Design-Led STEM: Interdisciplinary practice in hybrid mode.

Dr. Jeanne Tan, COO of AiDLab & Associate Professor, HKPOLYU

Funder

優質教育基金
Quality Education Fund

Collaborators

Local Academia

The Hong Kong Polytechnic University
香港理工大學

International Academia

Royal College of Art
Postgraduate Art & Design

Professional Community

hkdc
Hong Kong Design Centre
香港設計中心

Industry

the mills
fabrica
南豐作坊

Collaborating Schools

1) AD&FD POHL Leung Sing Tak College
2) Carmel Alison Lam Foundation Secondary School
3) Diocesan Girls' School
4) Leung Shek Chee College
5) Pope Paul VI College
6) S.K.H. Holy Trinity Church Secondary School
7) 'Society of Boys' Centres Hui Chung Sing Memorial School'
8) St Catharine's School for Girls (Kwun Tong)
9) Tsung Tsin Christian Academy
10) Yan Oi Tong Tin Ka Ping Secondary School

Project Beneficiaries

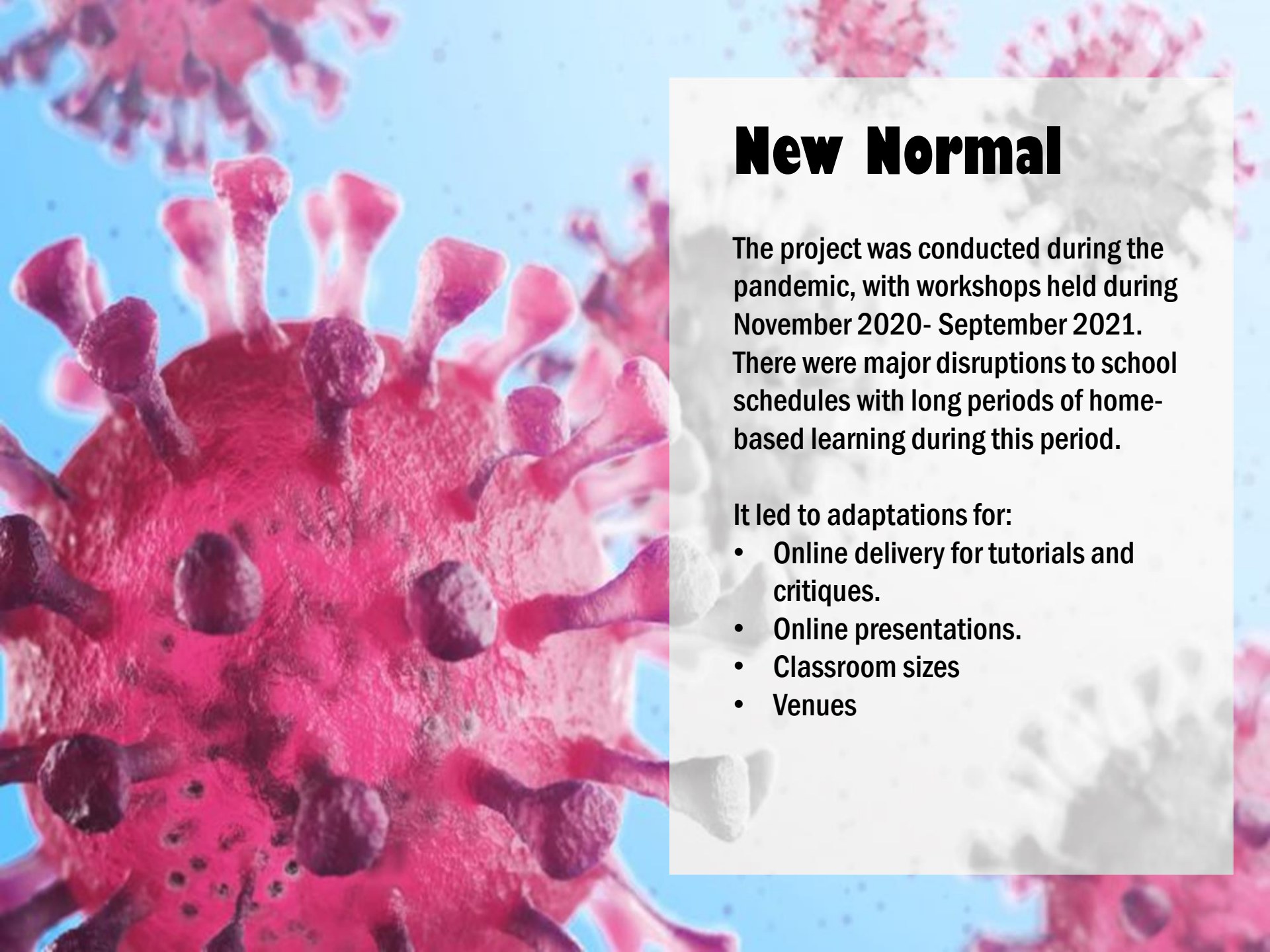
- ***Teachers:***

Secondary School Teachers in Design and Technology, Visual Arts, Technology and Living, STEM.

