香港教育大學
The Education University of Hong Kong

A Project entitled

Applying STEM education in redesigning human organs for improving the motivation of biology students in biological scientific inquiry

Submitted by

Lee Ching Suet

submitted to The Education University of Hong Kong

for the degree of Bachelor of Education (Honours) (Science)

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Declaration

I, Lee Ching Suet declare that this research report represents my own work under the supervision of Dr. YEUNG Chi Ho, and that it has not been submitted previously for examination to any tertiary institution.

Signed ____ ___

Lee Ching Suet

06th April, 2023

Abstract

This project comes from the idea of whether a human organ could be improved upon. In the lessons, I provided different perspectives to the students, such as heart disease and longevity as a rationale for the need for the redesign of the human body. The students selected their own favourite part of the heart to redesign in order to optimize the efficiency of the anatomical structural, physiological function, and/or the aesthetic and functional morphology; a redesign that might lead to, for example, lower risk of heart attack, and/or stroke. Through group work and interaction, students actively engaged in the learning process in order to understand the function and the structure of design in the functionality and vulnerability to disease of the human organ. By means of the design of such a curriculum for biology students through STEM education (design thinking process), it is hoped that students would be inspired to develop an interest in learning biology.

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1. Introduction

More than half of the DSE Biology curriculum focuses on human organs and human systems. Yet, many students who study the subject are just examination-oriented and not because of interest in it. Learning can be fun and enriching and not just confined to traditional mechanical classroom teaching and test-doing (Ratnam-Lim & Tan, 2015).

Studies have shown that STEM education can play a major role in changing some study habits and enhancing students' motivation. Regarding the application of STEM Education to Biological Science Inquiry, stimulating students' learning motivation should change from teacher-centered to student-centered. Having said that, simply increasing the integration of STEM disciplines may not necessarily be more effective if it is without a strategic approach to implementation.

2. Literature Review

According to International Education Research, redesigning the human body system is an effective teaching strategy to promote active learning and STEM education (Cherif, et al., 2012). Students can be actively engaged in the learning process to understand the role of design in the efficiency and function of the body's systems and susceptibility to disease. Most children in Hong Kong are exposed to STEM programs nowadays, including robotics teaching coding, and computer programming STEM education. Yet, there is a lack of STEM activity when it comes to talking about human organs and human systems. (Kim & Yuan, 2015). In light of this, this capstone project is designed to fill this gap and tries to examine whether applying STEM education to redesign human organs can increase biology students' motivation in exploring biological sciences. On the contrary, well-integrated instruction provides opportunities for students to learn in more relevant and stimulating experiences, encourages the use of higher levels of critical thinking, promotes imaginative problem-solving skills, and improves retention of knowledge (Stohlmann et al., 2012).

3. Introduction of the course

3.1 Rationale behind the lesson design

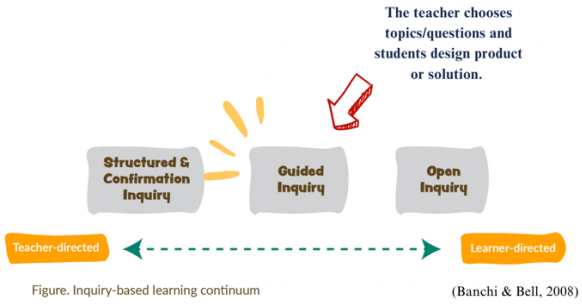

Figure 1: Inquiry-based learning continuum, based on Banchi and Bell, 2008

The lesson design follows the idea of Banchi and Bell (2008), which identifies different levels of inquiry, with varying degrees of teacher guidance. In applying guided inquiry (see in Figure 1) to learning about the human heart, student should learn how to identify the structure of the heart. The teacher creates a design thinking process that will guide students to achieve the teaching contact. The teacher will also supply extra knowledge for students to build up their basic knowledge. That means the teacher will choose the topics and guide students to design the product or solution based on the problem.

Inquiry-based learning is a student-centered approach, in which students play an active and participatory role in their own learning. At the end of the inquiry cycle, students reflect on "How the lesson connects to other topics of interest?" An inquiry on one topic often results in more questions and then further inquiry into new fields (Magnussen, Ishida & Itano, 2000). The learning in this model includes multiple content areas so that students can see how problem-solving can happen in the real world – and, ideally, in their own worlds.

3.2 Lesson design

Integration emphasizes the adoption of different disciplinary practices, allowing students to experience in STEM education what scientists and engineers tend to think and do during

their investigation and problem-solving process and is a self-directed approach. The important point is to cultivate students' ability to solve different problems in real-life scenarios. Moreover, integration is designed to enhance student learning and achieve positive learning outcomes. Such scientific investigation process and engineering design process are the essence in my lesson design.

3.2.1 Idea of the lesson design

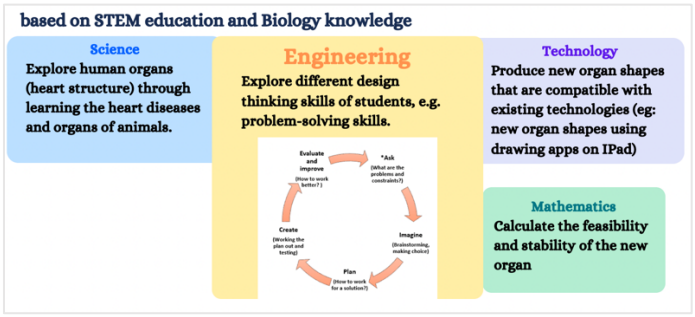

Figure 2: Lesson idea based on STEM education principles

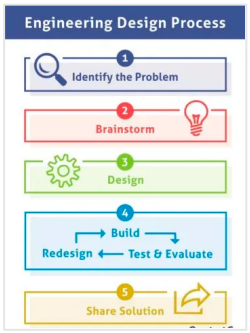

Figure 3: Engineering Design Process

Areas of study involved	Learning Objectives (Students should be able to learn…)	
Incorporate art into the more-familiar STEM model, which includes science, technology, and art.	Knowledge (K)	1. The function of the different organs in the human body. 2. The structure of the organs
	Skill (S)	1. Teach the basics of problems or diseases from the heart 2. Draw a heart shape showing at least 2 changes that redesign the heart's structure and function. (consisting of height, width and depth).
	Attitude (A)	1. Promote understanding and application to life and involve connecting new ideas to known concepts and principles 2. Solve problems in unfamiliar situations, and evaluate potential solutions to complex problems.

Table 1: Areas of study involved and learning objectives

With regard to the concept of curriculum design based on the structure of STEM education (see in Figure 2), I have particularly focused in this project on the “Engineering Design Process”, which is a step-by-step process in problem-solving through the creation of a product with a specific function (see in Figure 3). During the lessons, students need to learn

about the characteristics of the target audience or the disease for whom they are designing. For example, through learning heart disease knowledge, biological engineering in the heart, and the comparison of different animal heart structures, etc., extra-curriculum knowledge can be provided to students (see in Table 1). Students need to develop their own point of view that is based on user needs and insights. The aim is to foster the students to brainstorm, design, and also redesign their product. Last but not least, students need to share their prototype idea with their classmates for feedback.

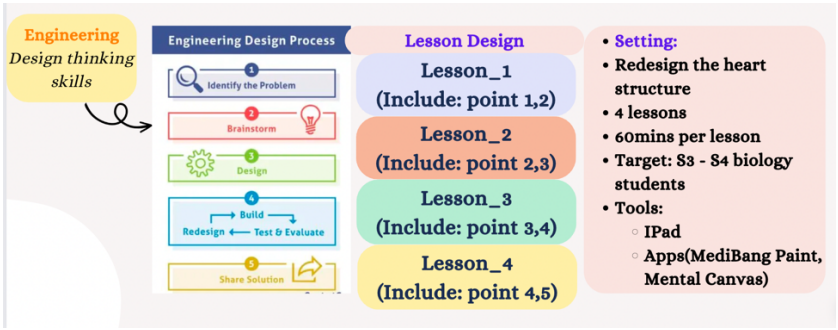

Figure 4: Original draft of the lesson design

In the original draft of the lesson design, this course was planned to cover the whole engineering design process in 4 lessons (see in Figure 4), with a duration of 60 minutes per lesson. The target group was Form 3 or Form 4 students who were studying Biology.

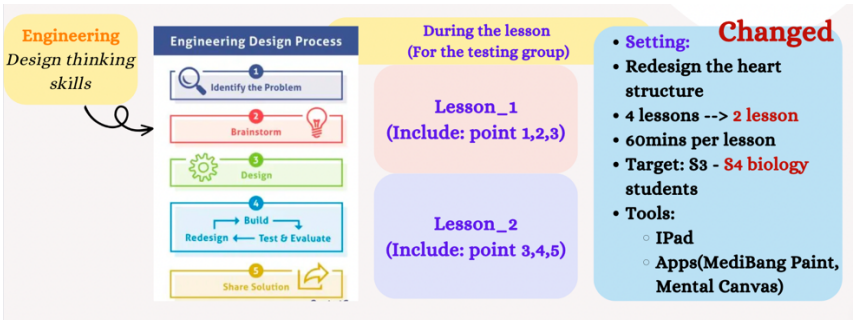

Figure 5: Tailor-made lesson design for the testing group

The target group in the end was CMI school secondary four students who studied biology. Actually, all participants had prior knowledge of heart structure. The total number of the participants was 23 students. A syllabus was also provided to the test group, following the new lesson design, which would be conducted in 2 lessons due to the constraints brought by

COVID-19 and the normal teaching timeslot. This is different from the original plan (see in Figure 5). (Please refer to the Appendix 8 for the teaching package).

3.2.2 Materials for the teaching package

During my preparation work, I have compiled materials for the teaching package. which include exemplars on learning and teaching activities, pre-test and post-test, lesson plans, teachers and students' worksheets, the PowerPoint, the technical support materials, Apps (MediBang Paint and Mental Canvas) with the apps drawing guideline. The padlet.com was used to group all the learning materials for students to review. (Please refer to the Appendix 2-8 for the teaching package)

Teaching content was modelled according to the level of learning of the test group.

Lesson 1

In lesson 1, the learning objectives, which follow the engineering design process, include the identification of problems, brainstorming, and design. The topic is to redesign the structure and function of human organs, explain the function and basic structure of the heart and blood vessels, etc. The objectives are mainly to allow students to identify the problem and provide some idea to student to facilitate the brainstorming for the redesign blueprint.

Lesson 2

In Lesson 2, the learning objectives cover the "design, build, and redesign" parts of the engineering design process. In the process, students learn how to design a reconstructed human (heart) organ, as well as redesign and build a human heart model. In this class, students are required to present their prototype ideas to their classmates for feedback.

4 Evaluation

Quantitative (pre-test and post-test questionnaire) and qualitative (interview) tests were conducted to measure the changes in various parameters of the students before and after the course.

4.1 Pre-test and Post-test (Questionnaire)

4.1.1 Methodology

Pre-test and post-test by questionnaires were administered to measure different parameters of the students before and after the lessons. Statistical analysis was then carried out to see if there were significant changes in these parameters, including students' leaning motivation, students' interest in the teaching content, and students' knowledge improvement (Please refer to the Appendix 2 for the Pre-test and Post-test Questionnaire).

3.1.1 Result

4.1.2.1 Mastery of the knowledge of the heart structure

t-Test: Paired Two Sample for Means		
	Pre-test	Post-test
Mean	2.434782609	3.565217391
Variance	1.802371542	1.075098814
Observations	23	23
Pearson Correlation	0.533815249	
Hypothesized Mean Difference	0	
df	22	
t Stat	-4.596194078	
P(T<=t) one-tail	7.03235E-05	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.000140647	
t Critical two-tail	2.073873068	

Table 2: Mastery of the knowledge of heart structure

Paired two sample t-test was administered to test whether the students showed a difference in their mastery of the knowledge of heart structure in the pre-test and the post-test. The result showed an increase in knowledge of the students and the increase was statistically significant difference ($p<0.05$) (see Table 2).

4.1.2.2 Motivation in learning biology

t-Test: Paired Two Sample for Means		
	Pre-test	Post-test
Mean	1.869565217	2.565217391
Variance	0.754940711	0.802371542
Observations	23	23
Pearson Correlation	0.391044357	
Hypothesized Mean Difference	0	
df	22	
t Stat	-3.425395354	
P(T<=t) one-tail	0.00121	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.002420001	
t Critical two-tail	2.073873068	

Table 3: Students' motivation in learning biology

Paired two sample t-test was administered to test whether there was an increase in the students' motivation in learning biology in the pre-test and the post-test. The result was positive and the difference was statistically significant difference ($p<0.05$) (see Table 3).

4.1.2.3 Students' interest in the course

t-Test: Paired Two Sample for Means		
	Pre-test	Post-test
Mean	2.391304348	3.217391304
Variance	1.067193676	2.723320158
Observations	23	23
Pearson Correlation	0.561078817	
Hypothesized Mean Difference	0	
df	22	
t Stat	-2.891366459	
P(T<=t) one-tail	0.004235771	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.008471543	
t Critical two-tail	2.073873068	

Table 4: Students' interest in the course

Paired two sample t-test was administered to test whether the students in the test group showed an increase in interest in the course. The result was positive and the difference was statistically significant difference ($p<0.05$) (see Table 4).

4.1.2.4 Helping students' difficulties in learning biology

t-Test: Paired Two Sample for Means		
	Pre-test	Post-test
Mean	2	2.652173913
Variance	0.818181818	0.509881423
Observations	23	23
Pearson Correlation	0	
Hypothesized Mean Difference	0	
df	22	
t Stat	-2.714050742	
P(T<=t) one-tail	0.006336156	
t Critical one-tail	1.717144374	
P(T<=t) two-tail	0.012672313	
t Critical two-tail	2.073873068	

Table 5: Helping students' difficulties in learning biology

A t-test was administered to test if this course could solve students' difficulties in learning biology. According to the result, the testing group showed a positive and statistically significant difference ($p<0.05$) (see Table 5).

4.1.2.5 Relationship between motivation and student interest in the course

Correlations

Correlations

		Post-T student Motivation	Post-T Student interested in my course
Post-T student Motivation	Pearson Correlation	1	.251
	Sig. (2-tailed)		.247
	N	23	23
Post-T Student interested in my course	Pearson Correlation	.251	1
	Sig. (2-tailed)	.247	
	N	23	23

Table 6: Correlation between motivation in learning biology and students' interest in the course

To analyze the relationship between motivation in learning biology and students' interest in the course, the SPSS software was used to carry out the quantitative analysis of the complex data. The correlation was .251, showing a positive but low correlation (see Table 6).

