

**Project Title**

Design-Led STEM (D-STEM) with interdisciplinary practice of Artificial Intelligence (AI) and design.

**Project Particulars**

**Project Period:** September 2020 to November 2021(15 months)

**Project Details****1. Needs Assessment and Applicant's Capability**

Science, Technology, Engineering and Mathematics (STEM) education has been recognized as an important interdisciplinary curriculum vital to a country's future foundational and economic growth in a world where global innovation is accelerating at high speed. World leaders

had placed STEM as a priority for education. To ensure competitiveness of local students, it is vital that STEM curriculum at the secondary level nurture innovation skills that will meet the demands of the future workforce (Lo, 2019). As noted by Herro and Quigley (2017), the goal is not to nurture more technologists but to equip students with interdisciplinary skills to solve real world problems.

While there is a myriad of research focused on STEM education, there is a tendency for it to skew towards single disciplines. Lee, Chai & Hong's (2019) review of existing work indicates while many studies were labelled as STEM-focused but most place emphasis on a single subject, usually science, and there is an obvious gap in teachers' professional development which enable them to foster STEM learning. Fundamentally, STEM requires interdisciplinary collaboration while most teachers had been trained in their discipline specific areas thus find it challenging to implement without collaborative support. It is vital to provide teachers with professional development that goes beyond the boundaries of their specialism that connects emerging concepts and innovative technology in order to ensure updated curricula that has realistic impact on society. In line with the 2019 HKSAR Policy Address, Mrs. Carrie Lam, Chief Executive of HKSAR, advocates for cross-sector, cross-profession collaboration with public-private partnership to enable more effective and efficient use of public resources. This project is proposed with collaborators from the industry, professional community, international leading academia, local stakeholders and sponsorship from the industry. The collaborations reflect the co-operative and multi-faceted nature of the D-STEM approach.

This project proposes a design-led approach to STEM (D-STEM) education. Conventional learning and teaching methods are often based on linear thinking by following known cycles and systematic progression. In contrast, design processes are reflective and adaptive, with considerations of multiple perspectives. Design provides a flexible problem-based approach which creative and scientific disciplines naturally intersect (Henriksen, Mehta & Mehta, 2019). D-STEM offers an adaptation of the conventional design process and aims to merge the creative aspects of design with the knowledge seeking aspects of STEM domains (Toomey & Tan, 2018).

AI will have a major impact on future society with technology integrated products creating the landscape of everyday lives. Engaging teachers and students in design thinking and connecting them with core concepts and innovative technology will ensure that the curricula maintains relevance to current and future real-world challenges. The project aims to enhance learning and teaching experiences of creative and STEM secondary curricula via the interdisciplinary practice using the medium of colour changing illuminative textiles with AI mobile application.

Lammer, Vincze, Kandlhofer and Steinbauer's study (2017) indicate teachers' fear of complex technology, poses a "threat" to the subject matter and may be detrimental in the fostering of STEM related content. The project proposes the transfer of knowledge of advance technology via the common medium of textiles. It is a material that is integral to everyday and future environments, its utilization span from aesthetic applications for fashion to the engineered functionality of aerospace fabrics. Textiles and soft materials are a viable medium to transfer knowledge for D-STEM as it can be applied in many different contexts and is relevant to typical experiences.

The project will conduct a series of D-STEM workshops and activities that utilizes creative practice as a learning and teaching means to engage users in the subjects of AI and textiles. The project is characterized by the study, experimentation, design and application of intelligent textiles. To encourage the syntheitisation of design and technological skills, the project will conduct practice-based workshops that utilizes creative experiments as a 'critical activity to interrogate the possibilities of materials' (Toomey & Kapsali, 2014). The project utilizes the act of making as a flexible means to inform, enhance and refine learning and teaching experiences for creative applications of technology pertinent to real life challenges.

## **Applicant's Capability**

### Particulars of Applicant:

the Institute of Textiles & Clothing, The Hong Kong Polytechnic University (PolyU). The university has established a Laboratory for Artificial Intelligence in Design (AiDLab)

The lab is the world's first and leading research platform that facilitates and promotes the integration of AI into the design of products and service that will greatly enhance the design industry, contribute to the wider economy, and improve quality of life. The AiDLab is a strategic partnership between PolyU

assumes official secondment duty as Assistant Director at AiDLab on 1<sup>st</sup> July 2020. Laboratory for Artificial Intelligence in Design (AiDLab) is a research operation initiated by The Hong Kong Polytechnic University (PolyU). It is the world's first research platform that focuses on artificial intelligence (AI) and design innovations. The AiDLab is located at the , it has a mission to be the leader of interdisciplinary AI and design innovations and research that will create positive impact on global design industry, contribute to the wider economy, and improve quality of life.

PolyU possess a unique position as Hong Kong's leading university for Design, recognized as one of the world's leading university for research and education. In recent years, the university had led studies with a cross disciplinary approach that integrates design practice (via wearables, materials, products and environment) with technology to address concerns of under-represented communities.

the university possess an unrivalled track record of leading cross-disciplinary research through applying design approaches in collaboration with disciplines such as engineering, materials science, technology and medicine to address some of the biggest societal challenges today. The AiDLab combines the experience and expertise of world caliber research, leading local research and teaching experience to address innovative approaches to D-STEM curriculum for secondary students in Hong Kong.

The teaching and research that conducts are practice-based with investigations at the interface of design and technology. Her research focuses on illuminative interactive textiles for sensory therapy (Fig.1), and smart fashion (Fig. 2). Her designs are developed from polymeric optical fibres, textile based yarns and sensors via D-STEM practice. Her multi-award winning interactive textile designs had been widely exhibited at venues

In tandem with academic research, actively engages with the industry via her design consultancies, her clients

Since 2005, had taught and conducted research on fashion design, textile design and smart textiles on undergraduate and postgraduate levels. Her strong background in D-STEM curricula is evinced by the invited international public talks, design residencies and design workshops at institutions

. She is experienced in conducting large scale projects involving international and local participants.