- ***Students:***

Secondary School Students in Form 3,4,5.

10 Hong Kong secondary schools, **38** teachers and over **500** beneficiary students.



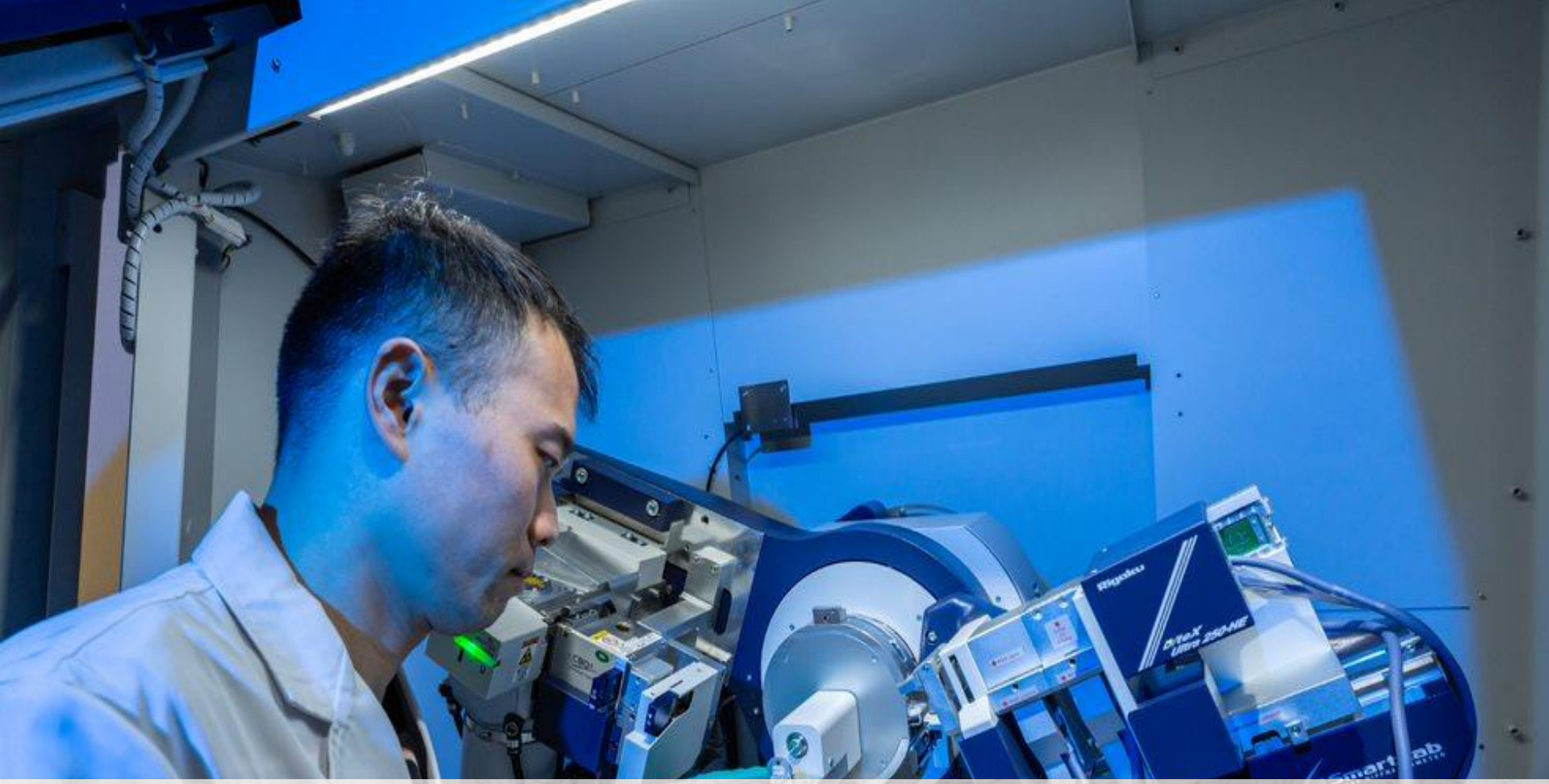
New Normal

The project was conducted during the pandemic, with workshops held during November 2020- September 2021. There were major disruptions to school schedules with long periods of home-based learning during this period.

It led to adaptations for:

- Online delivery for tutorials and critiques.
- Online presentations.
- Classroom sizes
- Venues

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. Many countries had placed STEM as a priority for education.



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.

Project Goal:

To enhance learning and teaching experience of creative and STEM secondary curricula via *interdisciplinary practice* of artificial intelligence and design.

Technology integration via:

- *Hybrid format*
- *Hybrid content based on AI and Design*

Deliverables: Workshops for teachers; workshop for students; Online D-STEM teaching materials and learning resources; website; e-book; videos of workshops and school-based exhibitions.

