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EMPOWERING THE COMMUNITY AND PROFESSIONAL DEVELOPMENT THROUGH COLLABORATIVE DIGITAL LEARNING

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Abstract

The global pandemic situation has shifted physical learning to online professional development to be challenging. This is particularly difficult to ensure effective psychomotor learning when learners are disconnected from the conventional peer interaction and physical hardware. This promoted the importance of resilience for both educators and learners to reconnect psychomotor learning through virtual/hybrid setting. A staff-student collaborative inspiration emerged with the collaboration across Malaysia and Edinburgh campuses in engaging multiple learning styles through remote digital learning. Aligned to the rising call of building innovation-entrepreneurship ecosystem, this student-led project focused on remote development of programming skills, translating ideas into tangible solution, and pitching among Malaysia and international students to address a selected Sustainable Development Goal. This inter-disciplinary initiative connects the field of engineering and psychology in studying the resilience context of learning. A resilience theme focuses on enhancing skills through digital platforms in building resilient communities. A total of 45 local and international students were engaged through an online prototype and idea pitching competition that supported by industrial workshops. A survey and thematic analysis were launched to gather the feedback from students upon completion of the project. The outcomes highlight the positive response from students' perspective as participants and judges, and their learning

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growth. The studied themes indicate the effectiveness of learning through hardware/physical aspect on cognitive, psychomotor, and affective learning domains. This project remarks a cross academic fields (engineering and psychology), sectors (academy and industry), countries (Malaysia and Edinburgh), and roles (educators and learners) inter-disciplinary team effort.

Keywords: Pandemic, virtual, practical, programming, psychomotor

Abstract

Situasi pandemik global telah mengubah pembelajaran fizikal kepada pembangunan profesional dalam talian menjadi mencabar. Ia menjadi amat sukar untuk memastikan pembelajaran psikomotor yang berkesan apabila pelajar terputus hubungan daripada interaksi rakan sebaya konvensional dan perkakasan fizikal. Situasi ini menggalakkan kepentingan daya tahan bagi pendidik dan pelajar untuk memulakan semula pembelajaran psikomotor melalui persekitaran maya/hibrid. Inspirasi kolaboratif kakitangan-pelajar wujud dengan kerjasama di seluruh Malaysia dan di kampus Edinburgh dalam melibatkan pelbagai gaya pembelajaran melalui pembelajaran digital jarak jauh. Sejajar dengan seruan yang semakin meningkat untuk membina ekosistem inovasi-keusahawanan, projek yang diterajui pelajar ini memfokuskan pada pembangunan secara jarak jauh kemahiran pengaturcaraan, menterjemah idea kepada penyelesaian yang nyata, dan melontarkan dalam kalangan pelajar Malaysia dan antarabangsa untuk menangani Matlamat Pembangunan Mampan (SDG) yang terpilih. Inisiatif antara disiplin ini menghubungkan bidang kejuruteraan dan psikologi dalam mengkaji konteks resiliensi pembelajaran. Tema daya tahan menumpukan pada meningkatkan kemahiran melalui platform digital dalam membina komuniti yang berdaya tahan. Seramai 45 pelajar tempatan dan antarabangsa terlibat melalui prototaip dalam talian dan pertandingan melontar idea yang disokong oleh bengkel industri. Tinjauan dan analisis tematik telah dilancarkan untuk mengumpul maklum balas daripada pelajar selepas projek selesai. Hasilnya menunjukkan tindak balas positif dari perspektif pelajar sebagai peserta dan penilai, dan pertumbuhan pembelajaran mereka. Tema yang dikaji menunjukkan keberkesanan pembelajaran melalui aspek perkakasan/fizikal pada domain pembelajaran kognitif, psikomotor dan afektif. Projek ini menyatakan rentas bidang akademik (kejuruteraan dan psikologi), sektor (akademi dan industri), negara (Malaysia dan Edinburgh), dan peranan (pendidik dan pelajar) usaha pasukan antara disiplin.