The event promotes Hong Kong as a creative capital for design-

led technology innovations for social good

This proposed project will be conducted with the support of partners from world leading academia, industry and professional community.

### **Academic Partner**

The project will partner with [redacted] is a textile design, color and materials specialist with international experience in research-based design, product development, manufacture and student-centred education. Her focus lies in design-led innovation and craftsmanship with materials, specifically new and emerging, in order to redefine the relationship between products and the human experience. She has a track record of initiating innovative approaches to cross-disciplinary collaborations and is a champion for Design-STEM practice, specialising in responsive and interactive printed surfaces.

The applicant and [redacted] have a well-established research collaboration which will serve as a strong foundation for the proposed project. Their research are rooted in D-STEM and had disseminated their findings in journal publication (Tan & Toomey, 2019), international exhibitions [redacted] exhibition book (Tan & Toomey, 2018) and international conferences notably the special session focusing on D-STEM



## **Industry Partner**

The proposed project will be supported by [redacted]. It is the innovation arm [redacted], which is a landmark revitalization project [redacted]. [redacted] is an incubator, space/ lab for techstyle startups and fund for talents at the intersection of technology and style. It is one of the three pillars of [redacted] a landmark revitalization project [redacted]. It will support the project with sponsorship for the workshops' venue, and supporting workshop equipment.

The co-directors serve on the advisory board of this project, they will participate and contribute to the sharing and critique sessions with [redacted]. [redacted] is the first techstyle prototyping space of its kind in Hong Kong, merging technology and style under the same roof. It possesses hardline, softline machines and a wet lab. Hardline equipment is focused for the construction, design and development of hard goods using materials such as plastic, metal, wood, etc. Softline is related to all equipment and activity that has to do with soft material such as textiles, fabrics, leather, etc. The wet lab include facilities for spraying, washing and drying

## **Professional Community Collaborator**

[redacted] a non-profit organization founded in 2002 as a strategic partner of the HKSAR Government in establishing Hong Kong as centre of design excellence in Asia. The centre's public mission is to use design and innovation to drive value creation of business development and improve the well-being of society, through the provision of diverse exchange platforms, anchored by five major work directions: CONNECT the design Industry, CELEBRATE design talents and good designs, NURTURE design-preneurs, ADVANCE design knowledge and ENGAGE the society. [redacted] represents the professional community in this project and will lend vital support to the project.

[redacted] will serve as chairman and members of the advisory committee of this project respectively. [redacted] will further contribute to the project by participating in the sharing sessions, critiques and advice for the project stakeholders.

### Local Secondary School Collaborators

The target beneficiaries are local secondary school teachers and students. The 8 proposed local secondary school collaborators are (Subject to change):

The project proposes to have 4 teacher representatives and 60 students per school (subject to change) to participate in the project with a total of 32 teachers and 480 students. The project confirms that the total number of beneficiaries will remain unchanged.

## **2. Goals and Objectives**

### Goals

The goal of the project is to enhance learning and teaching experience of D-STEM curricula via interdisciplinary practice of artificial intelligence and design. It will utilise intelligent textiles with AI technology as a medium. Within the context of this project, the materials will be based on AI controlled illuminative polymeric optical fibre (POF) textiles. Facilitating the teachers' professional training is the fundamental goal of the project in order to make a positive impact on students' learning. The expected learning outcomes for both teachers and students are changes in attitudes, behaviours and skills towards adaptive, creative and collaborative problem solving regardless of subject and medium.

### Objectives

- 1) To develop D-STEM teaching aids and guidelines based on AI integrated textiles and creative practice for secondary school teachers.
- 2) To enhance teacher's pedagogy to teach and assess D-STEM through direct communication and interaction with international and local experts in the workshops and seminars conducted in this project.
- 3) To enhance students' knowledge and skills to creatively solve real world problems via interdisciplinary practice.
- 4) To create engaging and effective D-STEM learning activities within a hybrid (Studio-Lab) environment.
- 5) To recommend strategies for training in D-STEM with reference to findings.
- 6) To assess and evaluate the impact of introducing D-STEM as compared to previous discipline specific approaches.

### Short Term

- To enhance teaching and learning experience for creative and STEM related curricula via D-STEM.
- To encourage interdisciplinary approaches and environments for curricula which is currently discipline focused.
- To provide an alternative for creative excellence by encouraging learning via practice instead of being reliant on conventional rote learning.

## Long Term

- To develop a collaborative culture for teaching and learning.
- To enhance communication between local secondary schools, international and local higher academia, industry and professional community for interdisciplinary curricula to ensure relevance and adaptability to real world needs and applications.
- To recommend professional support strategies for teachers in the area of design and technology.
- Sustained mode for D-STEM curriculum via close collaborative networks among the secondary schools, teachers, students, techstyle incubator with local, international academic and creative technology communities.

## **3. Targets and Expected Number of Beneficiaries**

- Teachers. Teachers involved in STEM, Technology and Living, Design and Technology or Visual Arts in participating schools will benefit from the provision of teaching materials, workshops, collaborations with industry, professional community, international and local academia. A total of 32 teachers will be invited with 4 representatives from each school. (Number of teacher participants and total number of schools are subject to change with total number of beneficiaries to remain unchanged).
- Students from the 8 participating secondary schools will be invited to take part in the project. A total of 480 students with 60 from each school. (The number of schools and the number of students from each school is subject to change with total number of beneficiaries to remain unchanged).
- The project will deliver outputs in the form of a comprehensive website containing teaching materials, videos of the workshops, e-book, school based exhibitions, compiled and analysed data from the project, project findings and details of the project applicant and collaborators. These tangible deliverables are of benefit to a large number of stakeholders in the local and international education community.
- The project leader will work with participating schools and teachers to select suitable students for the project.