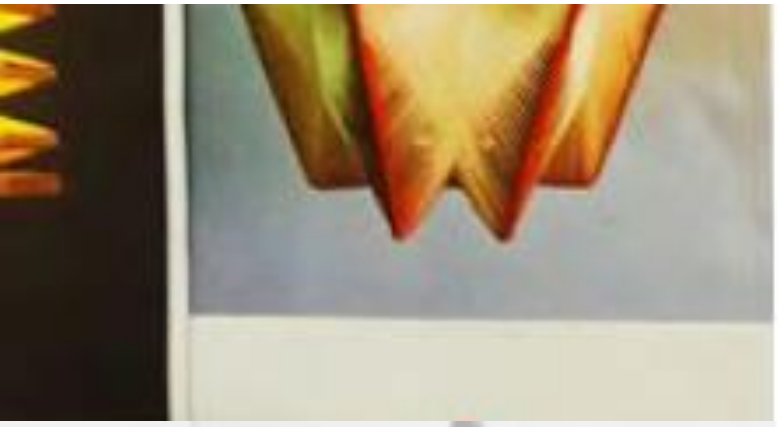
Project Core Elements

Approach:
D-Stem

Process:
Double
Diamond

Technology:
Artificial
Intelligence

Medium:
E-Textiles



Approach: D-STEM

(Design Led Science, Technology, Engineering and Mathematics)

What is D-STEM?

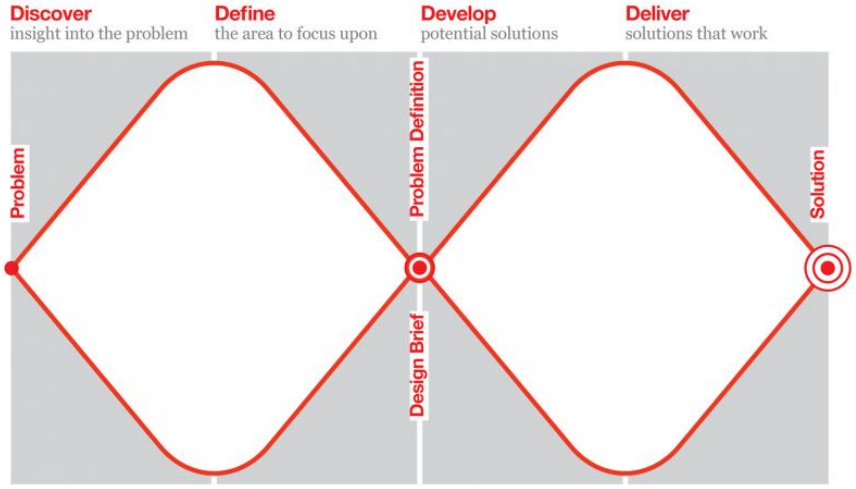
D-STEM merges the creative aspects of design with the experimental aspects of STEM

Why use the D-STEM Approach?

- Design thinking offers a cyclic process that encourages reflection and continuous refinement that is conducive to fast evolving contemporary lifestyles.
- It encourages active collaboration and creative thinking without being bound to discipline focused restrictions.



A **design-led approach** to STEM education encourages innovation by nurturing real world problem solving by **merging technological knowledge with creative practice**. Contemporary STEM content benefit from multi-faceted contributions of **cross-sector international collaborators** to ensure that content **maintains relevance and anticipates for future developments.**