Kata kunci: Pandemik, maya, praktikal, pengaturcaraan, psikomotor

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1.0 INTRODUCTION

The pandemic has created a sudden change to the teaching and learning communities academically and wellbeing. University students have reported an increasing stress and anxiety due to the outbreak concern and subsequent lockdown and stay-at-home orders (Son et al., 2020). Consequently, learners had to adapt to the online learning environment remotely which immediately shifted face-to-face learning mechanics into a computer monitor based interaction. Blended learning integrates both online and face-to-face modes to create a new life in digital learning. The approach serves as a guide in integrating the learning instruction, learning environment and media while seeking a balance point between the components for effective learning (Kaur, 2013). According to Yigit et al. (2013), blended Learning has shown to improve programming classes performance in a computer engineering course compared to traditional face-to-face setting particularly as it supports students who dropped classes. Nevertheless, the implementation of Blended Learning in a full-virtual learning and teaching platform still introduced a different learning environment. Achuthan et al. (2021) studied the use of remotely triggerable laboratory approach. Learners can remotely control the hardware and analyse the collected data. Meanwhile, Hoo (2021) introduced the virtual laboratory work through developing a Power Point module. The animation allows learners to run the experiment and collect data virtually. Both transformations introduced effectiveness in reducing the duration to run experiment or promote more frequency of conducting the experiment while not affecting the learning outcome and learning quality of the module. However, feedback shown that physical hands-on still preferable if allowed (Hoo, 2021). Therefore, it is not easy to seek the optimal mechanisms to perform an effective transition from a traditional classroom-based education learning environment into an open education environment (Krasnova, 2013). Firstly, learners are camera-shy and not used to the new interface. This reduces meaningful interaction between instructors and learners. Secondly, virtual setting limits the peer-to-peer engagement or interaction during or after class. Thirdly, remote learning is challenging in providing continuous students' professional development skills that they normally develop through extra-curriculum activities beyond classroom. These extra-curriculum activities have been put on pause and mainly transformed into webinars.

The conventional practical and outreach methodologies are not possible and has raised an alarming concern for practical hands-on learning. Hands-on learning taps into psychomotor component in learning. Atkinson (2018) model consists of five elements including imitate (ability to copy), manipulate (ability to repeat or reproduce action), perfect (ability to perform action with expertise), articulate (adapt skills in non-standard way or new context) and

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embody (ability to perform action automatically) ("Psychomotor domain - Sijen", 2022). Simon Atkinson argued that psychomotor skills require physical aspect that needs dexterity, strength, suppleness and motor skills. These skills are different from other learning skills such as thinking and reflecting (cognitive and metacognitive) skills, speaking, and interacting (social and interpersonal) skills. These skills may not be explicitly taught to undergraduate students but is expected of them. With remote learning, opportunities for hands-on are further reduce. Instead of only populating virtual talks and webinars, students should continue to grow in theory-hardware integrated knowledge and build their practical skills to be future-ready, especially in STEM (Science, Technology, Engineering, and Mathematics) subjects. STEM learning has been proven to be more effective with multiple intelligence-oriented STEM programmes compared to the traditional setting (Nasri et al., 2021).

According to an outcome-based education pedagogy, learning and teaching closely map the curriculum design to the three main learning domains, consisting of cognitive, psychomotor, and affective learning. Studies have also been conducted on the measurement mechanics for the different learning domains for traditional and virtual learning spaces (Rovai et al., 2009). An observation indicates the importance of having both virtual and physical activities to stimulate different styles of learning. Xhomara and Shkembi (2020) have shown the strong correlation between learning styles and multiple intelligences to promote effective learning. Inspired by the challenges addressed above, this project creates intermediate steps to enhance students' psychomotor skills, professional development, and peer-to-peer interaction through a 3-month student-led project. This project focuses on a sustainable journey to Learn, Apply and Perform, transforming technical knowledge into innovation solutions. The initiative of this student-led project is to deliver the use of programming knowledge by students in supporting their peers in building creative and innovative prototype. There are two parts to the project, first is to build their knowledge on programming and second is to support students' professional development.