## **4. Innovation**

The key innovations of the proposed project are:

Using AI technology and intelligent textiles as a medium with a design-led approach to enhance the teaching and learning of STEM and DSE subjects. (Subjects include, Technology and Living (T &L), Design and Applied Technology (D&T) and Visual Arts)

Intelligent textiles which are interactive and controlled by AI applications, encompasses advances in technology and design that is significant to current, emerging and future innovations. Textiles is an omnipresent material that serves as an ideal medium to transfer knowledge of advanced technology with interdisciplinary practice. It provides a social and inclusive way to look at the integration of computation in our everyday lives (Robertson, 2018), encouraging participants to utilize their daily experience and apply it on creatively on real life applications. This is in line with the recommendation to focus on inquiry-based learning for STEM curriculum at secondary levels by the Hong Kong Policy Research Institute (2017).

Co-nurturing of talents with industry, professional community and academia

This proposed project will be conducted by the applicant with collaborators from the industry

professional community, and leading international academia

. The applicant and collaborators will be involved in conducting, facilitating and assessing the workshops and developed outputs. Insightful contributions from the collaborators will provide teachers and students with an understanding of the values and prospects in D-STEM by receiving first hand and current information from front line practitioners of creative innovation. This is aligned with the HKSAR government's strategy to strengthen partnerships with community key players (Education Bureau of the Government of the HKSAR, 2016)

Hybrid practice that synthesizes creativity and technology to foster innovative real-world problem solving.

Real world problems often require multi-faceted solutions where discipline specific solutions do not hold true (Henriksen et al, 2019). Design practice that encapsulates multiple disciplines through research, experimental iteration, reflection and ideation refinement offers teachers and students with a framework of innovative thinking skills with connections to authentic real-world applications. In tandem with the hybrid practice, it provides opportunities where they can observe, practice, explore, solve problems (whether scientific or artistic) via hands-on skills. Participants are free to explore and experiment fluidly, to develop innovative solutions with the various tools and methods available without being encumbered by standard classroom equipment. The mix of instruction, coaching, practice and active

discussion will encourage participants to gain ownership of the content, adapt their learning process to independently derive solutions to the challenges addressed in the project.

Fostering collaborative teamwork, process and environments that are fluid and conducive to fast advancing innovations. Collaborative teamwork is a crucial core principle for the successful interdisciplinary applications. The project brings together leading international and local industry practitioners, designers, technologists, teachers and students to create a teaching and learning community that represents a wide range of perspectives. External input from collaborators will maximize opportunities for teachers and students to explore, experiment and apply their new acquired D-STEM knowledge. It is through praxis and the experience of working together that stakeholders from diverse backgrounds exercise and build essential skills with common language for collaborative practice (Tan & Toomey, 2018). To foster a collaborative culture, the workshops will be held at a state of the art lab which possess a design studio space equipped with sewing, textile, casting and internet of things (IoT) equipment to facilitate interdisciplinary practice.

## 5. Conceptual Framework

The proposed project aims to achieve its goal by firstly delivering 2 sets of workshops:

### 1) Workshops for teachers

To be delivered by project members (applicant, post-doctoral fellow, research assistant) international staff trainer and a design practitioner approved by the RCA, to participating secondary school teachers. In addition to gaining new knowledge of the subject, participants will be able to gain insights into the pedagogy using both the contexts of the teacher and student. This will enable teachers to adapt the teaching material and content to the specific needs and interests of their students.

### 2) Workshops for students

To be delivered by participating teachers to their own students with the support of the project members (applicant, post-doctoral fellow, research assistant), international staff trainer and a design practitioner approved by the RCA. This will enable participating teachers to gain ownership of the developed teaching materials and also create a collaborative dynamic whereby the students will be able to gain ideas and viewpoints from the international instructor, applicant and teachers. This will encourage students to consider both process and objective driven innovations.

### 5-Phase Project Schedule

The project will be conducted in 5 phases: 1) Context 2) Demonstration and Coaching 3) Reflection 4) Implementation 5) Review and Dissemination.

	Phase	Activity	Content	Parties involved	Mode of delivery	Expected Outcomes
1	Context	1 x pre-workshop introduction, sharing session between teachers, collaborators and applicant.	<ul style="list-style-type: none"> <li>• Introduction to project rundown, personnel and collaborators involved, D-STEM, materials and technology to be used during workshops.</li> <li>• Sharing session with collaborators about current D-STEM applications in the industry and their value.</li> <li>• Focus group with teachers.</li> </ul>	<ul style="list-style-type: none"> <li>• Teacher participants.</li> <li>• Applicant.</li> <li>• International Staff Trainer</li> <li>• Postdoctoral fellow.</li> <li>• Research Assistant.</li> </ul>	• 3 hr session inclusive of seminar and discussion group.	<ul style="list-style-type: none"> <li>• Basic concepts and understanding of project, D-STEM, technology and materials to be used in workshops.</li> <li>• Value and importance of D-STEM within the context of current and future industry.</li> <li>• Understanding of teachers' backgrounds and needs.</li> </ul>

