-foreign Higher Education Institution in Mainland China, adopting remote collaboration tools and techniques. This paper presents the background, software engineering development, and the project's unique characteristics. In addition, the challenges to project completion and remote collaboration, future recommendations, and the potential to extend this project into an Open Educational Resource (OER) are also discussed.

Index Terms—Open Educational Resources (OERs); student-staff collaboration; remote collaboration; software engineering; digital artefacts; showcase platform.

I. INTRODUCTION

Academic institutions across the globe have begun to make use of a number of different platforms to showcase students' work to global audiences [1]. Students at University of Nottingham Ningbo China (UNNC) have been producing various digital artefacts as part of their assignments in their majors and extra-curricular activities. Nevertheless, UNNC has not been effectively showcasing the artefacts to potential recruiters and other external stakeholders due to the inadequacies of the existing platforms.

This paper reports on a collaboration between Computer Science students and staff, and other UNNC personnel, conducted during the COVID-19 pandemic. Because of the pandemic, many teaching and learning activities were delivered in a blended manner, and the student team was partially remote with two members on-site and five members off-site. While developing the digital artefacts platform, the team also explored ways for how the product could eventually be made into an Open Educational Resource (OER) [2], [3].

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This paper describes the problems leading up to the project, the actual software implementation, and the student-staff remote collaboration. Team composition, planning, and management are discussed, followed by the challenges and evaluations of the team members throughout this project. The shortcomings of the current project and recommendations for future work are also discussed.

II. BACKGROUND

This section discusses OER, and how it can be used by members of the public. Some previous OER projects at UNNC are also introduced. Finally, digital artefacts, which are the main elements of this project, are defined.

A. Open Educational Resources (OERs)

OERs [2], in essence, are resources related to teaching, learning and research in any medium, digital or otherwise, that are in the public domain or released with intellectual property licenses that facilitate their free use, adaptation, and distribution.

Students often find answers to their questions by browsing the internet. More specifically, they often use online forums, such as "Stack Overflow" [4] or "Mechanical Engineering" [5]. Questions on these platforms are often answered or discussed by people having faced the same problem, or by experts from different parts of the world. However, to the best of our knowledge, there is not yet any such forum related to dealing with online-only collaboration. The "creative commons" platform [6] shares various types of artefacts and OERs, and itself serves as an OER.

According to Scott [7], in view of the Intellectual Property (IP) rights, copyright and policy considerations for OERs, it is important for universities who develop OERs to consider IP rights (especially copyright and personal rights), from the outset. This is because, under the terms of OER, users are granted rights usually reserved for the owners of the copyright [7]. Therefore, educational institutions releasing the content need to ensure that they own it, or have permission to use it,

to make it available under an appropriate open content license [8]. The UNESCO Institute for Information Technologies in Education (IITE) Policy Brief [9] shared a simple standardised way to grant copyright permissions of OER content, with reference to the different types of copyright licences from Creative Commons [10].

B. OER at UNNC

Although still a young institution, UNNC has developed several OER-related software development projects, including a note-taking app [11]; a language-exchange app for foreign-language learners [12]; a computer programming language training app for independent study [13]; a Virtual Reality (VR) platform to deliver phobia-inspired experiences [14]; and a VR application to teach web accessibility concepts [15].

C. Digital Artefacts

Digital artefacts are any items that are produced and stored in a digital format, including digital documents, video, audio and images. Compared to physical artefacts, digital artefacts tend to be easier to duplicate, modify, and use in other contexts [16]. For universities, some digital artefacts produced by students could be showcased for marketing purposes, to enhance the profile of the university, and its students, to the global audience.

III. THE PROJECT: DIGITAL ARTEFACTS SHOWCASE PLATFORM

In recent years, careers and employment are areas that have been highly affected by the rapid development of the Internet and digital platforms [17]. Career consultations and fairs, job advertisements, or even job interviews, have been shifting to online platforms. This has encouraged universities to suggest to their students to adopt digital resources and sites to find career and employment information. Universities and students have been exploring new methods to showcase students' work and accomplishments to attract potential employers [18].