2.0 METHODOLOGY

During the transformation from physical to virtual learning, teaching materials and resources had to be repackaged into digital materials. However, activities were planned which required hands-on materials for the participants to enhance their learning experience. In partnership with academic staff, the student organising team took up leadership roles, becoming trainers and facilitators in mentoring their peers in learning new skills. Collaboration between the School of Engineering and Physical Sciences (EPS), Malaysia campus and GRID (Global

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Research, Innovation and Discovery), Edinburgh campus has formulated the technical workshops to expand the learning concepts of GRID into the Malaysia campus. An advisor, the project manager of the technical team in GRID supported activity design and resource sharing from GRID to Malaysia. The project is also supported by the Psychology department from School of Social Sciences (SOSS), Malaysia in conducting focus group discussion to evaluate student responses and feedback to the project using thematic analysis. This enhances the global connection and knowledge transfer across campuses between staff and students and an industrial partner in building a global and resilient community. The project managed to organise design thinking and entrepreneurial pitching workshops by external industrial experts. Studies were deployed to measure the practical technical knowledge enhancement and the development of resilience through digital learning medium.

2.1 Professional Development on Technical Knowledge Growth

Figure 1 illustrates the flow of the events and activities. In the first part, students who participated in the project received an Arduino kit that was delivered to their home so they could participate in hands-on activity with their learning. Considering the different regions and international participation, training modules were designed based on physical programming kits and virtual kits (TinkerCAD) in a hybrid setting as illustrated in Figure 2. Together with the technical advisor from GRID, each workshop was designed to cover fundamental functions that enable simple prototyping of later products. Believing in the effectiveness of peer instruction learning approach (Tullis & Goldstone, 2020), peer-to-peer learning model is adopted to address the reduced interaction between instructors and learners, hence the knowledge growth. Therefore, in this project learners developed programming skills from three workshops delivered by the student organisers instead of teaching staff in the Malaysia Campus. Peer instruction served as catalyst to student's learning effort outside classroom (Alcalde & Nagel, 2019). This collaborative project involves experts from different fields, campuses, and industries to create a global learning context.

The second part of the project is in collaboration with industrial partners, two workshops were delivered to expose the participants to innovation-entrepreneurial mindset and pitching skill. Technical skills were integrated with ideas to build solutions that address one of their selected Sustainable Development Goal. Each project will be unique and extend the various possibilities of invention. A pitching/product showcase competition was held to conclude the series of activities using a virtual platform for participants to share their ideas and demonstrate their skills through prototype demonstration. The evaluation involved pairing

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senior students who received impactful achievement with academics as judges. This ensures high quality and constructive learning from each other from the staff-students circle. The judging criteria focus on the creativity and adaptability of the participant prototype and idea in addressing the chosen Sustainable Development Goal. At the end of the project, feedback questionnaires were distributed to students and focus group discussions were conducted. Further evaluation and thematic analysis were employed to evaluate the outcome of the project and to gain insights for future enhancement.

To evaluate students' learning experience, a post-event feedback survey was administered to all participants after the project. The questionnaire consisted of sales where students rate their experience with the Arduino kits and overall learning experience. There were two open-ended questions such as "What is the best experience you have in this event?" and "Overall and additional feedback". To gain a deeper understanding of the survey responses, participants were invited a focus group discussion upon completion of the project. Each discussion group consisted of 4 participants. This is a semi-structured interview with the purpose of assessing students' perception of the project and to gain more insights to their experience of the project. The focus group discussion was conducted based on a semi-structured interview guide, Table 1, with the moderator using semi-structured and open-ended interview questions to guide the discussion. The study employed thematic analysis (Braun & Clarke, 2006) inductive approach to identify themes from the focus-group discussion. This study was approved by the Engineering and Physical Sciences Ethics Committee at Heriot-Watt University (2021-1167-4289).

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Figure 1: Flowchart of the project journey