4.1.2.6 Relationship between motivation and mastery of knowledge

Correlations

Correlations

		Post-T student Motivation	Post-T Student Score in Ch.9 (heart structure)
Post-T student Motivation	Pearson Correlation	1	.277
	Sig. (2-tailed)		.201
	N	23	23
Post-T Student Score in Ch.9 (heart structure)	Pearson Correlation	.277	1
	Sig. (2-tailed)	.201	
	N	23	23

Table 7: Correlation between the motivation in learning biology and score of the post-test score in the Ch.9(heart structure)

The relationship between the motivation in learning biology and score of the post-test in the mastery of knowledge of the heart structure was analyzed by using the SPSS software. The correlation was .277 showing a positive but low correlation (see in Table 7).

4.1.3 Discussion

The p-values of all the statistical analysis are lower than 0.05 ($p<0.05$), showing that the differences are all statistically significant differences. Biology syllabus in the Hong Kong secondary schools generally does not include contents such as different animals' heart structures and redesign methods. Yet, such contents may increase the students' learning interest and motivation, or even increase their motivation in biological scientific inquiry.

The result shows a positive but low correlation between the motivation in learning biology and the post-test score in the mastery of knowledge of the heart. Moreover, the correlation between motivation in learning biology and students' interest in the course is also positive, even though it is a low correlation. This is probably due to the time constraints and the small sample size, which will be further discussed in the limitation section.

All the testing groups were able to redesign the human heart organ by following the engineering design thinking progress. Some of the groups finished the redesigned human heart product within two lessons only (Please refer to Appendix 9 for the students' product).

3.2 Interview

3.2.1 Methodology

The second data collection method in this study was interview with the 23 students in the testing group. The interviews were carried out after the course.

3.2.2 Result

All the interviewees responded that the course was innovative. For examples, students pointed out it was "very creative" and it was an "innovative course" (Please refer to Appendix 10 for the interview question with the feedback). Some of the responses are extracted below:

"Very creative! My favourite part of the course is that I can use the app to redesign the heart structure." (Student A)

"It was an innovative course and my favourite part was comparing the structure of the human heart to different animals. I realized that not all animals have two circulatory systems in their bodies." (Student B)

"I think it successfully implements new ideas for us to study the structure of the heart." (Student C)

Moreover, all the interviewees responded that they were interested in biological scientific inquiry. Students reflected that they hoped to do more experiments in the upcoming courses and found it interesting to do biological research:

"This is another way for us to learn the structure of the heart because I usually look at the model to learn the structure of the heart structure only, this is the first time I have tried to redesign the heart structure with my group mates. I hope to do more experiments in the upcoming courses."(Student A)

“Because I hope to do more experiments in the upcoming courses. Just like the structure of the heart. Interestingly, the structure of the hearts of other animals can be further studied.” (Student B)

“I find it interesting to do biological research, and I might try to read more about human organs and biotechnology in Hong Kong.” (Student C)

3.2.3 Discussion

The interview responses show that most of the students agreed that the project was innovative and creative. Moreover, the project has increased their motivation in biological scientific inquiry.

5 Limitation and suggestions for the course

5.1 Time constraints

Practical difficulties limit the time available to explore the research questions and monitor changes. The reason why a 60-minute session per lesson was designed was because that was the normal teaching timeslot. This is different from the original plan. Moreover, because the participating school was not able to provide four lessons during the COVID-19, the plan has to be modified from four lessons to two lessons. Lesson 1 included contents of problem identification, brainstorming, and design process. The design, redesign and presentation were included in lesson 2.

Suggestion for the first limitation: The lessons can be arranged after school. The students can join the lesson after school or use the online platform to preview the handout by themselves.

5.2 Insufficient sample size for statistical measurements

The testing group only had 23 students. The sample size was too small to test significant relationships in the data.

Suggestion for the second limitation: Statistical tests require a larger sample size to ensure that the sample is considered representative of a population and that the statistical result can be generalized to a larger population. Future studies can consider enlarging the sample size.

5.3 Student's learning diversity

There was a difference in the ability and learning speed of students, causing discrepancy in the learning outcomes.

Suggestion for the third limitation: Students can be divided into two groups based on the pretest of their abilities; groups with lower abilities can be provided with learning support.

6. Conclusion

Applying STEM education to redesign human organs is shown to be effective in arousing biology students' enthusiasm in biological scientific inquiry. However, other factors can also affect students' motivation to study biology, such as teachers' teaching methods, and so on. The result of this project supports the idea that STEM education can be applied to biology classes to keep students engaged during class.

(2307 words)

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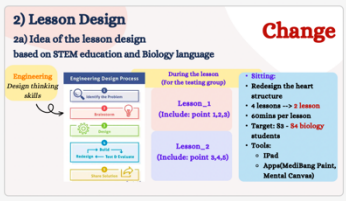
8. Appendices:

8.1 Appendix 1: Presentation PowerPoint



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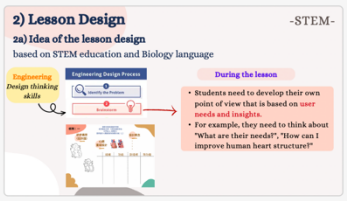

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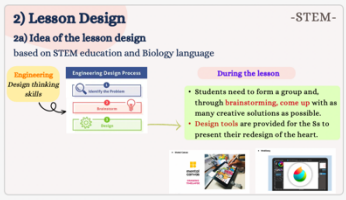

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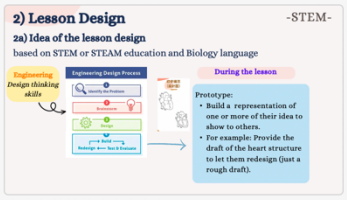

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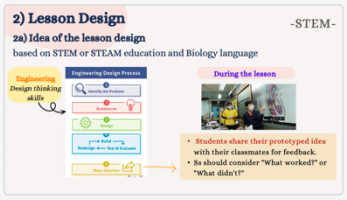

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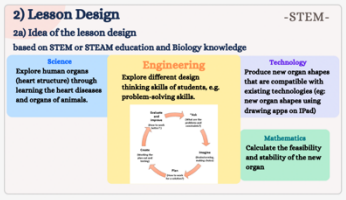

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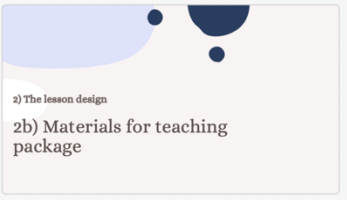

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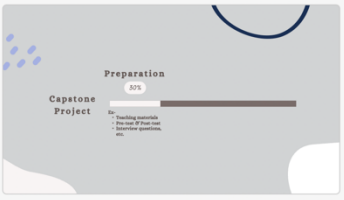

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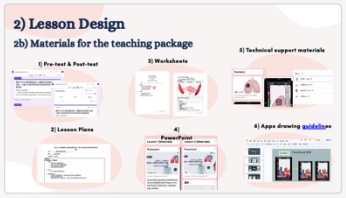

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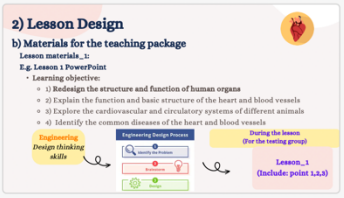

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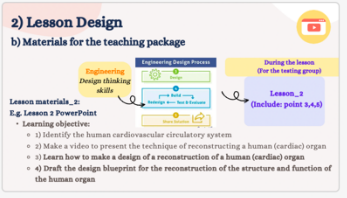

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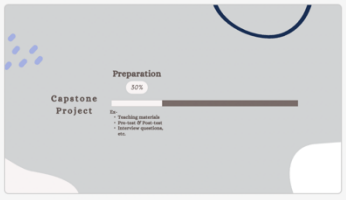

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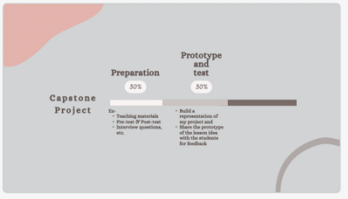

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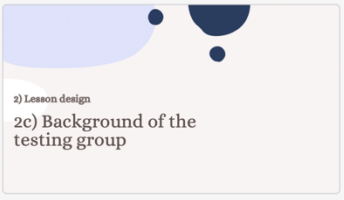

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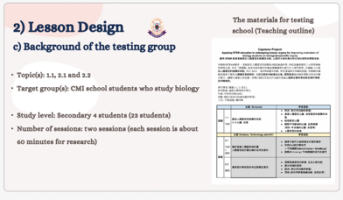

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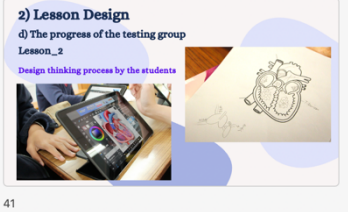

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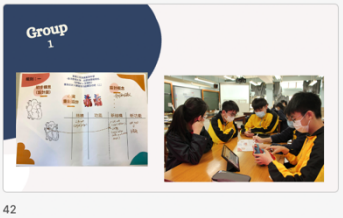

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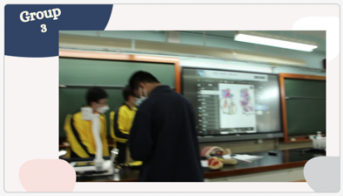

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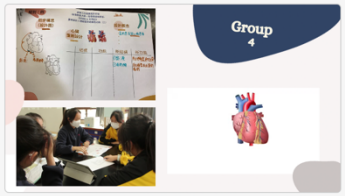

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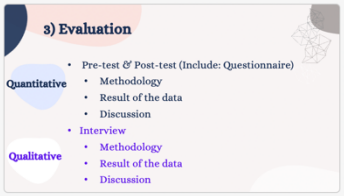

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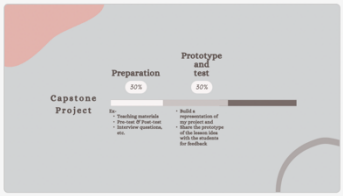

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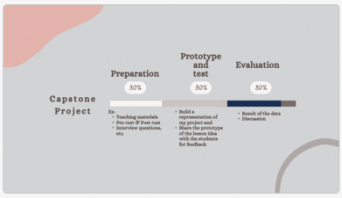

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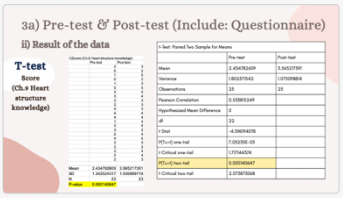

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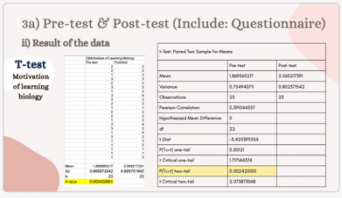

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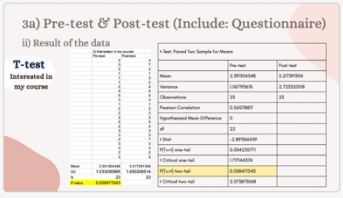

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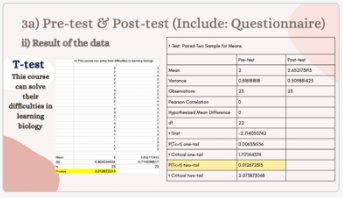

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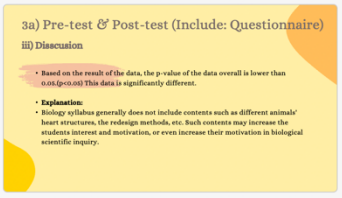

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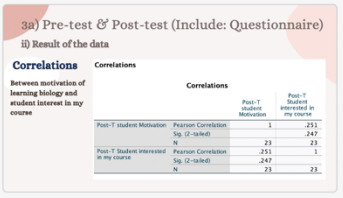

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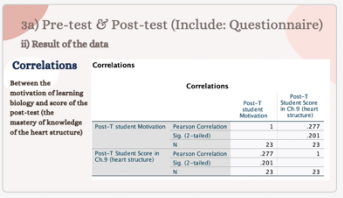

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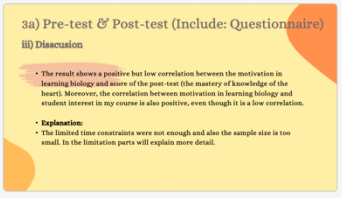

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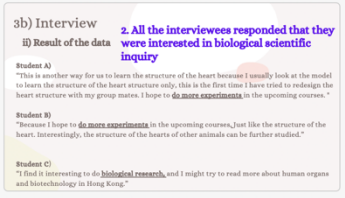

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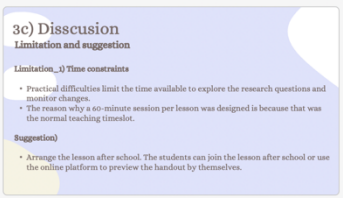

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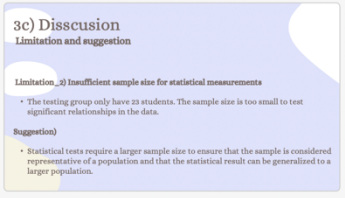

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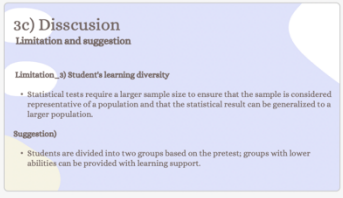

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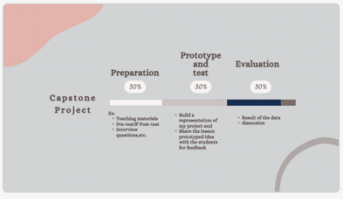

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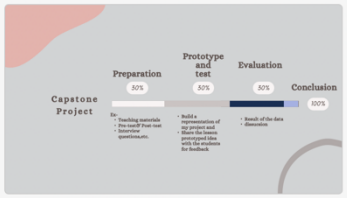

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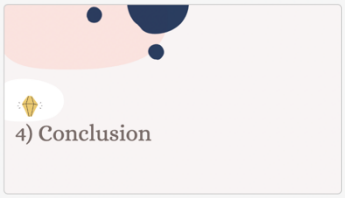

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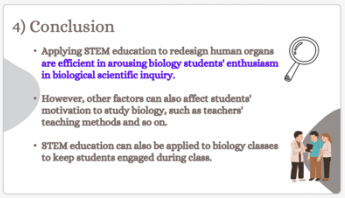

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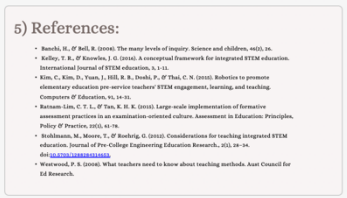