Double Diamond Framework

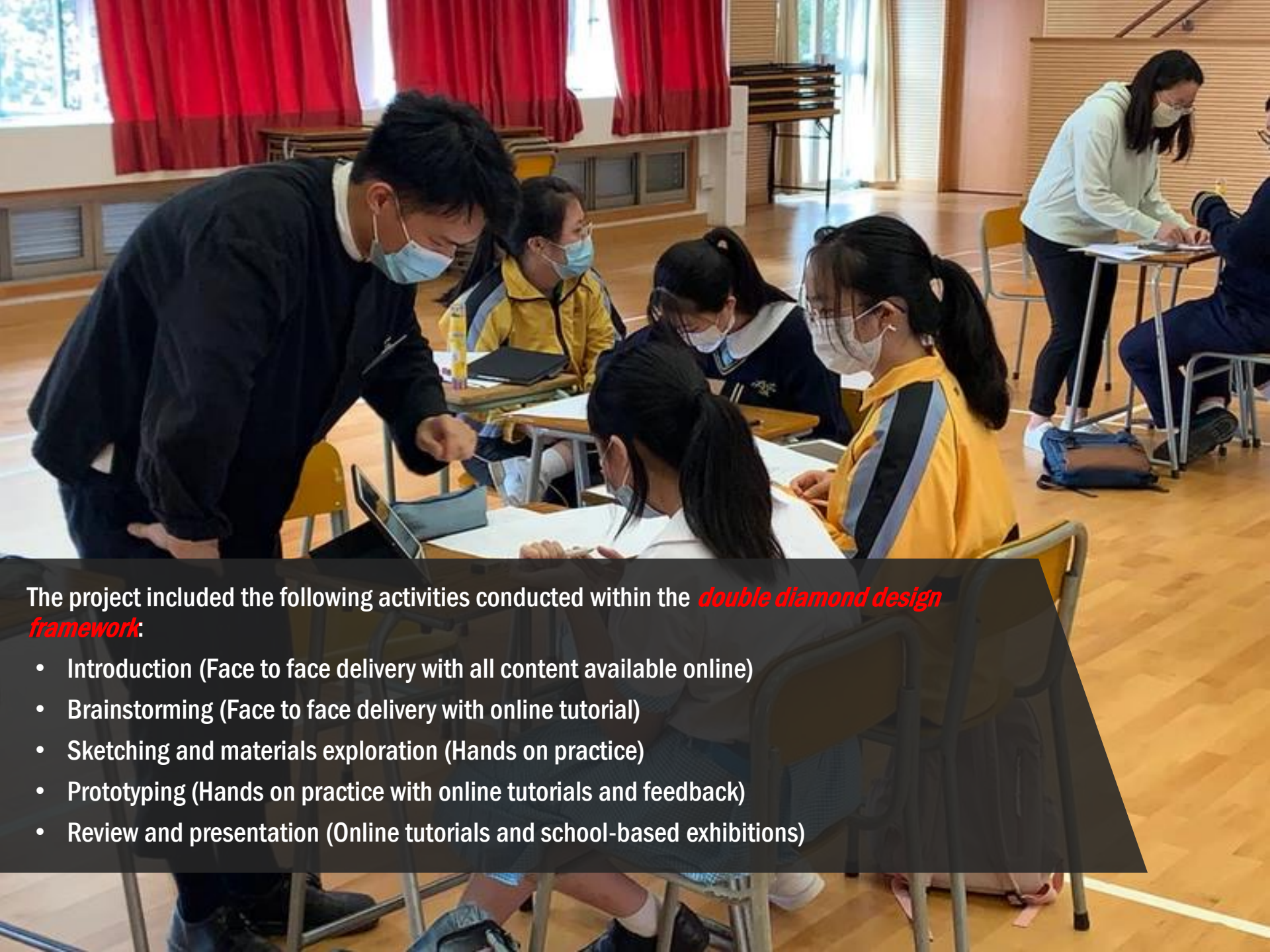
The design practice will be delivered using the UK Design Council's Double Diamond framework for innovation (Design Council, 2019). It encourages both divergent and convergent thinking.

Discover: Designers to gain an understanding of the problem via direct communication and experience. This will help the designers to understand rather than assume.

Define: Deriving knowledge from the insights gained in the first step, designers will define the challenge in a different way.

Develop: To seek multiple perspectives and actively explore potential solutions via experimentation.

Deliver: To test out different solutions, eliminating unfeasible ideas and further improving viable solutions.



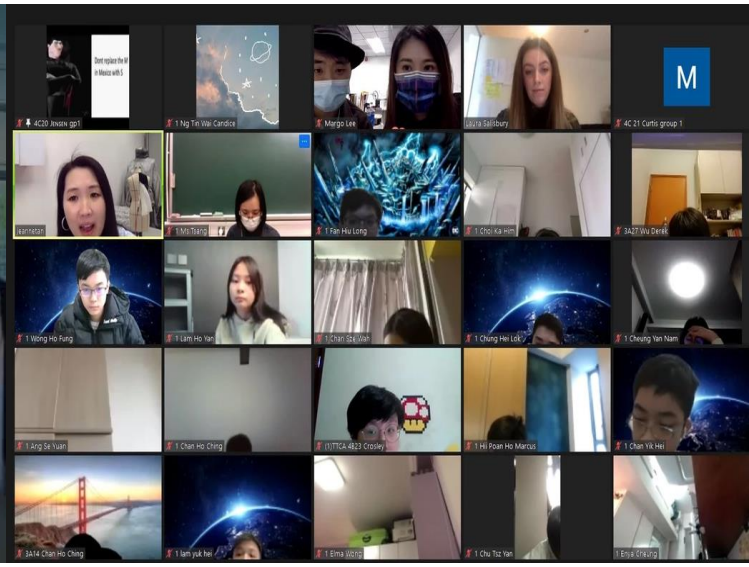
The project included the following activities conducted within the ***double diamond design framework***:

- Introduction (Face to face delivery with all content available online)
- Brainstorming (Face to face delivery with online tutorial)
- Sketching and materials exploration (Hands on practice)
- Prototyping (Hands on practice with online tutorials and feedback)
- Review and presentation (Online tutorials and school-based exhibitions)

Together with online and face to face content delivery, the project offers a hands-on approach for participants to **explore, experiment, co-design** and create simple prototypes. The final outcome is not defined, in order to encourage **out of the box thinking** and **creative diversity**.

Face-to Face Content Delivery

Online Tutorials and Ideation



Hybrid Format

Online lectures and design tutorials with RCA experts.

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.

Practice Based

Design studios with teachers.

Project team will conduct workshops with teachers and provide a detailed curriculum with comprehensive physical and online teaching kits for STEM and creativity integrated content. Teachers will be able to use the framework, resources and networks and adapt the recommended content and activities to conduct STEM workshops in the future.

Design studios with students

Teachers will conduct workshops for their students with the full support of the project team. The project team will be present to to support and contribute to the workshop.