2	Demonstration and coaching	Workshop 1 with teachers.	<ul style="list-style-type: none"> <li>• Launch project brief.</li> <li>• Introduction to AI, intelligent textiles and soft switches.</li> <li>• Challenge and target group identification</li> <li>• Storyboard</li> <li>• Exploration and experiments with technology and materials.</li> </ul>	<ul style="list-style-type: none"> <li>• Teacher participants.</li> <li>• Applicant.</li> <li>• International instructor.</li> <li>• Postdoctoral fellow.</li> <li>• Research assistant.</li> <li>• Student helpers.</li> </ul>	• 6 hour workshop.	<ul style="list-style-type: none"> <li>• To build teachers' skills and knowledge for D-STEM and interactive textiles via demonstration, interdisciplinary practice of workshop.</li> </ul>
		Workshop 2 with teachers.	<ul style="list-style-type: none"> <li>• Prototyping with materials.</li> <li>• Presentation boards.</li> <li>• Group presentation.</li> </ul>		• 6 hour workshop.	
				<ul style="list-style-type: none"> <li>participants.</li> <li>• Applicant.</li> <li>• International staff trainer.</li> <li>• Postdoctoral fellow.</li> <li>• Research assistant.</li> </ul>	• 3 x 1.5 hrs (10 teachers per group)	<ul style="list-style-type: none"> <li>• Reflection of the knowledge gained for all stakeholders to further refine the project brief and teaching content to the needs of the teachers and their students.</li> </ul>
4	Implementation (Teachers to conduct workshops with students with applicant and instructor as on-site guides and support.)	Workshop 1 with teachers for students. (1 for each school)	<ul style="list-style-type: none"> <li>• Launch project brief.</li> <li>• Introduction to AI, intelligent textiles and soft switches.</li> <li>• Challenge and target group identification</li> <li>• Storyboard</li> <li>• Exploration and experiments with technology and materials.</li> </ul>	<ul style="list-style-type: none"> <li>• Student participants.</li> <li>• Teacher participants.</li> <li>• Applicant.</li> <li>• International staff trainer.</li> <li>• Postdoctoral fellow.</li> <li>• Research assistant.</li> <li>• Student helpers.</li> </ul>	• 8 x 6 hr workshops.	<ul style="list-style-type: none"> <li>To reinforce teacher's skills and knowledge via workshop for students.</li> <li>• To build students' creative problem-solving skills via D-STEM.</li> <li>• To build students' knowledge in design and technology.</li> </ul>
		Workshop 2 with teachers for students. (1 for each school)	<ul style="list-style-type: none"> <li>• Experiments with materials.</li> <li>• Initial prototyping.</li> </ul>		• 8 x 6 hr workshops.	
5	Review and dissemination	Project presentation and critique	<ul style="list-style-type: none"> <li>• Each group to present their D-STEM projects.</li> <li>• Critique and sharing</li> </ul>	<ul style="list-style-type: none"> <li>• Student participants.</li> <li>• Teacher participants.</li> <li>• Applicant.</li> <li>• International staff trainer.</li> <li>• Postdoctoral fellow.</li> <li>• Research assistant.</li> </ul>	• 5 x 3hr critique sessions. (20 groups per session with 5 minute pitch per group)	<ul style="list-style-type: none"> <li>• Building and reinforcing both teachers' and students' competencies with relevance to industry and professional contexts.</li> </ul>



		Post workshop surveys and reflection.	<ul style="list-style-type: none"> <li>• Guided discussion.</li> <li>• Online questionnaire</li> </ul>	<ul style="list-style-type: none"> <li>• Student participants.</li> <li>• Teacher participants.</li> <li>• Postdoctoral fellow.</li> <li>• Research assistant.</li> </ul>	<ul style="list-style-type: none"> <li>• 8 x 2hr focus groups (1 per school)</li> </ul>	<ul style="list-style-type: none"> <li>• Final reflection phase to gather data on good teaching practices, skills and methods to contribute to the teaching materials, e-book, exhibition and final dissemination.</li> </ul>
		Final design, development and editing of teaching materials, videos, e-book and exhibition design.				
		School Based exhibitions. Uploading of all finalised materials onto project website.	<ul style="list-style-type: none"> <li>• Dissemination of project deliverables.</li> </ul>	<ul style="list-style-type: none"> <li>• All stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>• 2 month school based exhibitions (small scale exhibitions at the participating secondary schools)</li> <li>• Website.</li> </ul>	Encourage all stakeholders to develop sense of ownership for the project to nurture interest in D-STEM.
					Exhibition Venue: At participating secondary schools.	

### Workshop Programme

The workshops will offer a hands-on approach for participants to explore, experiment, co-design and create simple prototypes. It will use the medium of intelligent textiles: colour changing illuminative textiles (Fig.10) controllable via AI. Such materials provide application opportunities for fashion, wearables, environments and services. The final outcome is not defined, in order to encourage out of the box thinking and creative diversity.

Workshops for Teachers: Conducted by project members, international staff trainer (via video conferencing) and design practitioner approved to enable participants to gain learner's perspective of the content to further refine and adapt to the needs of their students.

Workshops for students: Led by teacher participants supported by project members, international staff trainer and design practitioner approved to deliver workshops to their students.

It will include the following activities:

- 1) Introduction: Introduction to intelligent textiles and AI technology. Identifying characteristics, pros and cons of both materials and technology.
- 2) Brainstorming: Mind mapping exercise, exploration of potential problems via narrative scenarios that will benefit from such materials. Brainstorming of design solutions and applications.
- 3) Sketching and materials exploration: Sketching, design development and material sample making. Experimenting with different application scenarios.
- 4) Prototyping: Final refinement of idea, creation of prototype and presentation boards.

5) Review and presentation: Presentation of final designs and group critique.