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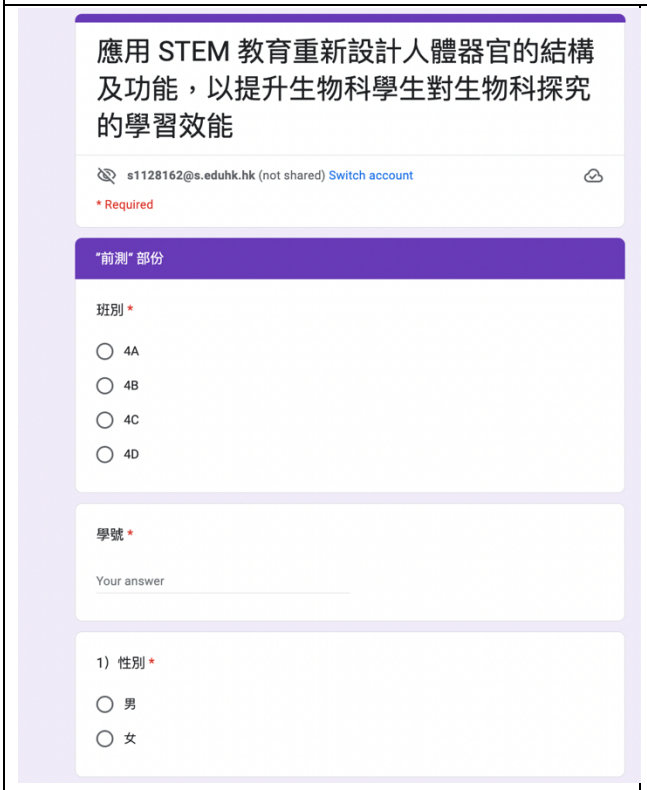
8.2 Appendix 2: The pre-test and post-test question (Questionnaire)

Part 1: **Motivation in learning biology and showing interest in the course**



應用 STEM 教育重新設計人體器官的結構及功能，以提升生物科學生對生物科探究的學習效能

s1128162@s.eduhk.hk (not shared) Switch account

* Required

"前測" 部份

班別 *

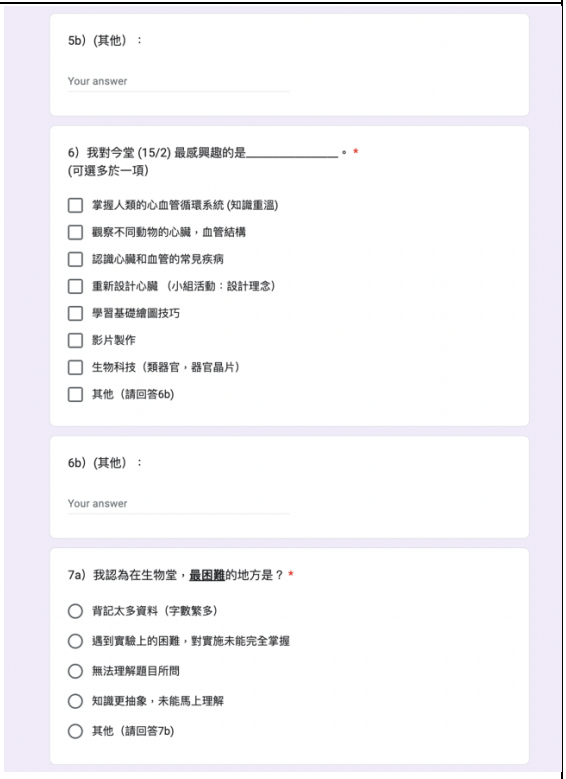
- 4A
- 4B
- 4C
- 4D

學號 *

Your answer

1) 性別 *

- 男
- 女



5b) (其他) :

Your answer

6) 我對今堂 (15/2) 最感興趣的是_____。 *
(可選多於一項)

- 掌握人類的心血管循環系統 (知識重溫)
- 觀察不同動物的心臟，血管結構
- 認識心臟和血管的常見疾病
- 重新設計心臟 (小組活動：設計理念)
- 學習基礎繪圖技巧
- 影片製作
- 生物科技 (類器官，器官晶片)
- 其他 (請回答6b)

6b) (其他) :

Your answer

7a) 我認為在生物堂，**最困難**的地方是？ *

- 背記太多資料 (字數繁多)
- 遇到實驗上的困難，對實施未能完全掌握
- 無法理解題目所問
- 知識更抽象，未能馬上理解
- 其他 (請回答7b)

2) 我每週課後，接觸生物知識的時間 (小時) *

- 0 - 2 小時
- 3 - 5 小時
- 6 - 8 小時
- 9 - 10 小時
- 10 小時以上

3) 我對生物第九課 心臟結構的掌握程度 *

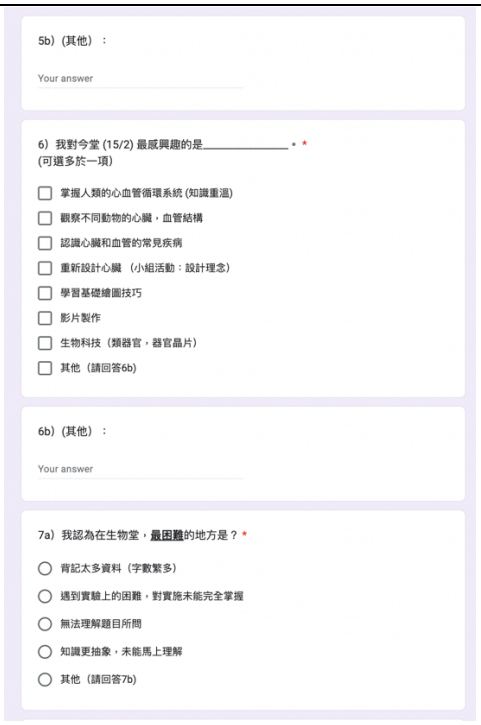
	1	2	3	4	5	
未能掌握	○	○	○	○	○	完全掌握

4) 我對生物科的感興趣的程度 *

	1	2	3	4	5	
完全不感興趣	○	○	○	○	○	十分感興趣

5) 我認為(這樣)_____的生物課才能引起我的學習動力/動機。 *

- 能夠學習生物冷知識
- 研究感興趣的題目
- 學習科學實踐技能與解決問題的能力
- 多樣化學習 (包括靜態和動態)
- 其他 (請回答5b)



5b) (其他) :

Your answer

6) 我對今堂 (15/2) 最感興趣的是_____。 *
(可選多於一項)

- 掌握人類的心血管循環系統 (知識重溫)
- 觀察不同動物的心臟，血管結構
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- 影片製作
- 生物科技 (類器官，器官晶片)
- 其他 (請回答6b)

6b) (其他) :

Your answer

7a) 我認為在生物堂，**最困難**的地方是？ *

- 背記太多資料 (字數繁多)
- 遇到實驗上的困難，對實施未能完全掌握
- 無法理解題目所問
- 知識更抽象，未能馬上理解
- 其他 (請回答7b)

7b)（其他）：

Your answer

8）我認為用以下方法能幫助我學習：*
(可選多於一項)

- [ ] 有效筆記（顏色強調內容/用顏色間字幫助學習）
- [ ] 網上學習資源（如短片）
- [ ] 自主學習（自行進行資料蒐集）
- [ ] 製作及設計個人化項目（如：進行匯報）
- [ ] 其他（請回答7b）

8b)（其他）：

Your answer

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Part 2: **Ch.9 Heart structure knowledge**

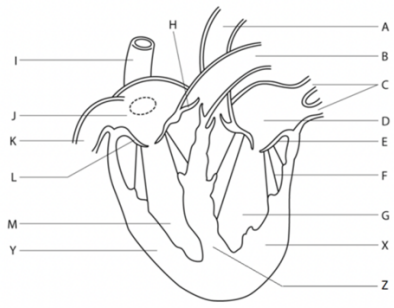
對生物知識的理解

內容：第九課 人體內物質的轉運

1) 為什麼人體血液循環被稱為雙循環？*

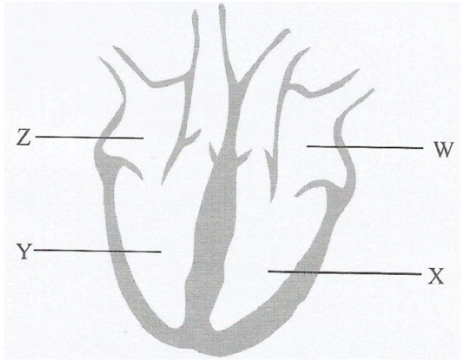
- A) 右心室收縮兩次。
- B) 血液流經心房和心室。
- C) 血液流經心臟兩次。
- D) 心房和心室交替收縮。

2)圖示人類心臟的縱切面。*
辨別構造F。



Your answer

3) 圖顯示心臟的切面：*
當W收縮時，以下哪個有關心瓣狀況的組合是正確的？



- 二尖瓣：張開；半月瓣：張開
- 二尖瓣：關閉；半月瓣：關閉
- 二尖瓣：張開；半月瓣：關閉
- 二尖瓣：關閉；半月瓣：張開

4) 以下哪一個是冠心病的病徵呢？*

- [ ] 95%堵塞會出現斑塊破裂，引致血栓。
- [ ] 血流速度加快。
- [ ] 嚴重的冠心病，導致心肌梗塞。

5) 當心室收縮時，心室與心房之間的心瓣關閉。以下哪項是心瓣關閉的原因？*

- A) 心腱索固定心瓣的位置。
- B) 心房再次充滿血液時，將心瓣推向閉合。
- C) 心瓣關閉以防止血液倒流入心臟。
- D) 心室在收縮時產生較高的血壓，將心瓣推向閉合。

課外知識題
6) 說明哺乳類動物及魚類心臟結構上的分別

Your answer

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應用 **STEM** 教育重新設計人體器官的結構及功能，以提升生物科學生對生物科探究的學習效能

教案

主題 ：_____人體器官的結構和功能_____

課題 ：__1.1 心臟及血管___

教學時間:60分鐘/節

學習目標:
完成本課堂後，學生應能夠:

A. 知識(K)
   1. 掌握人類的心血管循環系統
   2. 說明心臟，血管的功能和基本結構
   3. 探討不同動物的心血管循環系統
   4. 認識心臟和血管的常見疾病

B. 技能(S)
   1. 設計人體器官的結構圖及功能

C. 價值觀及態度(A)
   1. 促進對生活的理解和應用，並將新想法與已知概念和原則聯繫起來
   2. 尋求具創意或創新的成果
   3. 觀賞學生自己和他人的藝術作品，並對自己的作品和學習過程不斷反思和評估

課程相關學習領域的知識範圍及學習元素：

科學教育	9.1 運送系統的重要性 9.2 血液 9.3 血管 9.4 心 9.5 血液循環
科技教育	多媒體的運用 • 利用繪圖軟件塑造出心臟部的外部及內部結構圖，例如繪畫心臟 • 製作影片，以介紹器官重新設計的結構及其功能。
藝術教育	試驗不同藝術媒介和過程（例如繪畫） • 加入雕塑的元素

學生對概念理解的誤解：

1. (錯誤) 所有血管都具有瓣膜。
   (正確) 只有靜脈、大動脈及肺動脈（和心室相接處有瓣膜）都具有瓣膜。

建議學習階段：
中四年級（另設適合高階能力學生的延伸活動）

已有知識：
對人體的營養過程與消化系統的構造，及循環系統具有基本概念

時間 （分鐘） **60分鐘 (30)**	教學目的	重點內容	教學流程 （指示、提問、回應等） 教師	學生	工具 / 備註
引言					
0-10 分鐘 (10 分鐘)	K1	• 列出課堂學習目標及介紹課程	單元學習目標: • 透過重新設計描述及解釋心臟或血管的結構和功能上的轉變。 1. 課堂守則 2. 介紹課程: • 簡單介紹 “Capstone Project”研究的目的 • 整個課程學習內容及目標 • 課堂守則 • 今堂課堂流程 3. 課堂引入: • 以 “前測” 作引入 • 開啟 Google form 進行。 4. 然後向學生介紹今課堂進行重新設計心臟的結構及功能。	1. 填寫同意進行研究書及回答“前測的問題” 2. 到 google forms.com 進行。	• 簡報 • “前測” 回答 Google form的多項選擇題

拓展					
11-20 分鐘 (15 分鐘)	K1, K3 S1	• 心臟功能 • 心臟內部及外部結構	• **人類的心血管循環系統** **1.** 練習活動—**1**:《模擬人體血管結構及功能》 圖片: "動脈", "微血管", 及 "靜脈" 1) 學生抽出題目(適應性及功能) 2) 該組學生到黑板前, 配對出合適的答案 3) 填寫正確的答案在工作紙上 • **人類的心臟內部及外部結構** **2.** 練習活動—**2**:《標示心臟結構圖 心臟內部及外部結構》: 1) 教師向學生展示心臟的結構圖 2) 測試學生對心臟結構的熟悉程度: 讓學生在工作紙上的心臟結構圖, 加上正確的標示。 3) 教師向學生展示及解釋正確的心臟結構圖。 **3.** 心臟各個結構的功能: 展示心臟的功能, 播放約一分半鐘的影片, 讓學生掌握心臟的結構及功能部分, 及心跳及血流方向。 https://www.youtube.com/watch?v=R9Stt8HRTRU	1. 學生聆聽老師的教學 2. 練習活動—**1**: • 回答問題, 部分同學抽出題目(適應性及功能) • 學生需到黑板前, 配對出合適的答案包括:"動脈", "微血管", 及 "靜脈" 組別。 • 填寫正確的答案在工作紙上 3. 練習活動—**2**:在工作紙上的心臟結構圖, 加上正確的標示。 4. 留意影片, 並在工作紙上, 加上正確的標示。	• 簡報 • 工作紙 • 組牌 • 影片 (https://www.youtube.com/watch?v=R9Stt8HRTRU)

21-30 分鐘 (10 分鐘)	K3 C1	• 觀察不同動物的心臟，血管結構 • 增加學生對不同生物心臟結構的認識 • 認識心臟和血管的常見疾病	• 探討不同動物的心血管循環系統 (不同動物的心血管內部及外部結構) 1) 教師向學生展示 不同動物的心血管的結構圖，包括魚，青蛙等。 2) 增加學生對不同生物心臟結構的認識 3) 邀請學生分享：就觀察所得，比較不同動物與哺乳類動物的心臟結構分別 4) 教師向學生作解釋 • 認識心臟和血管的常見疾病 1) 介紹常見血管疾病 2) 心血管疾病是一組心臟和血管疾患，例如： 3) 冠心病：心肌供血血管的疾病 4) 風濕性心臟病：由鏈球菌造成的風濕熱對心肌和心臟瓣膜的損害 5) 先天性心臟病：出生時存在的心臟結構畸形等	1. 學生聆聽老師的教學 2. 就觀察所得，比較不同動物與哺乳類動物的心臟結構分別	
加強					
31-50 分鐘 (20 分鐘)	K2，S2，A1	• 運用學習探索的技巧	重新設計心臟 - 小組活動：設計理念： 1. 重新點出對背後的研究目的，例如：	1. 學生聆聽老師的教學	• 簡報 • 工作紙 • 設計工