Hybrid Content

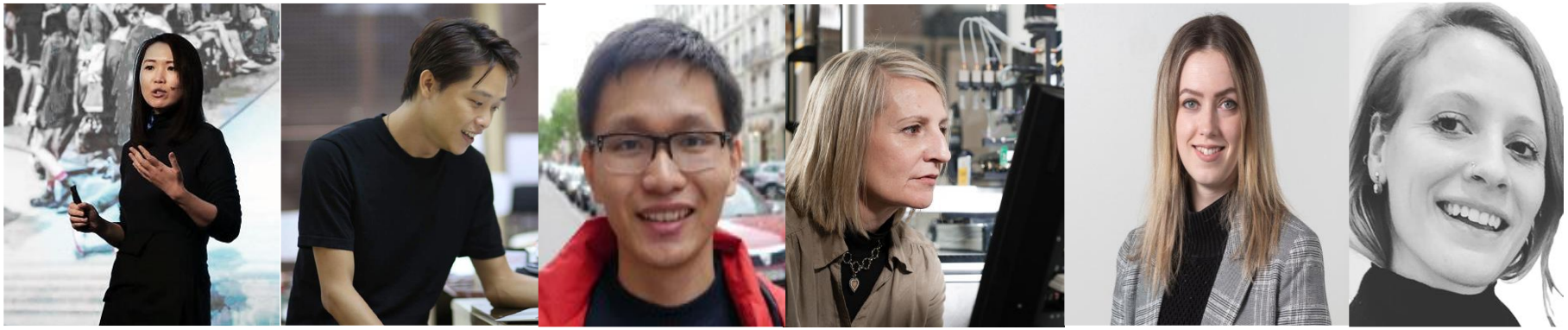
Integrating ***design thinking*** and ***technology*** knowledge for creative innovation. Utilising the medium of e-textiles design and AI concepts to solve real world challenges.

- Cross sector collaboration via online and face-to-face delivery
- Multi-Perspective Feedback and Support

Timothy Muller
The Mills Fabrica

Kennis Chan
HKDC

Bobo Fong
HKDC



HKPOLYU & RCA Team

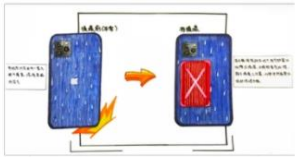
Video of teacher workshops

SMART PROBLEM-IDENTIFYING PHONE CASE

A smart phone case which illuminates areas of the phone which have hardware issues for easier phone problem identification.

Problem: It is difficult for phone users to identify hardware issues with their phone as it requires technical expertise.

Solution: A smart phone case which illuminates areas of the phone which have hardware issues for easier phone problem identification. It detects component issues through a grid of integrated sensors which detect the electrical signals emitted by various components in the phone. If a sensor detects a signal is weak, the area of that part of the phone will light up, indicating there is a specific hardware issue in the phone. POF is used as the illuminating source of the phone case for aesthetic purposes and to provide a smoother feel.



Group Members: Tsiao Wing Sum (SD), Chan Sui Ki (SE), Yeung Man Lok (SE), Chan Sin Ching (6B)

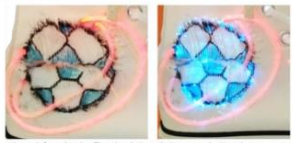
Above: The sketches above indicate our thinking process behind how the phone illuminates and the location of various components.

SOCCER MOVEMENT-DETECTING SHOE

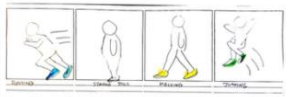
A illuminated color-changing shoe that helps coaches know the kicking posture of student soccer players.

Problem: Coahes have difficulty assesing their player's movement, and running speed.

Solution: Using polymeric optical fibers and textiles, the shoe's integrated design illuminates different colors to indicate the speed of the runner and the movement of the runner visually (walking, running, jumping, etc.). The movement is detected via accelerometers and various motion sensors, and the inputted data is analysed via AI to determine the type of movement.



Above left and right: The shoe's logo lights up red when the runner is waking at a certain speed, and lights up blue when running.



Above: This storyboard visualizes the different movements and consequential changes in lighting the shoe showcases. If the player is running it changes to blue, if he is not moving, no color is indicated.

The Society Of Boys' Centres Hui Chung Sing Memorial School

Group Members: Lee Sa Man, Hui Yam Cheung, Lo Ka Chun

A.I. SCULPTURE: THE TREE OF LIFE

It is an interactive AI structure promoting environment protection information that applied the POF textile to attract people's attention.

Problem: People have less interested to stay and appreciating the sculpture.

Solution: The balls with POF textile hanging on the sculpture will light up when the installed facial recognition detected there is someone getting closer and showing some environmental protection information. The ball and the structure will change their color according to the persons' clothes color in order to attract people's attention.

Above left and right: A prototype demonstrates the outlook of the sculpture.

Above left and right: The sketches show the design details and ideas of the sculpture.

BAG ZION: A WEIGHT-MONITORING BAG

A school bag which reminds the user to be aware of overloading it in order to protect the user's back from injury.