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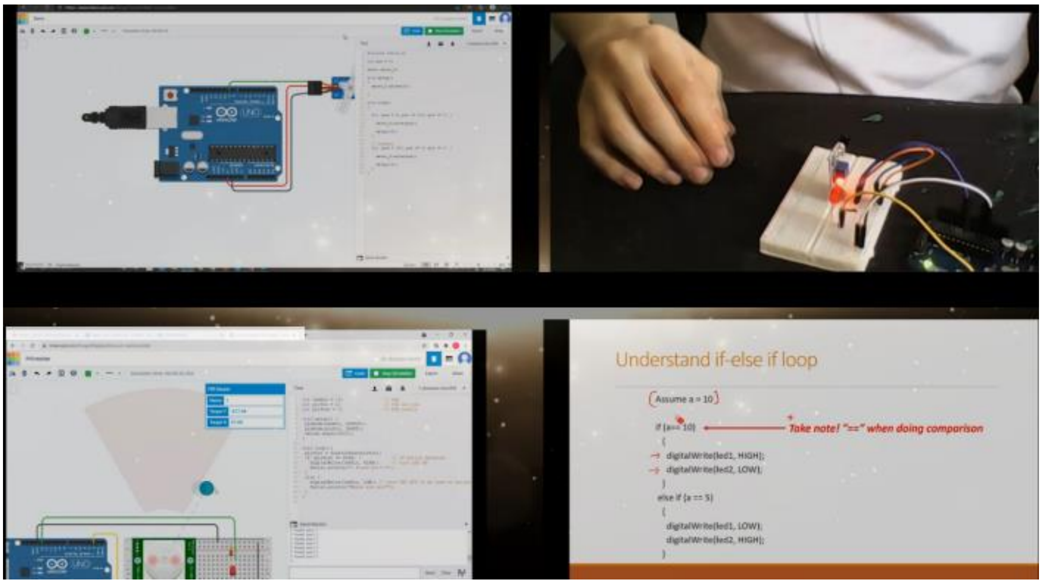

Figure 2: Arduino workshops through hybrid digital learning (physical + virtual)

Table 1: Semi-structured Interview Guide

No	Question
1	What are your attitudes towards this project (Professional Development through digital learning)? What are some of the advantages and challenges in this workshop?
2	How stressful did you find participating in this workshop?
3	When faced with challenges and stressful situations, what did you do to overcome these challenges?
4	How has this experience helped you with online learning or your future?
5	If this project would be organised again, what improvements would you like to see?

3.0 RESULTS AND DISCUSSION

A total of 45 local and international students ranges from undergraduate to foundation levels have participated in this project. Figure 3 shows a screen capture from the live session during the prototype showcase. The session began with the introduction of the challenges and SDGs, followed by proposed solutions and prototype demonstrations. Each participant received questions from a panel of judges and shared their screen to address them. A post-event feedback survey was provided where participants had to rate their experience of workshops (e.g., learning programming Arduino hardware and pitching), online delivery of the content and showcase of their prototype. The descriptive data showed >90% of respondents had an excellent hands-on (psychomotor) learning experience. A positive 8.3/10 rating was found for

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the acknowledgement of growth in knowledge (cognitive) in the project. The survey demonstrated an enjoyable and satisfactory experience of the digitalisation of creativity.

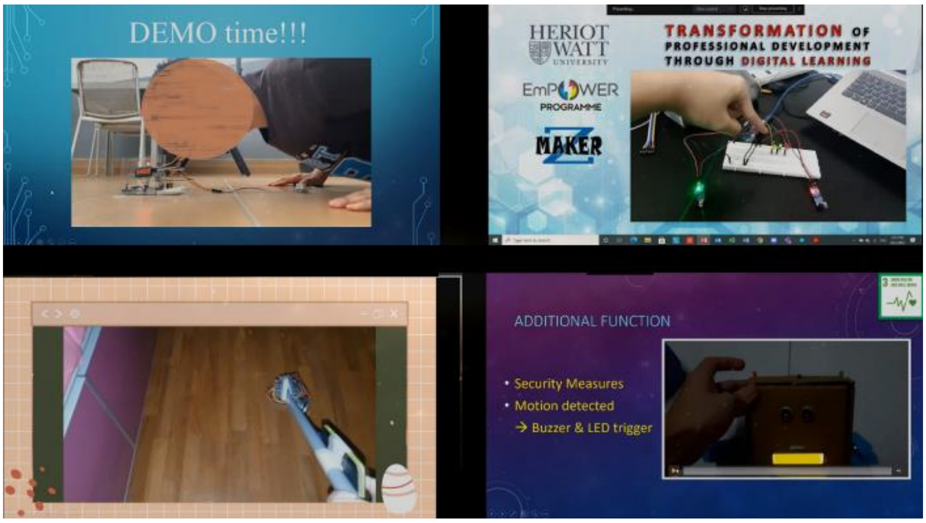

Figure 3: Live session during the final pitching session

Table 2: Feedback from some Student Participants

Respondent	Feedback
A	Able to be exposed to physical Arduino and coding application. Love this workshop and the pitching opportunity!! Looking for next workshops!
B	Learning the basics of programming.
C	…learning the codes in general was very fun to me and i enjoyed it a lot and during the 2 days of making a prototype, it felt amazing when i succeeded in making the prototype...
D	Challenge myself to work out of my comfort zone.
E	Getting the opportunity to showcase your own inventions