			• 令同學從中得到啟發，尋求具創意或創新的成果 • 提高對生物探究的興趣 2. 說明重新設計人體器官的結構及功能 • 設計需包含以下項目： 1) 心臟的結構圖 （短片形式） 2) （包含： a) 外部 b) 內部 c) 內部放大圖（最少兩張） d) 重新設計（最少兩項設計及其功能） • 時限：5分鐘 • 小組討論（搜集資料）：3分鐘 • 描述/繪畫：2分鐘	2. 分組，解剖不同動物的部分 3. 拍照及完成工作紙（繪畫器官的特徵，比較與人體的異同。）	作紙（草圖）
總結					
51-55 分鐘 (5 分鐘)	A2，A3	• 預告重新設計的器官 • 接觸基礎的繪圖技巧 • 預告下堂內容	• 預告_接觸繪圖的技巧 1. 預告各小組需在最後一堂匯報- 重新設計的器官。當中包括： - 重建該器官的立體設計圖； - 匯報時間：5分鐘加3分鐘問答 - 簡報（平面圖加標示，新加的功能）； - 每組需至少為該器官加入2項新結構及功能（可參考其他動物的特徵及功能）；	1. 學生聆聽老師的教學及注意事項 2. 小組討論	• 簡報 • 工作紙

			2. 所有最終設計會上載至 Padlet.com 讓同儕互評及欣賞。 ● 預告下堂內容 3. 簡單介紹 2 組推介的軟件供同學使用，包括：（Mental Canvas + MediBang)		
56-58 分鐘 (2 分鐘)	- 學生回顧這堂課所學內容	● 學生回顧這堂課所學內容 ● 總結課堂	1. 教師和學生重溫課堂重點，並預告餘下的課堂內容	1. 學生聆聽老師的教學及注意事項	● 簡報

教學資源：

1. 生物教科書 (作參考之用) - 香港中學文憑生物學: 概念互通5 (2019年版)
2. 牛津大學出版社

所需教具 / 教材：

- 簡報
- 活動工作紙
- 電腦
- 平板電腦
- 實體3D 心臟模型
- 3D model 網頁

應用 STEM 教育重新設計人體器官的結構及功能，以提升生物科學生對生物科探究的學習效能

教案

主題 ：_____人體器官的結構和功能_____

課題 ：__2.1 擬訂重建人體器官設計圖 及 2.2 重新設計器官設計作品匯報及展示_

教學時間：60分鐘/節

學習目標：
完成本課堂後，學生應能夠：

A. 知識(K)
1. 掌握人類的心血管循環系統
2. 製作影片介紹重建人體心臟器官

B. 技能(S)
1. 人體器官設計圖加建的技巧及製作
2. 擬訂重建人體器官設計圖

C. 價值觀及態度(A)
1. 促進對生活的理解和應用，並將新想法與已知概念和原則聯繫起來
2. 尋求具創意或創新的成果
3. 觀賞學生自己和他人的藝術作品，並對自己的作品和學習過程不斷反思和評估

課程相關學習領域的知識範圍及學習元素：

科學教育	9.1 運送系統的重要性 9.2 血液 9.3 血管 9.4 心 9.5 血液循環
科技教育	多媒體的運用 ● 利用繪圖軟件塑造出心臟部的外部及內部結構圖，例如繪畫心臟 ● 製作影片，以介紹器官重新設計的結構及其功能。
藝術教育	試驗不同藝術媒介和過程（例如繪畫） ● 加入雕塑的元素

建議學習階段：
中四年級（另設適合高階能力學生的延伸活動）

已有知識：
對人體的營養過程與消化系統的構造，及循環系統具有基本概念

時間 （分鐘） **60分鐘 (30)**	教學目的	重點內容	教學流程 （指示、提問、回應等） 教師	學生	工具 / 備註
引言					
0-5 分鐘 (5 分鐘)	K1, C1	• 列出課堂學習目標及介紹課程	單元學習目標： • 透過重新設計描述及解釋心臟或血管的結構和功能上的轉變。 1. 課堂守則 2. 介紹課程： • 簡單介紹 “Capstone Project”研究的目的 • 整個課程學習內容及目標 • 課堂守則 • 今堂課堂流程 3. 重溫部分：人類的心臟，血管的功能和基本結構 4. 課堂引入： • 以圖片及問題引入，例如： • “問學生有沒有聽過生物科技，例如器官晶片、類器官的研究發展與應用及3D 生物打印？” 5. 然後向學生介紹今課堂進行重新設計心臟的結構及功能。	1. 學生聆聽老師的教學 2. 就觀察所得，想像現今生物科技，對人類進行重新設計器官的技術。	• 教學簡報

拓展					
11-20 分鐘 (15 分鐘)	K1,C1, C2	• 心臟功能 • 心臟內部及外部結構	• STEM 部分：講解設計思維（同理心、定義問題、創意發想、製作原型及測試驗證） • 生物科技及工程部分： 1) 器官晶片、類器官的研究發展與應用及3D 生物打印 2) 認識現今科技的器官重建 **1. 練習活動—1：小組討論** 1) 重新設計心臟 - 小組活動：設計理念： 2) 引用上堂所學，重新點出對背後的研究目的，例如： 3) 令同學從中得到啟發，尋求具創意或創新的成果 4) 學生自訂題目及對象(適應性及功能) 5) 在工作紙上，繪畫並標示設計理念（包括：人類的心臟內部及外部結構，功能及位置） 6) *如學生有需要，可用IPad或電腦進行資料蒐集。	1. 學生聆聽老師的教學 2. **練習活動（小組）—1：** • 設計及擬訂合適的人類的心臟內部及外部結構，並填寫在設計工作紙上。	• 簡報 • 小組設計工作紙
21-40 分鐘 (20 分鐘)	K2, S1, S2, C1, C2	• 繪圖程式的基礎使用（Mental Canvas 及	• 掌握MediBang繪圖程式的使用方法 1) 教師向學生展示 MediBang 的功能及使用方法。	1. 學生聆聽老師的教學 2. 練習活動（小組）—2：	

		MediBang 使用方法）	2) 引導學生運用所提供的圖例，嘗試加減心臟的功能。 **2. 練習活動—2：小組討論** 重新設計心臟 - 小組活動：在平板電腦上，繪畫出心臟的設計理念圖。 ● 掌握Mental Canvas制作影片程式的使用方法 1) 教師向學生展示 Mental Canvas 的功能及使用方法。 2) 引導學生運用各小組的設計，製作出出心臟的設計影片，以展示小組在心臟上，重新設計的更改部分。 **3. 練習活動—3：小組討論** 重新設計心臟 - 小組活動：在平板電腦上，製作影片，展示心臟的設計理念圖。	● 重新設計心臟 - 小組活動：在平板電腦上，繪畫出心臟的設計理念圖。 3. 練習活動—3：小組討論 ● 重新設計心臟 - 小組活動：在平板電腦上，製作影片，展示心臟的設計理念圖。	
加強					
41-58 分鐘 (18 分鐘)	K2, C2, C3	● 運用學習探索的技巧	**重新設計心臟 - 小組活動：設計理念：** 1. 重新點出對背後的研究目的，例如： ● 令同學從中得到啟發，尋求具創意或創新的成果 ● 提高對生物探究的興趣 2. 說明重新設計人體器官的結構及功能 ● 設計需包含以下項目： 1) 心臟的結構圖 （短片形式） 2) （包含：	1. 小組活動： 重新設計人體器官的結構及功能 ● **時限：10分鐘** ● **小組討論（搜集資料）：5分鐘** ● **繪畫及影片製作：5 分鐘** 2. **小組匯報**：	● 簡報 ● 工作紙 ● 設計工作紙（草圖）

			a) 外部 b) 內部 c) 內部放大圖（最少兩張） d) 重新設計（最少兩項設計及其功能） ● **<u>時限：10分鐘</u>** ● **小組討論（搜集資料）：5分鐘** ● **描述、繪畫及影片製作：5 分鐘** **4. 練習活動—4：小組匯報** ● 各小組匯報- 重新設計的器官。當中包括： - 重建該器官的立體設計圖； - 匯報時間：2分鐘內加2分鐘問答 - 簡報（平面圖加標示，新加的功能）； - 每組需至少為該器官加入2項新結構及功能（可參考其他動物的特徵及功能） - 用影片進行匯報 ● 所有最終設計會上載至 Padlet.com 讓同儕互評及欣賞。	按教師安排各小組匯報- 重新設計的器官。當中包括： - 重建該器官的立體設計圖； - 匯報時間：2分鐘內加2分鐘問答 - 簡報（平面圖加標示，新加的功能）； - 每組需至少為該器官加入2項新結構及功能（可參考其他動物的特徵及功能） - 用影片進行匯報	
總結					
58-60 分鐘 (2 分鐘)	K1	● 學生回顧這堂課所學內容 ● 總結課堂	1. 課堂總結： ● 以 “後測” 作總結 ● 邀請部分同學做訪問 ● 開啟 Google form 進行。 2. 重溫課程重點，贈送紀念品	1. “後測” 或部份同學進行訪問 2. 學生聆聽老師的教學及注意事項	● 簡報

教學資源： 1. 生物教科書 (作參考之用) - 香港中學文憑生物學: 概念互通5 (2019年版) 2. 牛津大學出版社
所需教具 / 教材： ▪ 簡報 ▪ 活動工作紙 ▪ 電腦 ▪ 平板電腦 ▪ Mental Canvas 使用方法 ▪ MediBang 使用方法 ▪ 實體3D 心臟模型 ▪ 3D model 網頁 ▪ 後測 ▪ 訪問問題

8.5 Appendix 4.1: Lesson_1 students' worksheet

東華三院馮黃鳳亭中學

-香港教育大學 - 科學與環境學系-

《STEM x 生物科》

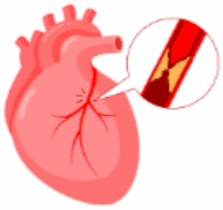
第一課

重新設計人體器官的結構及功能

班別:_____ 學號:_____ 日期:_____

學習重點:

- **重新設計人體器官的結構圖及功能**
- **說明心臟, 血管的功能和基本結構**
- **探討不同動物的心血管循環系統**
- **認識心臟和血管的常見疾病**



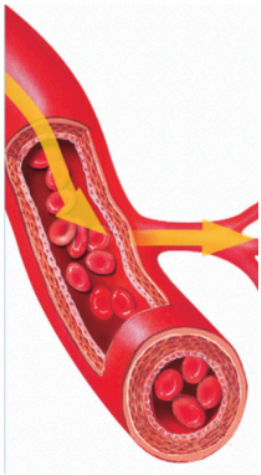
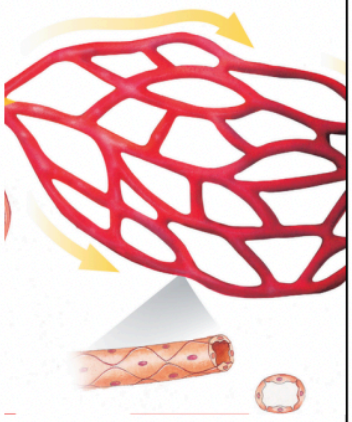
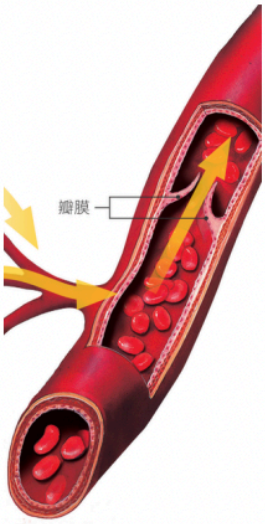
核心問題:

1. **有甚麼種類的血管？及其適應特徵。**
2. **心由甚麼組成？有何功用？**
3. **如何擬訂重建人體器官設計圖？**

第一部分:掌握人類的心血管循環系統

人體器官 - 血管結構

題目: 下圖顯示哺乳動物心臟的切面。填上正確的標示。

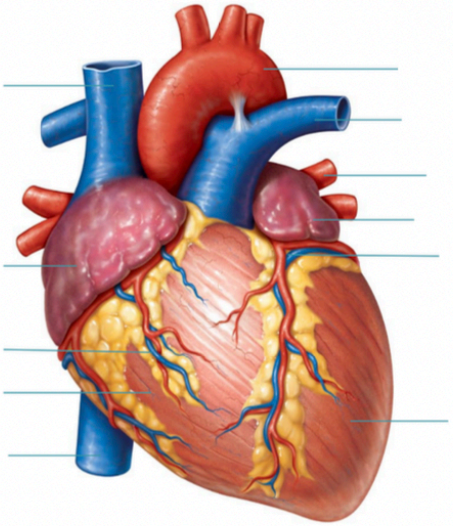
動脈/靜脈/微血管	動脈/靜脈/微血管	動脈/靜脈/微血管
		

配對以下正確的英文字母在正確的位置上		
(e.g. A)	**(e.g. B)**	
(答案可重複使用)		

A. 將血液從心帶到身體組織
B. 由動脈流向靜脈
C. 血壓較高其他血管為高
D. 管壁最簿
E. 沒有瓣膜
F. 管腔較小
G. 管內是缺氧血(除了肺靜脈和胎兒的臍靜脈除外)
H. 管壁彈性比動脈弱
I. 血液與體細胞進行物質交換
J. 有瓣膜 : 可以防止血液倒流, 確保血液只循單方向流動(即流往心臟)

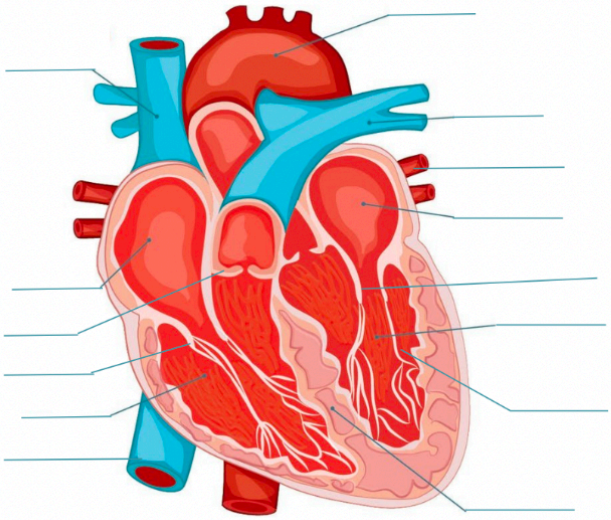
練習活動—**2**:《標示心臟結構圖心臟內部及外部結構》

題目**:** 下圖顯示哺乳動物心臟的切面。填上正確的標示 **(A**至**J)**。



哺乳動物心臟的的外部結構

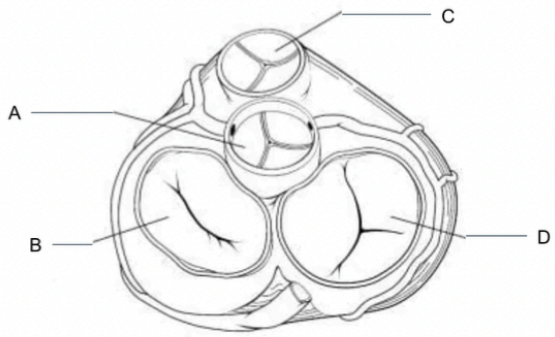
配對以下正確的英文字母在正確的位置上
A. 大動脈 B. 肺動脈 C. 右心房 D. 左心房 E. 肺靜脈 F. 冠狀靜脈 G. 左心室 H. 冠狀動脈 I. 右心室 J. 下腔靜脈 K. 上腔靜脈 L. 腔靜脈