According to Nils [19], showcase platforms and social media should be considered as vital components in an overall marketing strategy. Rapid changes around the world have encouraged the use of social media as a means of communication. This has resulted in companies and institutions needing to competitively design social media applications, websites, and platforms to be able to effectively communicate with their potential customers [20]. Lopez and Sicilia [21] also found that social media may be among the strongest marketing tools, with more than 70% of Internet users active on social media for around two hours per day. This led to a belief motivating this project — that integrating a digital showcase platform with social media could attract the global audience to explore UNNC students' work, and eventually serve as a platform for other institutions, perhaps in the form of an OER [2].

Employers often seek exceptional skills in prospective employees, which can be challenging to explain and visualize in a text-based document, such as a *Curriculum Vitae*. Good mindsets, strong personalities, and work experience are some
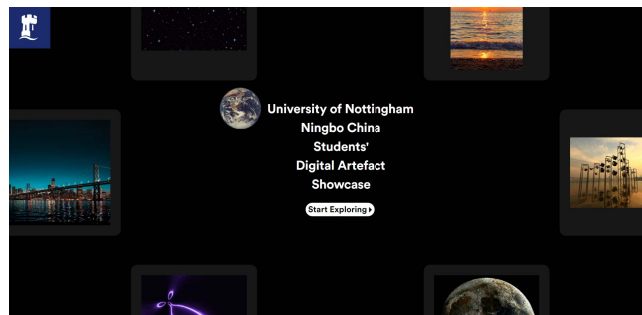

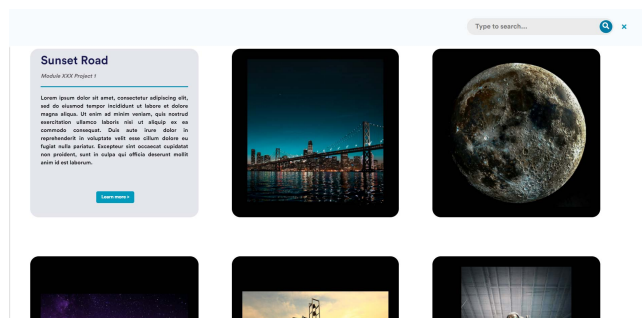Fig. 1: Welcome page of the proposed platform

Fig. 2: Home page of the proposed platform

of the strong points desired by recruiters, and digital platforms could be harnessed to exhibit these aspects [22]. However, many websites and platforms still lack key principles of good user interface design, such as consistent colours, icons, and fonts, clear placements of menus and buttons, and intuitive user navigation [15], [23]. In addition, static images, identical font sizes, and dull colour choices may contribute to a poor user experience. It is also crucial for artefacts to be accompanied by explanatory information, to encourage viewers to explore more.

Our digital artefacts showcase platform, as the final deliverable of this project, will enable employers to view the artefacts and find students who fulfil their preferred qualifications. It may also serve to enhance the profile of UNNC, and its students, with the combination of high-quality, user-friendly interfaces, and social media engagements.

A. Motivations

Not many universities have showcasing platforms that exhibit their students' work. Some of the few universities that do have, appear limited to PDFs, images, articles and videos [24]–[26]. This project explored how to enhance the presentation of various digital artefacts produced by students to potential employers. One of the aims of the project was to enable a viewer to interact with artefacts created by students.

Previously, only a few artefacts from some of the extra-curricular activities were displayed on the UNNC website. Static and non-interactive user interfaces, insufficient information about the artefacts, and complex hyperlinks, were among the inadequacies observed in the previous system.

A requirements elicitation process revealed the following features desired by the stakeholders:

1) It should be possible to host different artefact formats (beyond static images).
2) Website loading time should be short and not noticeable by users.
3) Users should be able to interact with the website, which should have interactive features, such as flip cards [27].