Problem: Primary students in Hong Kong always need to carry a lot of books to school. Their parents may be afraid that they may develop spinal problems over time.

Solution: Bag Zion can check whether its contents are overweight for the user in order to prevent potential spinal injury. The bag lights up red and initiates a alarm sound when the bag is overweight. If not, the bag lights up in green. A force sensor detects the weight of the bag. Overload is calculated according to data such as the user's height, age, and sex and an AI model is trained to statistically determine the optimal load for a specific user based on this data.

Above left and right: The FOP fabric lights up to indicate the state of the bearing weight.

Above: This storyboard visualizes thow the bag remind the user, and how it works.

Group Members: Hsu Po Yi, Tang Hoi Ying

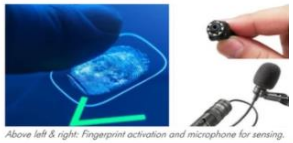
A.I.-ENABLED SMART WHEEL CHAIR

A smart wheelchair that recognizes voice input so that users can move on their own without the need of a caretaker.

Problem: Wheelchair users who have arm and leg problems and are unable to push their wheelchair on their own cannot use their wheelchairs on their own without a caretaker.

Solution: A smart wheelchair that recognizes voice input so that users can move on their own. POF is integrated into a seat cover with a local AI processing unit and lights up when the wheelchair is active. It utilizes a seat cover so that old wheelchairs can also be adopted. Besides voice recognition, the wheelchair also recognizes hand gestures so that the wheel chair can drive itself towards the user.

Above left & right: The "disabled" signage lights up to indicate that the smart wheel chair system is active and listening for voice input.



Above left & right: Fingerprint activation and microphone for sensing.

Group Members: Wong Lok Tung Christy

A.I.-ENABLED EMOTIONAL EXPRESSION SHIRT

A smart, AI-enabled shirt which utilizes color and illuminative textiles to display the emotion of its wearer.

Problem: People with certain neurocognitive disorders are unable to express their emotions to others through physical and verbal means, creating stress and communication issues.

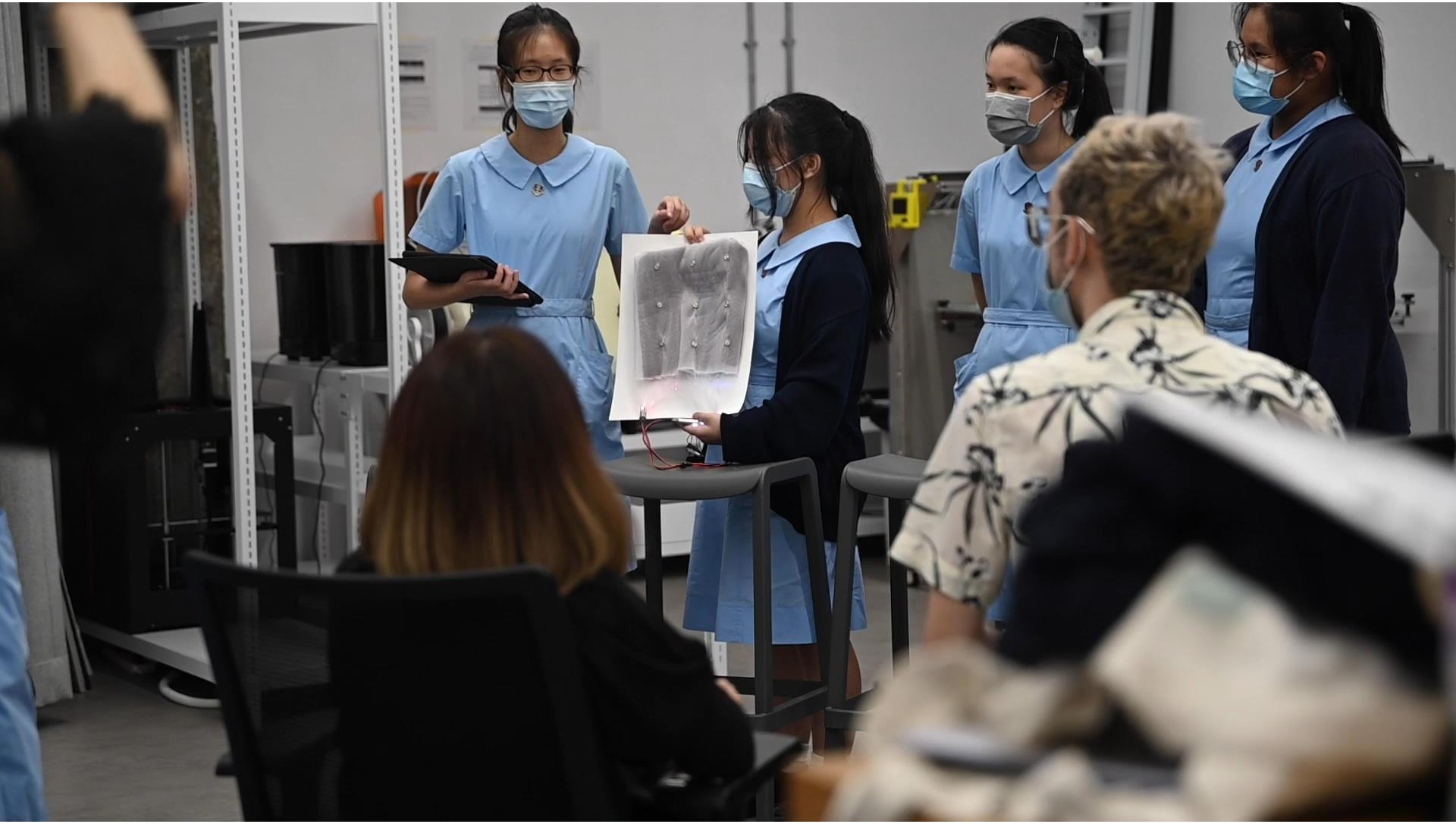
Solution: The shirt detects the emotion of its wearer through integrated heart rate and skin conductivity sensors which gather biometric information for an on-board AI-based emotion recognition model. When the emotion is recognized, the shirt illuminates using POF textiles and the color of the identified emotion, e.g. red for anger, etc. The design of the shirt showcases each emotion as a color and emoji as seen in the pictures of this poster. Through this, we hope that people with emotional problems can better express their emotions to others.