哺乳動物心臟的的內部結構

配對以下正確的英文字母在正確的位置上
A. 大動脈 B. 肺動脈 C. 右心房 D. 左心房 E. 肺靜脈 F. 隔 G. 冠狀靜脈 H. 左心室 I. 冠狀動脈 J. 右心室 K. 下腔靜脈 L. 腔靜脈 M. 半月瓣 N. 腔靜脈 O. 三尖瓣 P. 二尖瓣 Q. 心腱索 R. 上腔靜脈

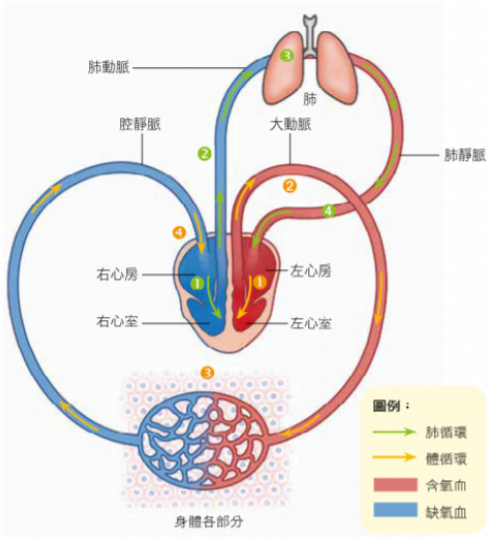
題目：下圖顯示哺乳動物心臟的切面。填上正確的標示。
（**A**和**C** 是什麼血管？**B**和**D**是什麼構造？）



A:	**B:**	**C:**	**D:**

短片介紹：《血液如何在人體內循環》

題目：血液如何在人體內循環？



第四部分:設計理念

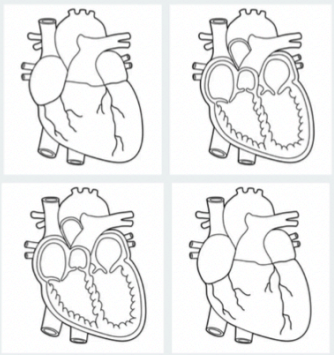
準則）重新設計人體器官的結構及功能

目標：重新設計人體**心臟**的結構及功能

設計需包含以下項目：

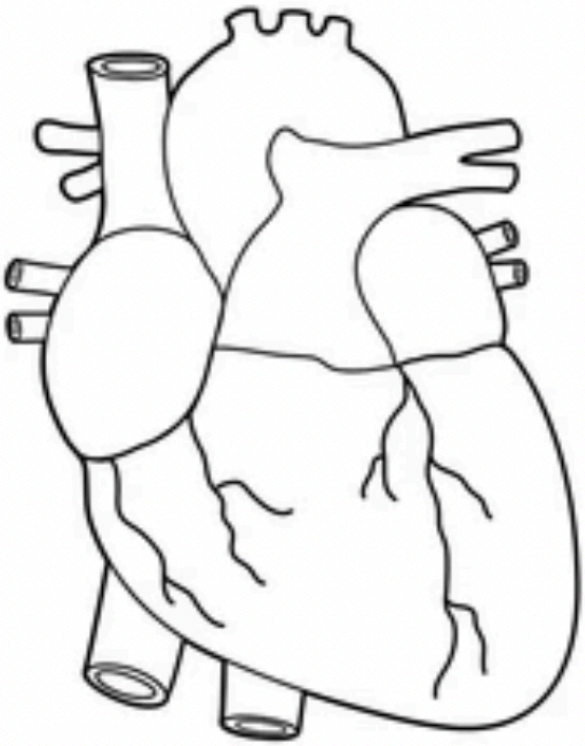
A) 心臟的結構圖 （短片形式）
（包含：1. 外部
2. 內部
3. 內部放大圖（最少兩張）
B）重新設計（最少兩項設計及其功能）

下一堂匯報：
每組 5分鐘 匯報設計



小組討論:(第_____組)

目標:於A4紙上描述/繪畫出重新設計的設計構思



8.6 Appendix 4.2: Lesson_1 Teachers' worksheet

東華三院馮黃鳳亭中學

-香港教育大學 - 科學與環境學系-

《STEM x 生物科》

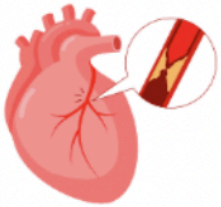
第一課

重新設計人體器官的結構及功能 (教師版)

班別:_____ 學號:_____ 日期:_____

學習重點:

- 重新設計人體器官的結構圖及功能
- 說明心臟, 血管的功能和基本結構
- 探討不同動物的心血管循環系統
- 認識心臟和血管的常見疾病



核心問題:

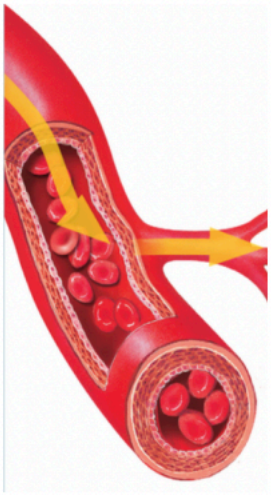
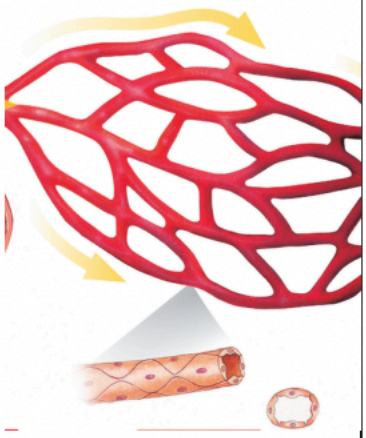
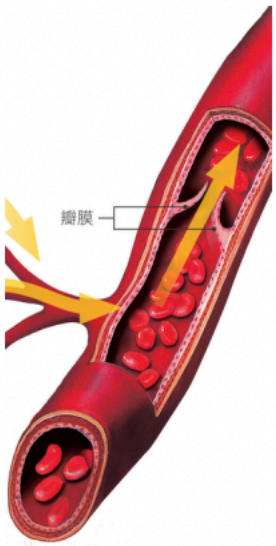
1. 有甚麼種類的血管？及其適應特徵。
2. 心由甚麼組成？有何功用？
3. 如何擬訂重建人體器官設計圖？

P. 1

第一部分:掌握人類的心血管循環系統

人體器官 - 血管結構

題目: 下圖顯示哺乳動物心臟的切面。填上正確的標示。

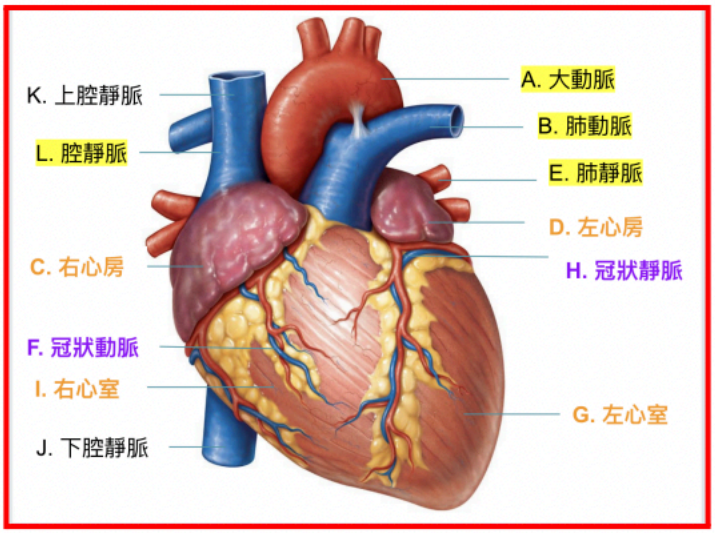
動脈/靜脈/微血管	動脈/靜脈/微血管	動脈/靜脈/微血管
		

配對以下正確的英文字母在正確的位置上		
(e.g. A) C, E, F	(e.g. B) D, E, I	G, H, J
(答案可重複使用)		

A. 將血液從心帶到身體組織
B. 由動脈流向靜脈
C. 血壓較高其他血管為高
D. 管壁最薄
E. 沒有瓣膜
F. 管腔較小
G. 管內是缺氧血(除了肺靜脈和胎兒的臍靜脈除外)
H. 管壁彈性比動脈弱
I. 血液與體細胞進行物質交換
J. 有瓣膜 : 可以防止血液倒流, 確保血液只循單方向流動(即流往心臟)

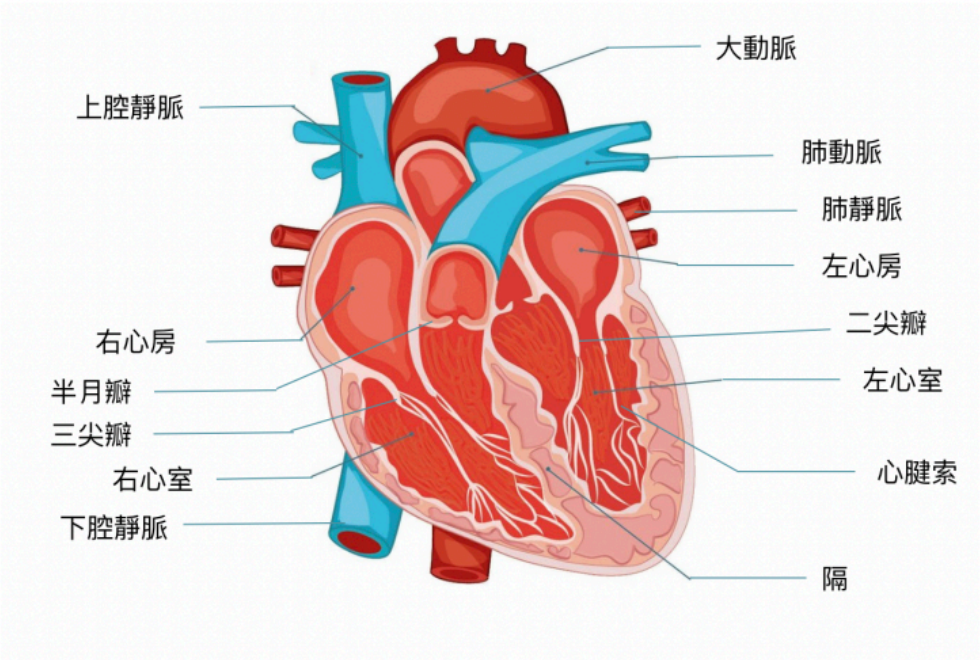
練習活動—**2**:《標示心臟結構圖心臟內部及外部結構》

題目**:** 下圖顯示哺乳動物心臟的切面。填上正確的標示 **(A**至**J)**。



哺乳動物心臟的的外部結構

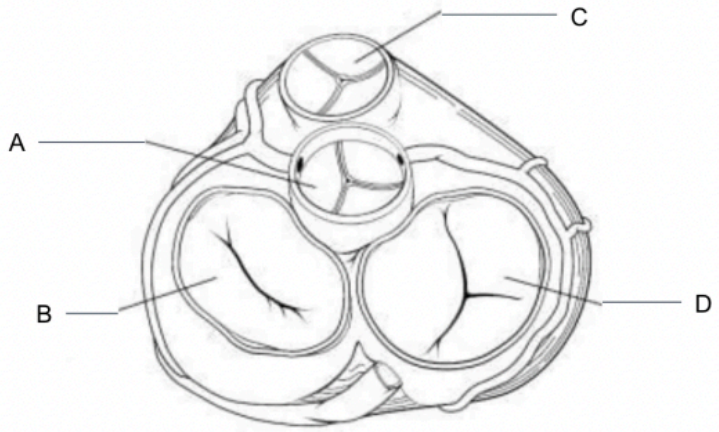
配對以下正確的英文字母在正確的位置上
A. 大動脈 B. 肺動脈 C. 右心房 D. 左心房 E. 肺靜脈 F. 冠狀靜脈 G. 左心室 H. 冠狀動脈 I. 右心室 J. 下腔靜脈 K. 上腔靜脈 L. 腔靜脈

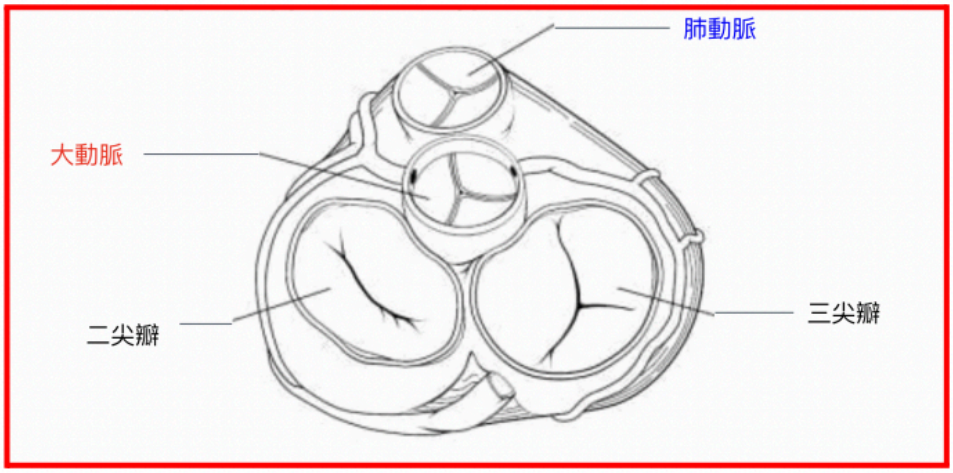


哺乳動物心臟的的內部結構

配對以下正確的英文字母在正確的位置上
A. 大動脈 B. 肺動脈 C. 右心房 D. 左心房 E. 肺靜脈 F. 隔 G. 冠狀靜脈 H. 左心室 I. 冠狀動脈 J. 右心室 K. 下腔靜脈 L. 腔靜脈 M. 半月瓣 N. 腔靜脈 O. 三尖瓣 P. 二尖瓣 Q. 心腱索 R. 上腔靜脈