Double Diamond Framework

The design practice will be delivered

. The workshop activities work with the framework to encourage both divergent and convergent thinking. The combination of concept and practice flexibly guides designers towards a meaningful exploratory process. The framework conveys a reiterative 4 step design process that enables divergent exploration and convergent action (Fig.11). This non-linear framework includes the following steps:

1. Discover. Designers to gain an understanding of the problem via direct communication and experience. This will help the designers to understand rather than assume.
2. Define. Deriving knowledge from the insights gained in the first step, designers will define the challenge in a different way.
3. Develop. To seek multiple perspectives and actively explore potential solutions via experimentation.
4. Deliver. To test out different solutions, eliminating unfeasible ideas and further improving viable solutions.

The underlining principles of the framework are:

- Human centred approach. To start with an understanding of the users who are in need of the proposed solution.
- Communicate visually and inclusively. Help designers, stakeholders and general public gain a shared understanding of the proposed challenge and solutions.
- Collaborate and co-create. Create a boundary blurring dynamic to reinforce design team with strong combinations of expertise and know-how.
- Iterate. Constant presentation and sharing of ideas to help refine ideas and build ownership and confidence.

The concept, approach and environment work collectively to transfer knowledge through practice instead of conventional textual learning. The process of critical making encourages critical thinking and reflection through the manipulation of materials and consideration of realistic scenarios.

Conventional assessments are often conducted in the form of written assignments and exams, it reveals academic progress in a quantitative manner. It often neglects to offer constructive means in which the learners can further improve their knowledge and skills. This project's assessment will be conducted via critiques and exhibition. The critiques will involve the applicant, industry and professional collaborators who will be able to help identify strengths, weaknesses and provide constructive comments that is relevant to industry and professional expectations. The exhibition serves as a summative assessment that chronicle the processes and products of a sustained problem-based inquiry that is central to a transdisciplinary approach (Constantino, 2018).

Prototype Theme

To utilise intelligent textiles as a medium to develop, design and products that will enhance everyday lives. The process will be interdisciplinary can be integrated into curriculum pertinent to Design and Technology, Technology and Living, Visual Arts, STEM education and Educational Technology.

Learning Contents

The project's learning contents are aimed at students with no foundation knowledge in design and STEM subject matters using intelligent textiles (AI integrated illuminative textiles that can be controlled by body language) that are specially

developed for this project. The project content is designed to be inclusive and adaptable to different age groups, however within the context of project collaborators, upper secondary school students are preferred but not restricted to. The learning contents will be delivered via interactive activities. As part of the teaching and learning process, participants will be required to develop a prototype (conceptual, virtual or artefact) according to a design brief with the support of the project team.

Learning activities will include:

#### Face-To-Face Workshops

- Lecture (Deliver text based knowledge)
- Studio Practice (Hands-on creative development)
- Small group tutorials

#### Video Conference

- Design development discussion
- Tutorials

#### Additional Learning Support

- In addition to the website, with public access to all developed teaching and learning materials, e-book and videos (detailing the design process and results of the project) beyond the duration of the project, the team will establish a communication network (available as applications for mobiles and computers). It will facilitate casual/ ad-hoc discussions, meetings and sharing of information between the different schools and the project members. Separate teams will be established for teachers and students to ensure privacy of teachers. A comprehensive list of relevant contacts and resources will be shared to ensure participants have direct contact with project members to resolve queries and share updated resources.

#### Indicative Contents:

##### 1) Artificial Intelligence

- Introduction to AI.
- Machine learning, deep learning, strong artificial intelligence, and weak artificial intelligence
- Daily applications

##### 2) Intelligent Illuminative Textiles

- Introduction to intelligent textiles.
- 
- What, Why, How.

##### 3) D-STEM: Interdisciplinary creative processes with technology

- Human-centered approach.
- Collaborative communication as a creative tool.

##### 4) Design Studio

- Hands-on design practice to design and develop innovative intelligent textiles products.

##### 5) Exhibition Design

- Exhibition design as part of project reflection and assessment.

#### Intended Learning Outcomes

Upon completion of project, teacher participants will be able to:

- 1) Apply interdisciplinary approaches to conduct workshops pertinent to creativity and STEM subject matters.
- 2) Create an effective learning environment for design led activities using conventional school resources.
- 3) Design and plan effective D-STEM learning activities pertinent to students with little to no foundation knowledge in design, AI and technology.
- 4) Effectively assess D-STEM via critique, exhibitions and recommended criteria.

Upon completion of this project, student participants will:

- 1) Gain foundation knowledge about AI and its applications in everyday live.
- 2) Gain foundation knowledge of intelligent materials via the medium of technology integrated textiles.
- 3) Develop skills to adapt new technologies to design and develop innovative ideas.
- 4) Utilise interdisciplinary approaches to develop problem solving strategies.
- 5) Develop critical and creative thinking skills.

### Learning and Teaching Materials

The project will develop an online and a practical learning and teaching toolkits which teachers and learns can adapt according to their subject needs, scheduled time and venue requirements. As the project is interdisciplinary, the project content will be relevant to teachers and students studying the following subjects: Design and Technology, Technology and Living, Visual Arts, STEM education and Educational Technology. The toolkits will comprise of the following:

#### Online Toolkit (available for download on project website)

- Introductory fact sheets on AI.
- Introductory fact sheets on Intelligent Textiles.
- Introductory fact sheets on D-STEM creative processes.
- Detailed D-STEM project briefs with guidelines and marking criteria.
- Systematic D-STEM workshop activities and recommended formats.
- Online resource list.
- Online discussion forum

#### Practical Toolkit (Available for participating schools)

- Intelligent textile toolkit (Materials and instructions for operation)

## **6. Implementation Plan**

Project Duration: September 2020 to November 2021 (15 months)