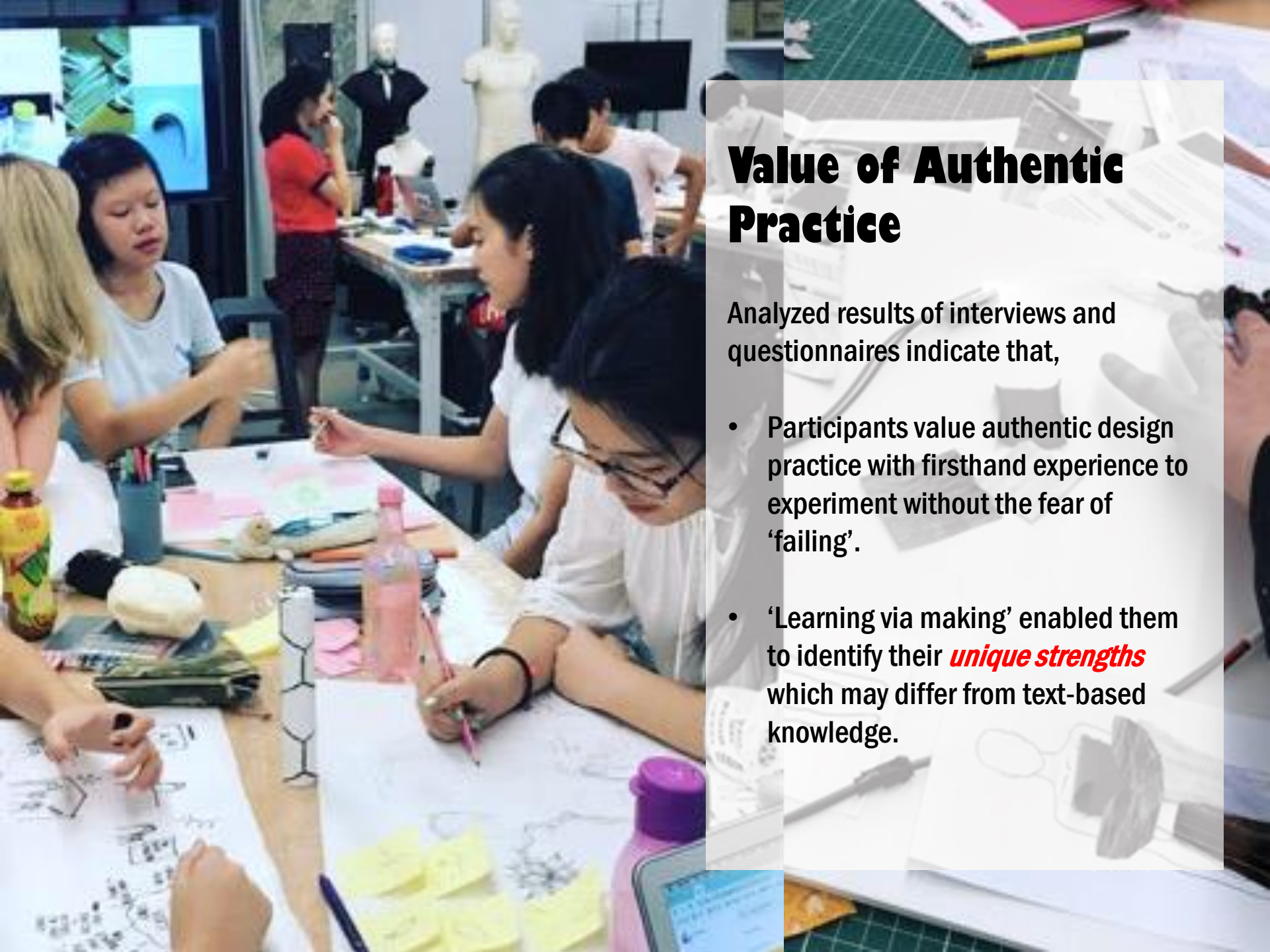
Above: These sketches indicate the way we integrated and designed the shirt and its components.