題目：下圖顯示哺乳動物心臟的切面。填上正確的標示。
（**A**和**C** 是什麼血管？**B**和**D**是什麼構造？）

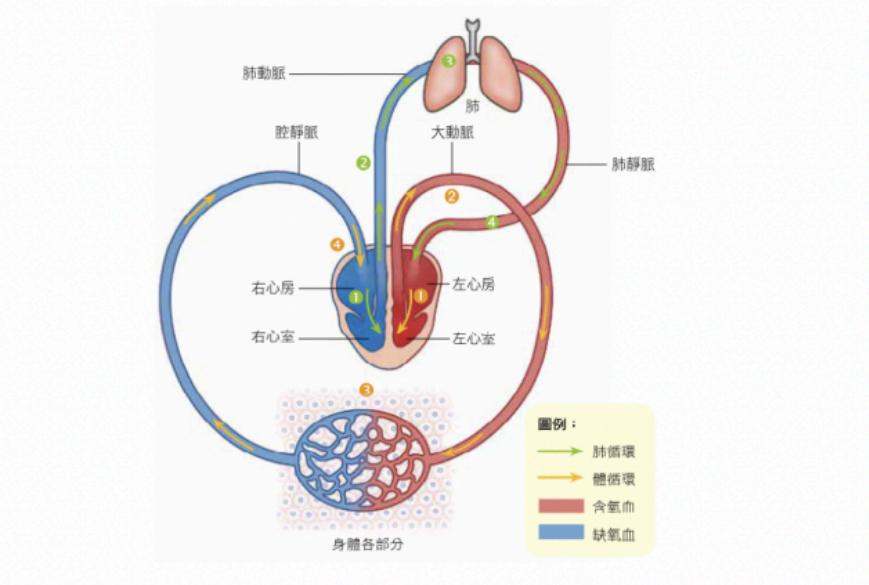




A:	B:	C:	D:

短片介紹:《血液如何在人體內循環》

題目: 血液如何在人體內循環？



第四部分:設計理念

準則）重新設計人體器官的結構及功能

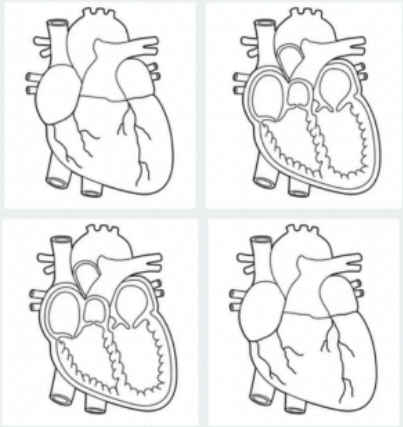
目標：重新設計人體**心臟**的結構及功能

設計需包含以下項目：

A） 心臟的結構圖 （短片形式）
（包含：1. 外部
2. 內部
3. 內部放大圖（最少兩張）
B）重新設計（最少兩項設計及其功能）

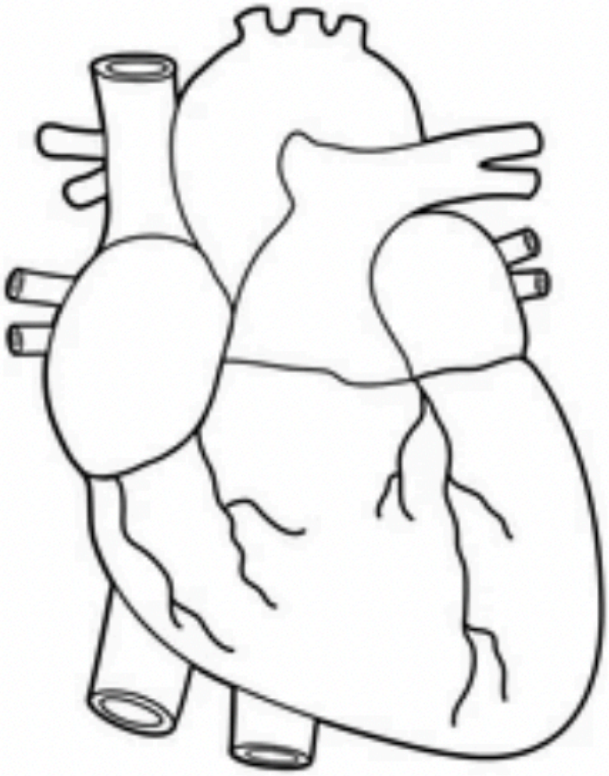
下一堂匯報：

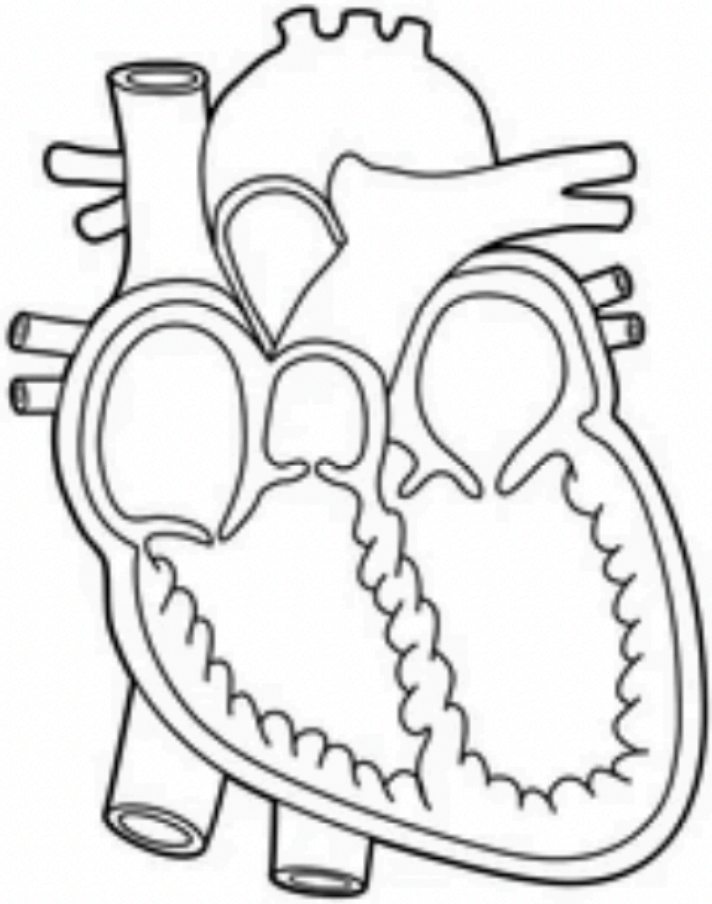
每組 5分鐘 匯報設計



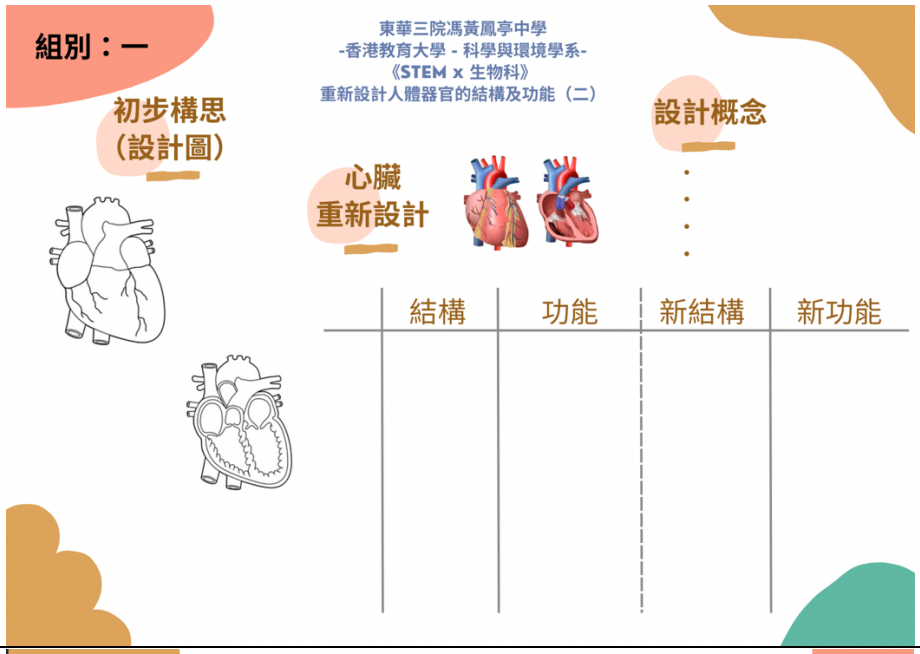
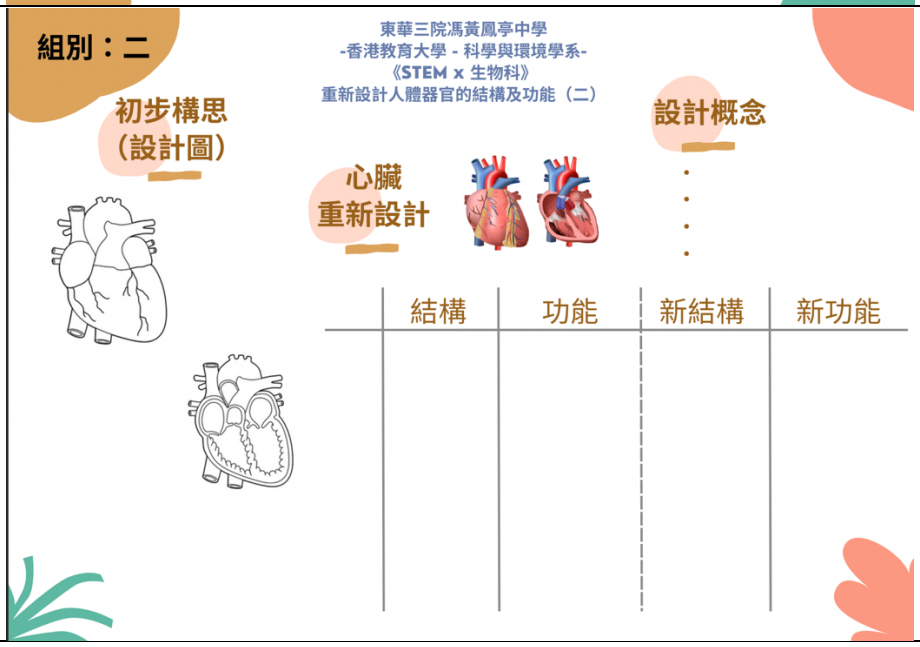
小組討論:(第_____組)

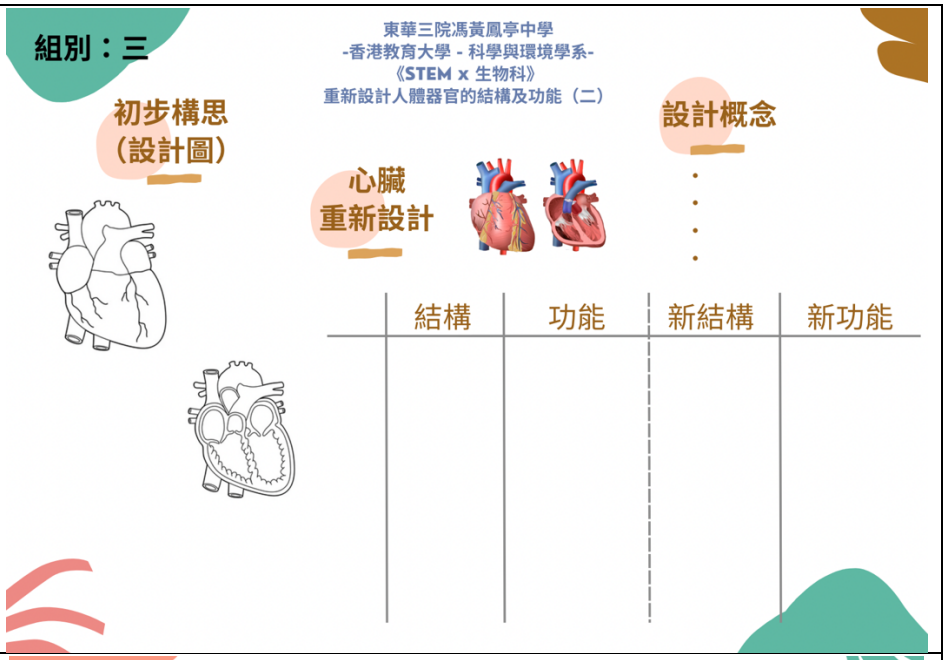
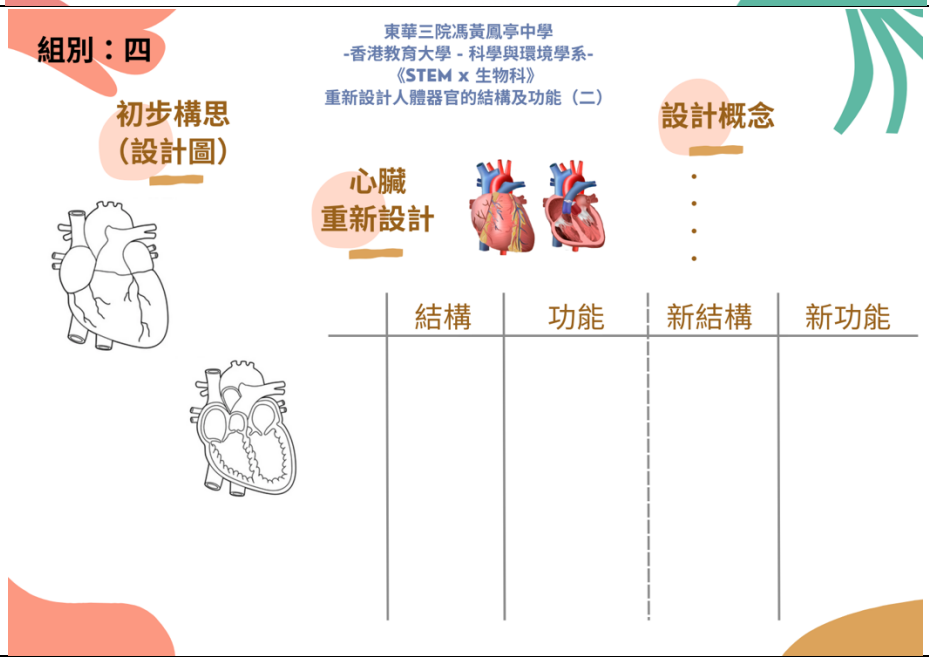
目標:於A4紙上描述/繪畫出重新設計的設計構思