<b>Activities</b>	Sep 2020	Oct-Nov 2020	Dec-Jan 2021	Feb-Mar 2021	Apr-May 2021	Jun-July 2021	Aug-Sep 2021	Oct-Nov 2021
Training of project staff								
Begin tendering procedure for website								
Preparation of teaching and learning content with materials for teachers								
Co-ordination of activity dates with teachers by project staff								
Launch website. (With all basic information and contact details)								
Pre-workshop focus groups with teachers and sharing sessions with industry and professional community collaborators								
Workshops for teachers; Conduct user feedback questionnaire; Refine teaching material according to feedback								
Workshops for students with teachers (2 for each school); Conduct user feedback questionnaire								
All participants to continue working on D-STEM project at their schools								
Sharing and critique session with industry and professional community collaborators								
Initial design of e-book, exhibition materials and finalisation of online toolkits								
Workshops with teachers and students to refine their D-STEM projects with the support of the applicant and project staff								

Final refinement of project outputs and content for website and exhibition: Teaching materials, e-book, videos, exhibits, school based exhibition design								
School based exhibitions								
Documentation and analysis of collated data								
Update and uploading of content onto website								
Consolidation, and concluding report for project								

## 7. Expected Project Outcomes

The expected project outcomes are:

- Teachers to acquire related knowledge and skills for curriculum delivery of D-STEM via interdisciplinary practice, intelligent textiles and AI applications for design.
- Students to develop new knowledge in intelligent textiles and AI applications in design, learning methods, communication skills, innovative techniques and positive attitudes for creative real-world problem solving using multiple perspectives.
- Comprehensive teaching materials, videos and exhibition which serve as an important point of reference for local and international secondary school teachers.
- Teachers and students to gain pedagogical experience and skills for collaborative work.
- A supportive network comprising of industry, professional and academia contacts that will sustain positive collaboration, values and attitudes towards D-STEM. (The project will establish a comprehensive contact list and group for participating secondary school teachers. The teachers will be able to contact the project leader, RCA collaborators, instructors, supporting organization mentors directly beyond the scheduled period of the project for support and advice. This supportive network will contribute to the sustainability of the project enabling teachers to further carry out D-STEM projects for the future.)

## 8. Teacher's and Principals' Involvement

Teachers and principals will be invited to support the implementation of the project in the following ways:

- Arranging and coordinating time for the activities in this project.
- Participating in focus groups and surveys to help design and evaluate the workshop content and materials.
- Engage in the workshops, activities and exhibition in their role as coordinator, guides, facilitators and participants.
- Disseminate information about the project via school website and social media.
- Implement school based exhibitions with the exhibits and materials developed with the support of the project team.

## 9. Budget

Budget	Amount
<b>Staff Costs</b>	
<ul style="list-style-type: none"> <li>• <u>Postdoctoral Fellow</u> HKD\$ 35,000 x 15 months + MPF HKD\$1500/month</li> </ul>	HKD\$547,500
<ul style="list-style-type: none"> <li>• <u>Research Assistant</u> HKD\$17,500 x 15 months +5% MPF</li> </ul>	HKD\$275,625
<ul style="list-style-type: none"> <li>• <u>Student Helpers</u> (Hourly Basis at HKD\$ 60/hr) 4 student helpers x 2 teacher's workshops x 8 hrs</li> </ul>	HKD\$3,840
<ul style="list-style-type: none"> <li>4 student helpers x 16 students workshops x 8 hrs</li> </ul>	HKD\$30,720
<b>Total Staff Costs</b>	<b>HKD\$857,685</b>
Services:	
<ul style="list-style-type: none"> <li>• <u>Staff trainer for teachers' workshop.</u> - Lecturer fee Teachers' Workshops \$1020 x 2 workshops x 6 hrs</li> </ul>	HKD\$12,240
<ul style="list-style-type: none"> <li>• <u>Staff trainer for students' workshop.</u> - Lecturer fee Students' Workshops \$880 x 16 workshops x 6 hrs</li> </ul>	HKD\$84,480
<ul style="list-style-type: none"> <li>• <u>Website</u> - Website design</li> </ul>	HKD\$35,000
<ul style="list-style-type: none"> <li>- Bilingual editing and Chinese translation of content.</li> </ul>	HKD\$20,000

<ul style="list-style-type: none"> <li>- E-book design.</li> <li>- Photography and video recording of workshops</li> <li>- Video editing</li> <li>• <u>Exhibition</u></li> <li>- Production fee for exhibition (Inclusive of plinths, display panels and rental of TV panels with stands and so on)</li> </ul>	<p>HKD\$40,000 HKD\$50,000 HKD\$40,000</p> <p>HKD\$40,000</p>
<b>Total for services</b>	<b>HKD\$321,720</b>
<b>General Expenses</b>	
<ul style="list-style-type: none"> <li>• <u>Audit Fee</u></li> <li>• <u>Materials for 22 workshops:</u> POF materials, intelligent material development, components, drawing materials, paper, stationery, printing, travel costs related to data collection and workshop delivery</li> <li>• <u>Transportation Fee</u> (Round trip coach for 7 schools 16 x HKD\$2000)</li> </ul>	<p>HKD\$15,000</p> <p>HKD\$70,035</p> <p>HKD\$32,000</p>
<b>Total for general expenses</b>	<b>HKD\$117,035</b>
<b>Subtotal</b>	<b>HKD\$1,296,440</b>
<b>Other Expenses</b>	
<ul style="list-style-type: none"> <li>• Administrative Overheads (Around 15% of university overhead administration for research project and financial administration)</li> </ul>	HKD\$194,460
<b>Total Funding Requested</b>	<b>HKD\$1,490,900</b>