B. Project Approach

The development team consisted of seven Computer Science undergraduate students and a staff member who worked together over the course of one academic year.

The approach to this problem was to complete several cycles of Requirements Engineering (RE) and iteratively implement a platform for future digital artefact delivery and deployment. The complete RE process was a mixture of Plan-driven [28] and Agile [29] approaches, as requirements were elicited from the stakeholders, with an iterative and Agile approach was taken to design and implementation. This platform could be further integrated with various social media channels to increase engagement with the global audience.

C. Software Development

As the types of produced artefacts vary, the platform was developed to include videos, short films, games, websites, data visualization, and mobile applications. Each of these artefacts should be presented with interactive features such as flip cards [27] and draggable cards [30], to increase user engagement with the system.

As part of the Software Engineering (SE) process, low-fidelity and high-fidelity prototypes were produced using Marvel App [31] and Adobe XD [32], respectively. Prototypes were used to provide the look and feel of the system, and confirm the UI and functionalities with the stakeholders. The UI development was implemented using basic web development technologies (such as HTML, CSS, and JavaScript), with the support of W3.CSS [33] and Bootstrap [34] frameworks. Entity Relationship Diagrams (ERDs) and Use Case Diagrams (UCDs) were produced to better visualize the interaction between the visitors and the website.

For the server-side development, the team used Python, since it provides a wide selection of libraries and frameworks that are easy to integrate, and are maintainable [35]. The Django [36] framework was also used as it enabled rapid development of secure and maintainable websites. The combination of Python and Django makes a portable, maintainable, and scalable website that fits the requirements of the project.

D. Project Unique Characteristics

The digital artefacts showcase platform is a platform where visitors can view various digital artefacts and their metadata. The main page of the platform displays images from the uploaded projects, and enables exploration of artefacts that a visitor may be in interested in. Visitors can flip the artefact cards to view the artefact's details (Figure 3). Artefacts
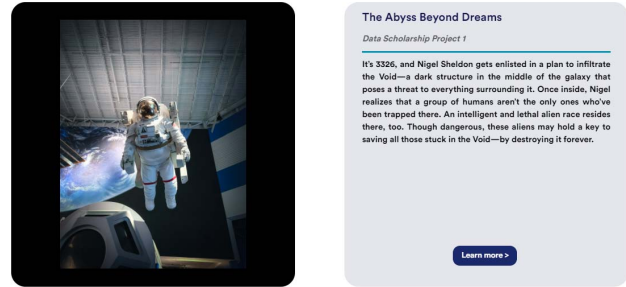

Fig. 3: Illustration of flipping artefact card

published on the platform include images and videos. Authors can log in to upload and edit their projects. The administrator has the ability to review, approve, reject, or delete uploaded projects.

IV. SOFTWARE ENGINEERING REMOTE COLLABORATION

A. Effective Collaboration

This section discusses some of the ways in which the team management [11], [37] was handled during the project.

1) Project Team: Overseeing the project progress was hard to keep track of. The front-end and back-end teams had their own leaders, who were responsible for monitoring the progress of the members and making sure the deadlines within the sub-team were met.

Weekly reports were written by the leaders of both sub-teams and reviewed by the project manager to ensure the progress of the team as a whole. The weekly reports contained the weekly work report and plans for the following week. The weekly reports and Gantt chart [38], a tool used to plan the project progress, were used to monitor the progress of the project.

2) Communication Tools: One of the most challenging aspects of the remote collaboration was the communication within the team. While most Agile SE projects involve frequent stand-up meetings and discussions [39], the communication in a partially-remote project is not the same. The team relied on different communication tools to discuss any challenges and expectations.

The on-site members played a significant role in the project, especially in terms of communication. In all the interviews with stakeholders, the team ensured that at least one on-site member was present. These members made it possible for the team to grasp the content of the interviews more accurately.