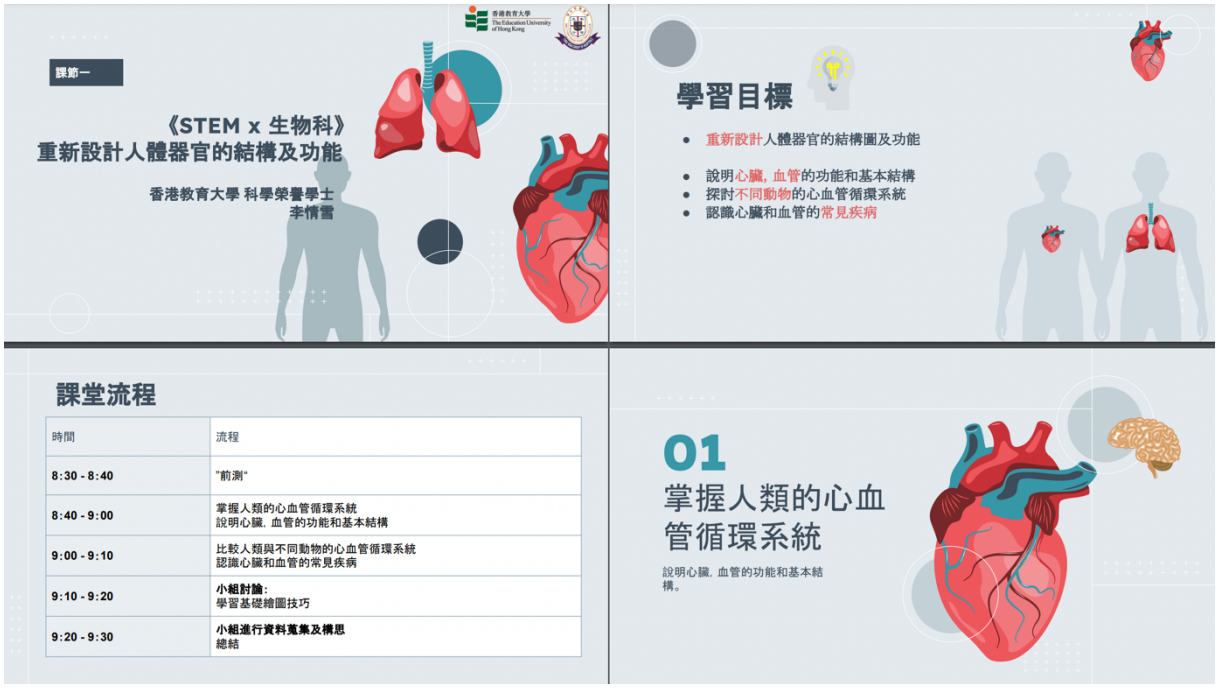


8.7 Appendix 4.3: Lesson_2 students' design worksheet

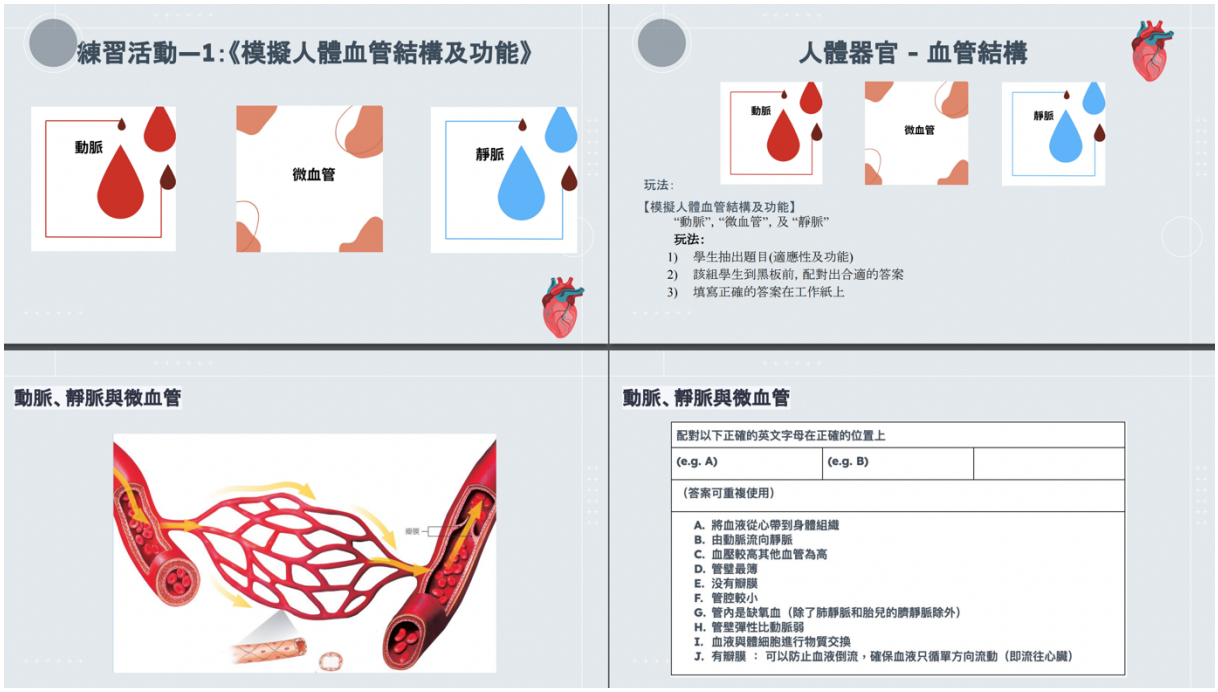
Group:	Design materials
1	
2	

3	
4	

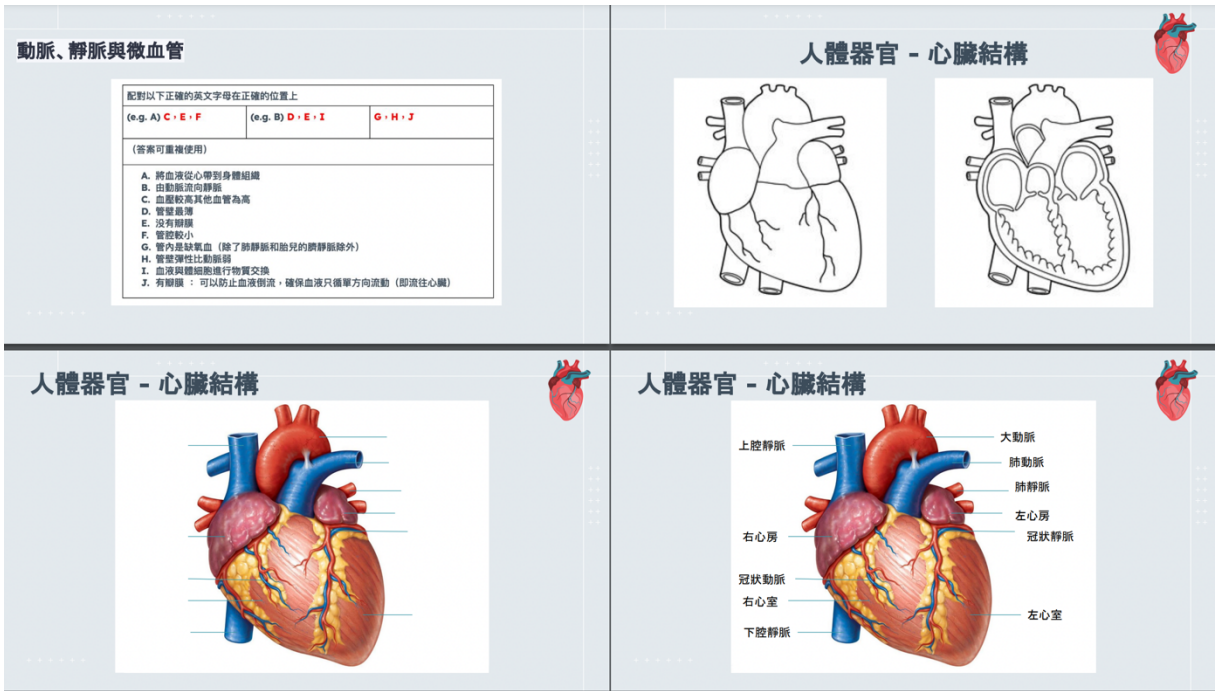
8.8 Appendix 5.1: Lesson_1 PowerPoint



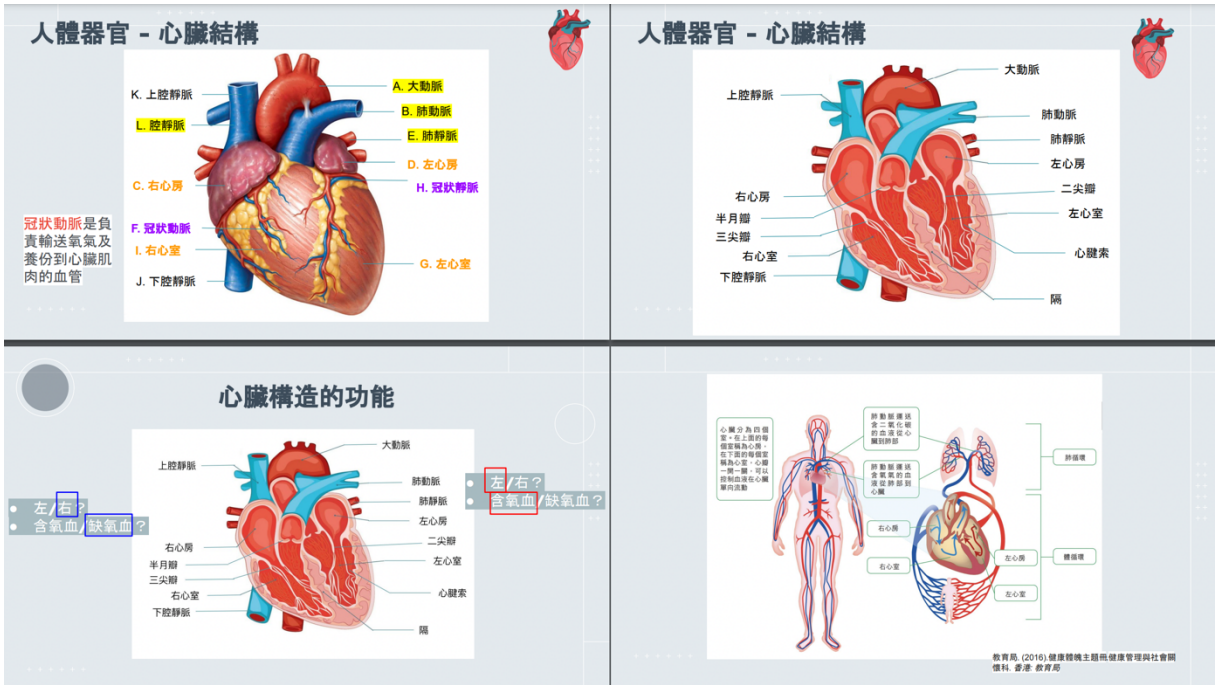
P.1-4



P.5-8

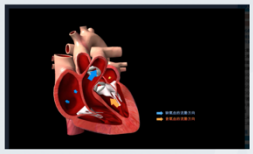


P.9-12



P.13-16

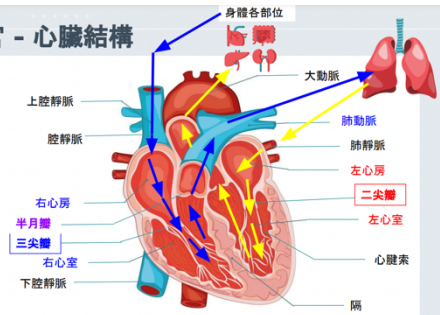
心臟的心跳及血流方向



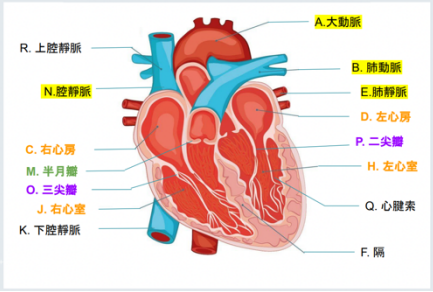
101科學教室:心臟(國家地理)雜誌
https://www.youtube.com/watch?v=R9Stt8HRTRU

Aristo 3D結構:
https://www.aristo.com.hk/biocc/3dmodel/model_6_2.html?lang=tc

人體器官 - 心臟結構



人體器官 - 心臟結構



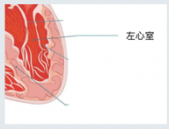
心臟構造的功能

	半月瓣
位置	在心室和大動脈/肺動脈之間
功能	當心室<u>壓強</u>時，半月瓣會閉合，<u>防止血液倒流回心室</u>。

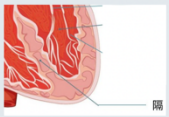
	三尖瓣	二尖瓣
位置	分隔右心房和右心室	分隔左心房和左心室
功能	心室<u>收縮</u>時，心室所產生的高血壓使二尖瓣和三尖瓣閉合，<u>防止血液倒流回心房</u>。	