#### Justification of Requested Funds

##### Staff

- Postdoctoral Fellow  
A postdoctoral fellow will be employed to work full time on the project throughout the entire duration. He/She will work with all stakeholders to co-ordinate the activities, workshop development, teaching materials, development, website content development, exhibition design, data collection, data analysis, events organization, finance monitoring etc. It is expected that the postdoctoral fellow will hold a PhD in design research or education; experience in research management within a university context; good command of English and Chinese.
- Research Assistant  
A research assistant will work with the project manager to assist with the preparation of the workshop, teaching material, maintain content of website, design of exhibition, data collection, visual and textual records of project; updating social media, administrative work and supportive work. It is expected for the project assistant to possess a master's degree relevant to design or electronic engineering; good social media literacy; good graphic skills; good command of English and Chinese.
- Student Helpers  
Student helpers will be engaged on a part-time basis to assist at all workshops. 4 helpers will be required for each workshop and they will be required for an additional 2 hours for 1 hour preparation for pre and post workshop. They will assist the instructors, manager and participants with the preparation of the lab, materials and assist with the practical demonstrations for participants. Helpers with design backgrounds will be recruited

##### Services

- International staff trainers and HK based design instructors for workshops.  
International trainers will be engaged to provide design instruction and tutorials via video conferencing (total of 20 hours) and supported by design trainers in Hong Kong during the face-to-face workshops. collaborators will be involved in the development of project content and materials.
- Website.  
Services will be engaged to design, upload and maintain a comprehensive website that will contain all project content and outputs. It is necessary to engage bilingual editing, website design, e-book design, photography, video recording and video editing. The website is necessary for ensuring maximum international and local reach with impact on project beneficiaries.

- School Based Exhibitions

School based exhibitions will be held at the participating schools. The exhibitions will serve as a means for participants to consolidate, review, assess and communicate the new knowledge and creative innovations that were developed.

#### General Expenses

- Audit Fee.

Required for independent examination of financial statements and funds utilized within the project.

- Materials

Consumable materials and services such as POF materials, application development, components, drawing materials, paper, stationery, printing, travel costs related to data collection and workshops are necessary for the delivery of the project content.

- Transportation Fee.

Round trip transportation will be provided for students to attend the workshops as it is not conducted at their usual campus. This will ensure the safe and timely delivery of the workshops.

#### Other Expenses

- Administrative Overheads

mandatory overhead charges for non-UGC funded activities that require support from the university's administrative and supporting units.

#### Budget Adjustment Justifications

- International staff trainers for workshops.

Due to budget adjustments and the uncertain travel restrictions resultant of COVID-19 with potential implications to public health and insurance matters, collaborators will contribute to the face-to-face workshops in Hong Kong via video conferencing for design discussions and group tutorials. In addition to the applicant, post-doctoral fellow and research assistant, design instructors will be employed to assist with the workshops. The design instructors will possess a Master's degree in design. The lecturer fee will be paid to the collaborators and the HK based design instructor on an hourly rate.

- Exhibition

The final exhibition will focus on school based dissemination enabling the teachers and students to utilise the exhibition as part of the teaching and learning process. The project members will support the participants in the preparation and design of the materials and they can adapt them to the school's exhibition venue.

## **10. Project Evaluation**

The project will be evaluated using both qualitative and quantitative methods involving the following methods:

Focus Groups. Focus group discussions will be conducted before the workshops with the teachers to gain a better understanding of the existing relevant curricula (STEM, design and creativity), students' previous exposure to STEM and learning environments. The discussions will be conducted in a semi-structured format to encourage active communication and sharing of experiences. The purpose of the focus group is to gain an understanding of the needs and curriculum gaps pertinent to each school and design teaching materials that will be applicable for all participants.

User Feedback Questionnaires. Teacher and student participants of the workshops and seminars will be requested to provide feedback via digital surveys. The initial survey for teachers and survey for students will cover aspects on the general impression of the workshop's environment, content, materials, and delivery. The final survey for teachers will focus on the design of the teaching and learning materials, responses of the students, support provided by the website and the project team. Data will be collected and analysed and contribute to the refinement of the teaching material and workshop content of the next phase of activities. This enables a reflective process that improves and adapts to the specific needs of the project beneficiaries.

D-STEM Project Critiques. As part of the workshops, all participants will be required to design and develop D-STEM applications/service or products using intelligent textiles. Collaborating partners and the applicant will share their insights and critique the proposed designs developed during the workshops. They will provide direct feedback to the teachers and students from the perspectives of the industry, professional and higher education. First hand feedback will contribute to the professional and academic development of the beneficiaries. An advisory committee will be established

to review, assess and advice to the design and implementation of the project. The committee will comprise of academic, industry and professional experts in the field of design, technology and education.

## **11. Sustainability**

- Well-developed website containing all teaching materials, e-book, videos, exhibition content and outputs. It will be accessible to participants, collaborators and the general public. It will serve as a point of reference and discussion for schools who had not taken part but will like to explore D-STEM within their curricula.
- Crucial partnerships are formed within the project. Curricula in secondary schools are further enriched with discussion and feedback from the industry, professional community, higher education that are potential destinations for secondary school students. All stakeholders and potential schools interested in exploring D-STEM using the resources available on the website can connect with the contact details of all collaborators on the website.
- The school, teachers, student participants together with the applicant and collaborators are encouraged to share the project with other schools at different educational levels. To ensure maximum impact and reach on the local educational environment.