One of the biggest communication challenges for the partially-remote team was choosing the team's collaboration tools. This was compounded by the fact that the team needed tools that were accessible both in the People's Republic of China (PRC), and in other parts of the world. One of the tools used was OneDrive [40], which allowed the team members to share documents and edit them simultaneously from anywhere. Even though OneDrive and Microsoft Teams [41] may not usually be the main tools used in offline collaborations, these

tools were particularly useful in this remote collaboration. Microsoft Teams is a business communication platform that offers team chat and video-conferencing. The team used this platform to make announcements and schedule weekly meetings, since it offers meetings with a better stability than other video-conferencing tools. Moreover, OneDrive and Microsoft Teams are linked to the university accounts, making it easy to search, contact, or invite other team members to meetings. WeChat [42] was used as a tool for daily communication and urgent matters. It is accessible in most parts of the world, including in the PRC.

3) Development Tools: The team used GitLab for code storage as it enabled the team to create multiple instances of the same code, allowing each member to freely edit and add new code to the project. This enabled the team to exchange and update code faster. To ensure the compatibility of all the code, the team also used a "Virtual Environment": An isolated environment that contained a complete copy of everything needed to run a Python program. This made it possible for team members using machines with different operating systems to be able to replicate the exact same environment. During the development phase, members also adhered to standard coding and naming conventions, and emphasized keeping the code easy to read and maintain [43].

B. Challenges and Evaluation

1) Communication as Key: Due to the pandemic situation, some team members were unable to return to UNNC and remained in different countries. Some members experienced slow and unstable internet connections, leading to frequent disconnections from team meetings, and poor communications.

In addition, according to the Myers-Briggs Type Indicator (MBTI) test [44], it was found that most members were introverted. Some members hesitated over discussing their problems during meetings, meaning that the team was not aware of them. This resulted in some problems remaining unknown, and unaddressed, for longer than should have been the case. Some team members reflected that, perhaps due to their apparently introverted personalities, decision-making was time-consuming and difficult, with decisive actions not being taken very quickly. However, as time went on, the team became more comfortable working with each other, and members became aware that good and open communication was key to a successful project. Furthermore, with the MBTI test information, student team members reported being more aware of how the other members would probably react in difficult situations: To a certain extent, the MBTI results may have improved the quality of team management and communication.

The team also held regular meetings to update the progress from each sub-teams, discuss any challenges faced, and prepare the plan for the following week. As reflected by one of the members, meeting other team members virtually lessened the feeling of social isolation and loneliness, which is reportedly one of the biggest challenges of being remote [45].

Throughout the project, although members worked most closely within their sub-teams, the weekly meetings allowed for everyone to come together and discuss the overall progress. The team described the internal leadership style as a combination of democratic and coaching styles [46], [47], describing efforts made to ensure that everyone engaged with the project, and that workload was (more or less) evenly distributed. The team also encouraged each other to strengthen both hard and soft skills, which in turn enhanced the success of the project.

2) The Software Engineering Experience: This project was initiated by a group of stakeholders from UNNC. Due to this fact, it was crucial for the team to work closely with the stakeholders and complete several iterations of interviews, meetings, and email exchanges to confirm the requirements and specifications of the system. This involved communications, both internally and externally, that were done predominantly through virtual platforms.

Internal team communications were conducted mainly through meetings. However, having only two of the seven student members physically present in UNNC, all meetings were conducted online. Due to this, the team needed to establish a practice that would allow an efficient and productive online meeting. The team adopted a model that emphasized shorter meetings, since these were deemed to be most productive. To further support this, "house rules" that served as guidelines for meetings were introduced, such as: (1) setting and following a meeting agenda; and (2) members should find a location with stable network connection. Finally, the cooperation and commitment of each member were essential to ensure that these practices were successful.