The post-event survey also contained an open-ended question for example “What is the best experience you have in this event” to capture participants learning experience. Overall responses were positive, and students are interested in having it again in the future. Based on the frequency these specific word occurrences, Table 3 summarises the overall themes student experience from the project. The main themes extracted were expanding knowledge on hardware (Arduino), learning (mainly in the context of programming), hands-on and challenges. To gain a deeper understanding to these feedback responses from the perspective of student participants, a thematic analysis from a focus group discussion is provided below.

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Table 3: Categorised Themes of Feedback (Student Participants)

Rank	Highlighted experience (themes)
1	Arduino (hardware)
2	Learning / Programming
3	Hands-on / Prototypes
4	Challenges / Showcase / Ideas / Innovation

Theme 1: Expanding knowledge of Arduino. Participants appreciate flexibility of Arduino kits and noted that it is able to create a lot of projects from the same kit.

Theme 2 and 3: Learning with programming and hands-on practice to produce prototypes. Participants noted that they learned a great deal from programming that they were able to create a prototype by the end of the project. They were able to learn coding and wiring of the prototype, allowing them to see how both components work together. The project facilitates peer-to-peer learning from a community of student participants and student organisers. Participants described it as transfer of basic knowledge or understanding of programming. Amongst peers, the project was a platform to engage with peers to discuss helpful feedback/solution, share innovative ideas, shortcuts and solutions to understand what went wrong in their programming and improve upon their work. Participants felt that this process and interaction motivated them to engage in self-study to learn more about Arduino hardware programming. They identified this learning with fun and positive affect. The participants acknowledged in-person learning is preferrable to online learning as they often found it difficult to focus throughout the lectures. However, the participants found that remote hands-on approach in programming with online workshops to work along motivated them to learn and found it easier to focus throughout the project. Coming across some programming errors motivated them to keep working to troubleshoot and improve upon their prototype. It is important to note that the delivery duration of the project is shorter than a typical semester, it is possible that students may find it easier to commit time and effort to the project.

Theme 4: Challenges. There were some challenges during the project such as constraints in immediate and personalised support or help. This is to be expected due to online environment that some responses will be delayed. This may contribute to difficulty in learning programming as participants were focused on the issue and unable to move along with progress.

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The categorisation also done to the collected student judges' feedback based on the pitching session as shown in Table 4. For the student judges, higher 'learning' theme was visible while equal weightage of other themes. Student participants were closely engaged with the core learning while able to apply and demonstrate the knowledge into tangible outcomes through innovation and physical hardware.

Table 4: Categorised Themes of Feedback (Student Judges)

Rank	Highlighted experience (themes)
1	Learning
2	Challenges / Showcase / Ideas / Innovation / Arduino (hardware)

4.0 CONCLUSION

The student-led project has successfully enhanced the conventional physical professional development activities into a hybrid event. Incorporating the technical programming knowledge and partnership with industries, the project promoted the transformation of idea into innovation in building a resilient community. The project received participation from engineering and non-engineering undergraduate and foundation students. Along the project, students gauged with the Arduino programming through a series of three hands-on workshops with physical kit or online programming tool that eventually transformed idea into prototypes. In order to promote a 360-degree evaluation mechanism, the judges consist of pairing between academician and senior student during the final pitching competition. Witnessing various innovative ideas and prototypes proved the attainment of one of the learning objectives where students showcased the learned technical skills to produce solutions that address Sustainable Development Goals. Even though the sample size is small, the study indicates students' preference for similar approach on remote hands-on learning to be adopted in online learning. Observing a positive perception from the focus group study, it shows a good attempt to present obstacles and allow students to work through them in order to enhance learning and build a resilient community. The project received positive feedback from both student participants and judges for the fun learning and satisfaction in transforming ideas and creativity into a digital form.

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