## **12. Dissemination/ Promotion of Project Outcomes**

- Website. The project website will provide all relevant information and supporting material about the project and include open access to the following:
  - Teaching materials and resources: Inclusive of guides and notes that were disseminated during the workshop.
  - Videos of workshops: One edited short video of the teacher's workshops and one edited short video of the students' workshop for sharing of good practices and ideas via the website.
  - E-book of Project: The e-book will serve as a content summary of the project with supporting information of the collected data and analysis.
- Social media. Information about the project will be shared on social media of the applicant and collaborators with shared links to the project's website to enable dissemination amongst international/ national academia, industry and professional communities.
- School Based Exhibitions
- Individual exhibitions will be held at each participating secondary school. The project team will assist each school to design and develop exhibition materials pertinent to each venue.

## **13. The Asset Usage Plan**

No equipment and assets will be purchased for this project.



## 14. Report Submission Schedule

The Grantee commits to submit the reports in strict accordance with the following schedule:

Project Management (Should be submitted via the “Electronic Project Management System” (EPMS) )		Financial Management (Hard copy together with supporting documents should be submitted to the QEF Secretariat by mail or in person)	
Type of report and covering period	Report due date	Type of report and covering period	Report due date
Progress report 01/09/2020-28/02/2021	31/03/2021	Interim financial report 01/09/2020-28/02/2021	31/03/2021
Progress report 01/03/2021-31/08/2021	30/09/2021	Interim financial report 01/03/2021-31/08/2021	30/09/2021
Final report 01/09/2021-30/11/2021	28/02/2022	Final financial report 01/09/2021-30/11/2021	28/02/2022

## Declarations

- The project will ensure sufficient number of teacher participants for delivering student workshops and experience sharing,
- The project applicant will ensure that the project is non-profit making in nature.
- The project will ensure the procurement of goods and services to be made in an open, fair and competitive basis with measures taken to avoid conflict of interest in the procurement process.
- The project declares that the deliverables/ materials developed this project should be vested with the QEF and note that any reproduction, adaptation, distribution or provision of the deliverables to the public for commercial purposes by the service provider is strictly prohibited.

## References

1. Costantino, T. (2018) STEAM by another name: Transdisciplinary practice in art and design education, *Arts Education Policy Review*, 119:2, 100-106, DOI: 10.1080/10632913.2017.1292973
2. Education Bureau of the Government of the HKSAR (2016) Report on Promotion of STEM Education - Unleashing Potential in Innovation, December 2016.
3. Henriksen D., Mehta R., Mehta S. (2019) Design Thinking Gives STEAM to Teaching: A Framework That Breaks Disciplinary Boundaries. In: Khine M., Areepattamannil S. (eds) STEAM Education. Springer, Cham
4. Herro, D. & Quigley, C. (2017) Exploring teachers’ perceptions of STEAM teaching through professional development: implications for teacher educators, *Professional Development in Education*, 43:3, 416-438, DOI: 10.1080/19415257.2016.1205507
5. Hong Kong Policy Research Institute. (2017) STEM+ Gocalization & top level design of STEM education. Hong Kong, The Centre for Education Policy. ISBN: 978-962-8240-16-6
6. Hong Kong Special Administrative Region Government (2019). Policy address 2019. Retrieved from <https://www.policyaddress.gov.hk/2019/eng/policy.html>
7. Hong Kong Special Administrative Region Government (2018). Policy address 2018. Retrieved from <https://www.policyaddress.gov.hk/2018/eng/policy.html>
8. Lammer L., Vincze M., Kandlhofer M., Steinbauer G. (2017) The Educational Robotics Landscape Exploring Common Ground and Contact Points. In: Merdan M., Lepuschitz W., Koppensteiner G., Balogh R. (eds) Robotics in Education. Advances in Intelligent Systems and Computing, vol 457. Springer, Cham
9. Lee, MH., Chai, C.S. & Hong, HY. Asia-Pacific Edu Res (2019) 28: 1. <https://doi.org/10.1007/s40299-018-0424-z>
10. Lo, S (2019. January 14) Reform education to address Hong Kong’s manpower mismatch. *China Daily: Hong Kong Edition*, p.10.
11. Robertson, S. (2018) COLLABORATION: LEARNING AND SHARING KNOWLEDGE FOR SMART TEXTILES, ICERI2018 Proceedings, pp. 7192-7195.
12. Executive Office of the President of the United States of America (December, 2018) STEM Education Strategic Plan. Retrieved: <https://www.whitehouse.gov/wp-content/uploads/2018/12/STEM-Education-Strategic-Plan-2018.pdf>

13. Tan, J., Kim,H. & Toomey, A. (2018) SENSORY TACTILITY: DESIGNING INTERACTIVE TEXTILES FOR WELL-BEING, ICERI2018 Proceedings, pp. 7064-7068.
14. Tan, J. and Toomey,A. (2018) CraftTech. London: Royal College of Art. (ISBN: 978-1-910642-31-0) <http://hdl.handle.net/10397/78800>
15. Tan J, Toomey A, Warburton A. CraftTech: hybrid frameworks for textile-based practice. Journal of Textile Engineering and Fashion Technology. 2018;4(2):165-169. DOI: 10.15406/jteft.2018.04.00135
16. Tandler, L. (2018) THE SMART TEXTILE PROBLEM AND ITS IMPLICATION FOR TEACHING, ICERI2018 Proceedings, pp. 2618-2624.
17. Toomey, A., & Kapsali, V. (2014) D-STEM: a Design led approach to STEM innovation. In: A Matter of Design: Making Society through Science and Technology Proceedings of the 5th STS Italia Conference. STS Italia Publishing, Milan, pp. 425-438. ISBN 9789078146056
18. Toomey, A. & Tan, J. (2018) Interrogating D-Stem: A Design led approach to STEM Innovation, ICERI2018 Proceedings, pp. 2964-2969. Doi: 10.21125/iceri.2018.1665
19. Yenigun, E.O, (2018) Reshaping teaching strategies for innovative materials in art and design., ICERI2018 Proceedings, pp. 4034-4037.