The SE experience undoubtedly still presented the team with many challenges, including audio issues, miscommunications, and different expectations among stakeholders. However, instead of diminishing the team motivation, these challenges allowed the team to exercise critical thinking and problem-solving skills to break each challenge into smaller, solvable pieces. Upon reflection, the team found that these challenges and the experience of working to solve them, were in fact, what made the SE experience authentic.

3) Diversity as Strength: Another unique aspect of this project was about the diversity of the people involved in it. Not only was there student-staff collaboration, but the people involved also came from different countries and cultural backgrounds, which presented the team with both challenges and benefits. According to Saxena [48], diversity in a workforce (or in this case, the people involved in this project), when properly and skillfully managed, would be a strength to the team and increase productivity. This could be observed through how members interacted with each other and with people beyond the immediate team.

In the context of collaboration between staff and students [49], it was evident that this was a major element of the project. For example, the presence of an advisor to the team played a crucial role in the success of the project itself. In this particular project, the advisor's role was to guide the team towards the correct direction without directly interfering

or influencing the decision-making and/or creative process of the students. Reflecting upon this experience, the team found that only because of the observation, guidance, and occasional interference, the team were able to not only deliver the project but also to learn and grow from the SE experience.

4) Evaluation: Software engineering is not a single process. Inside it is a plethora of different components and creative processes that could only be combined into a deliverable by an SE team. The project discussed in this paper was not a usual one. The project involved unique circumstances surrounding the COVID-19 pandemic, which required the team to work on the SE processes remotely.

Remote SE presented its own set of challenges that are not present in traditional SE, thus requiring the team to adapt flexibly to overcome them [50], which in turn contributed to the growth of both the team and individual members.

Shifting from the ways of traditional SE was not easy. Traditional norms and practices were already ingrained into the team, making it difficult to adjust to remote SE. This transition did not happen instantly, as the team had to get used to the various new tools and utilities that would support and allow collaboration in a virtual space. Although these tools and utilities are easily accessible, it was their careful selection that enabled the team to achieve the good results that it did — not only in quantity of output, but also in the quality of each part of the project. The use of appropriate tools allowed the team to increase productivity without sacrificing quality.

As discussed already, the project was only possible through the collaboration of a diverse group of people, including the team, the advisor, and the stakeholders. Each of the people involved in the project brought with them a set of skills and individual talents that all contributed to the creative process. Additionally, having a diverse background and personal values also meant that members needed to communicate properly, to reduce misunderstandings that could have jeopardised the project. Therefore, this provided an opportunity for the team members to learn from each other and promote a sense of belonging to the project.

In the end, all of these remote experiences and collaborative processes became integrated and internalised as a part of the team's identity.

V. CONCLUSION AND FUTURE WORK

In the current digital age, the number of digital artefacts produced by universities around the world has increased drastically. Digitization has many obvious advantages, however it has also prompted a need to rethink what universities could do to showcase these artefacts. There is a lack of a standard infrastructure to store and showcase students' work. This digital-artefacts showcase platform provides advantages for collaboration and encourages pedagogical innovation [51], [52], and could be further developed into an OER [3], a digital repository capturing students' best achievements or evidence of learning. This platform could enhance the teaching and learning process [53]. In addition, it could also help students to build a digital footprint that may lead to future job opportunities. One important aspect to consider is how to protect the digital IP on the free and open internet.

The current version of the platform has fulfilled the main requirements as specified by the stakeholders: Authors are able to upload and edit image and video artefacts; administrators can manage accounts and projects; and visitors to the platform can view and interact with the published artefacts.

This project's design and protocol have laid the groundwork for future expansion to include more digital artefact formats, integration with university credentials and implementation of Digital Object Identifier (DOI) and ORCID ID. Although this project was initiated to target a single unit, the Nottingham Advantage Award (NAA) [54] and its related student work, we anticipate that the platform will be adopted by many other units at UNNC, and elsewhere.

In conclusion, the team experienced the real Software Engineering process through a remote collaboration. Through this project, the team has achieved the first milestone for UNNC's international development of platforms to showcase students' work.

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