Group Members: Wai Yui Lam (SB), Fung Sze Ching (SD), Wong Ka Ying (SE)

Guided creativity via hybrid mode enables students to explore a ***diverse range of outputs*** that are relevant to their areas of interests.

Video of student workshops

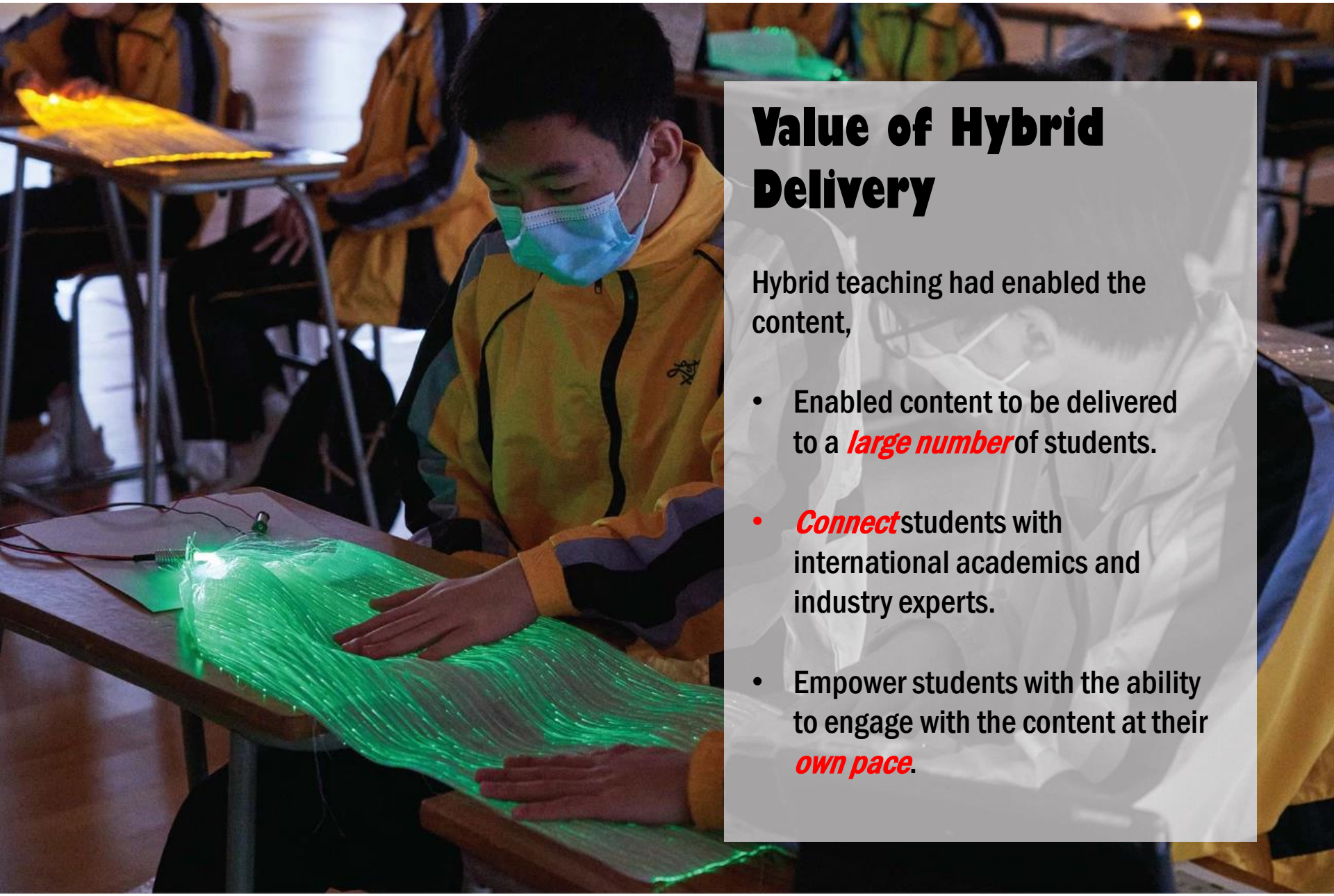




Value of Authentic Practice

Analyzed results of interviews and questionnaires indicate that,

- Participants value authentic design practice with firsthand experience to experiment without the fear of ‘failing’.
- ‘Learning via making’ enabled them to identify their ***unique strengths*** which may differ from text-based knowledge.



Value of Hybrid Delivery

Hybrid teaching had enabled the content,

- Enabled content to be delivered to a ***large number*** of students.
- ***Connect*** students with international academics and industry experts.
- Empower students with the ability to engage with the content at their ***own pace***.

Conclusion:

Hydrid content and Hybrid format has enabled STEM content to be ***inclusive and accessible*** for all students.

www.drjeannetanresearch.com

www.dstem.net