P.17-20

心臟構造的功能



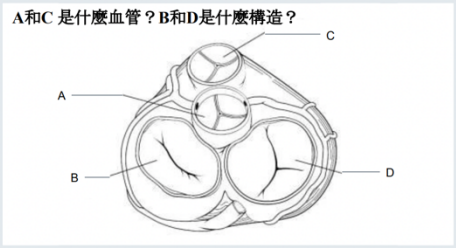
左心室
左心室需要產生較大的力，把血液泵至全身。



隔
可防止缺氧血和含氧血混合

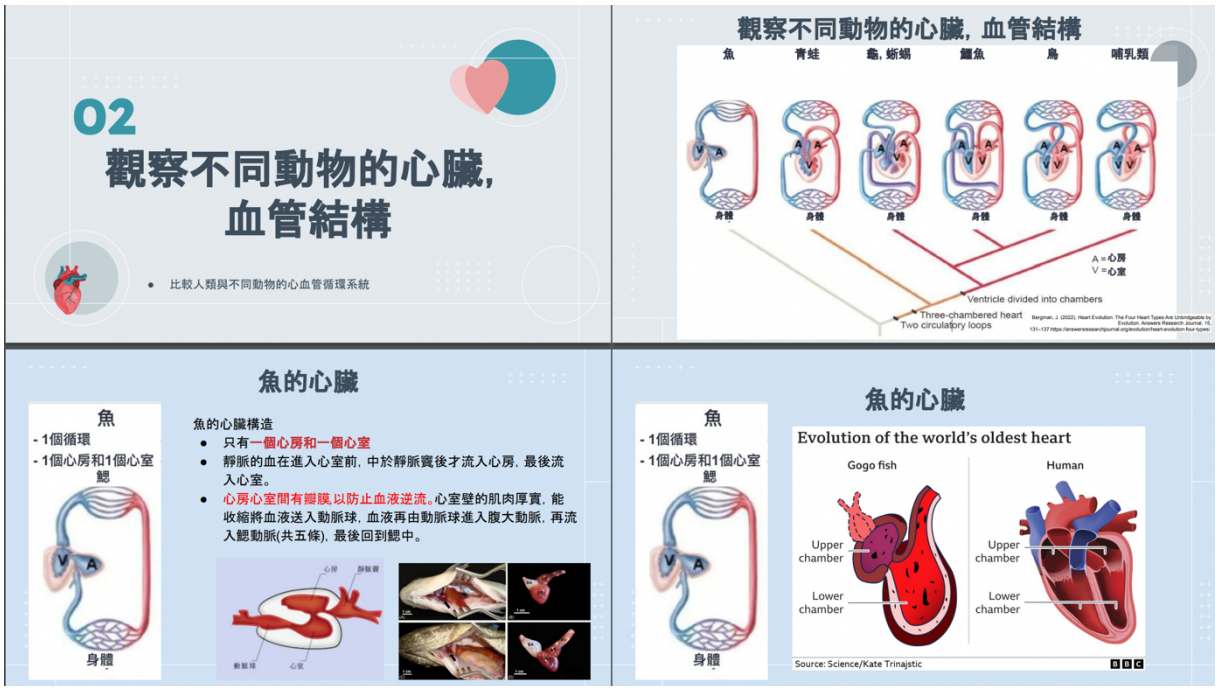
心腱索
可防止心室收縮時瓣膜翻向心房

人體器官 - 心臟結構（小測試）

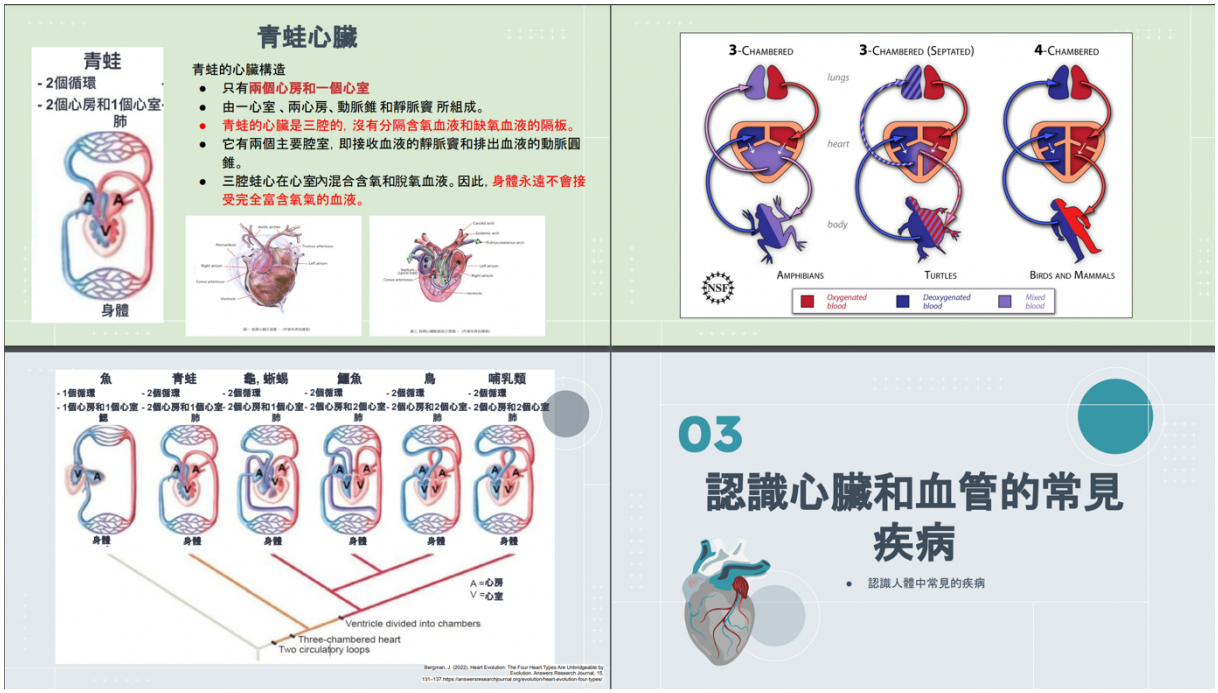


人體器官 - 心臟結構（小測試）

P.21-24

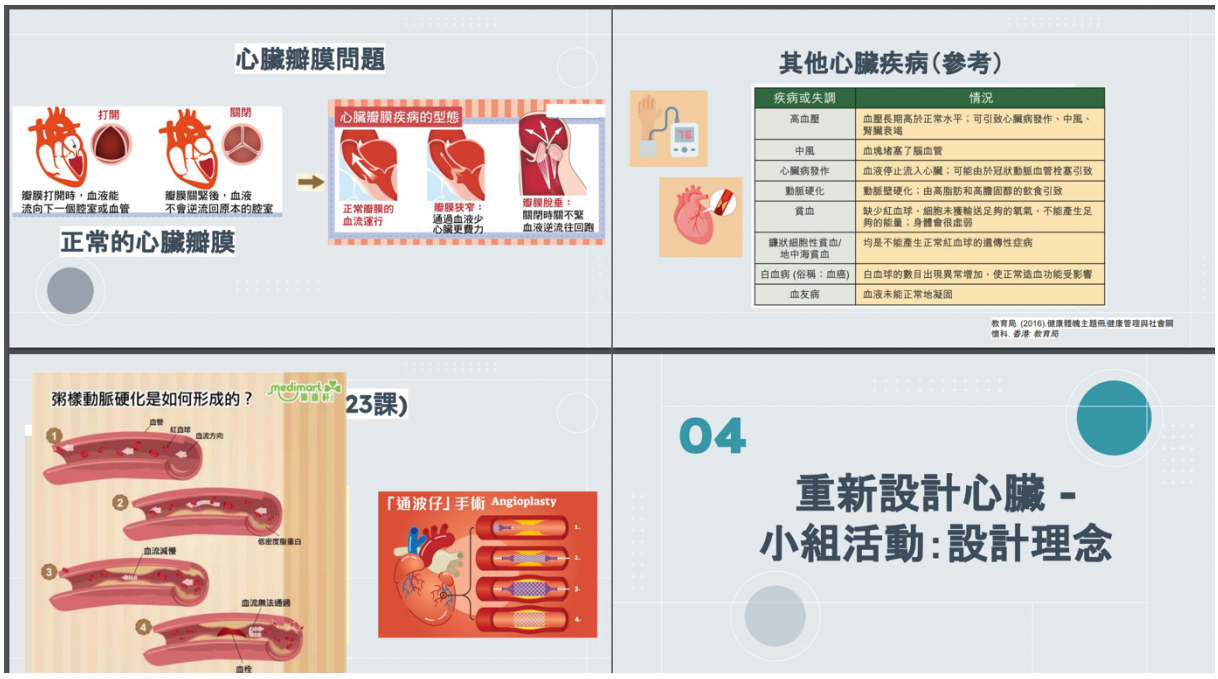


P.25-28

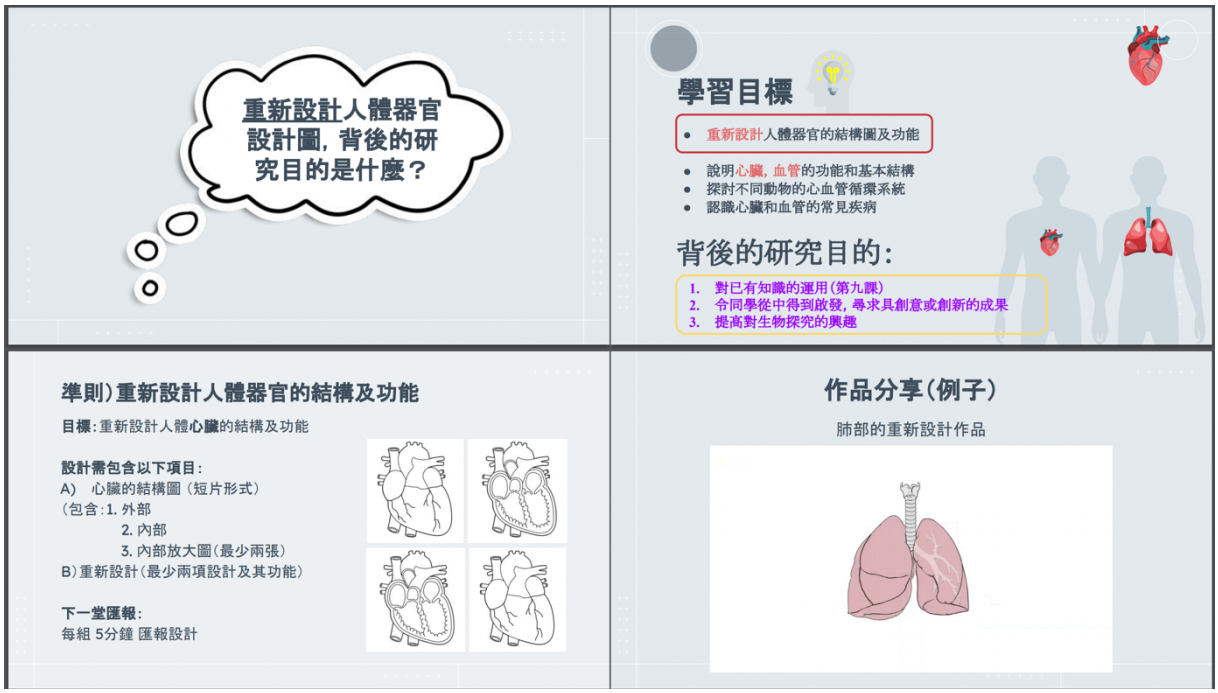


P.29-32

P.33-36

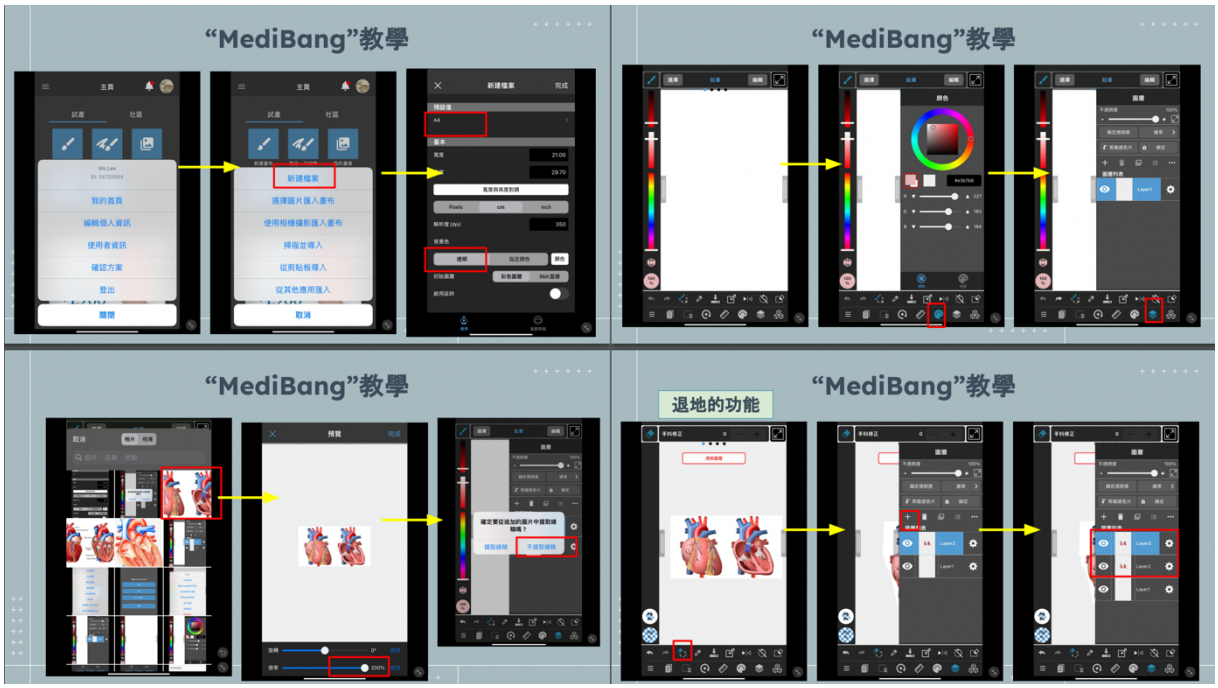


P.37-40

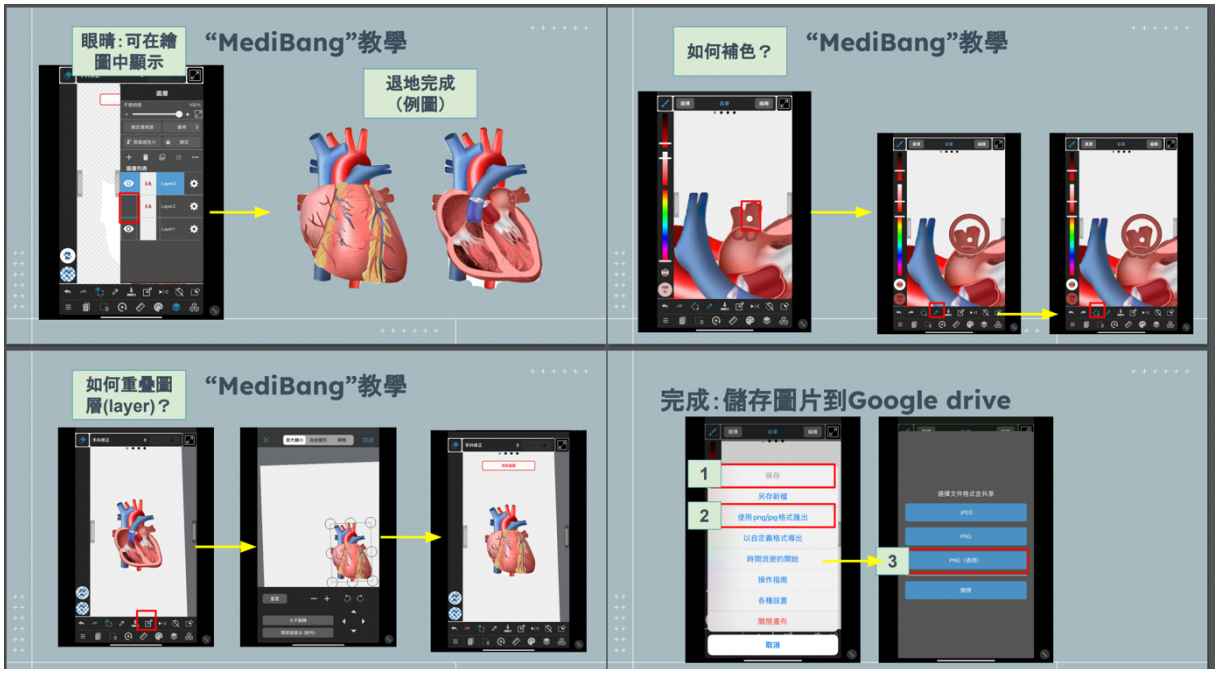


P.41-44

P.45-48



P.49-52



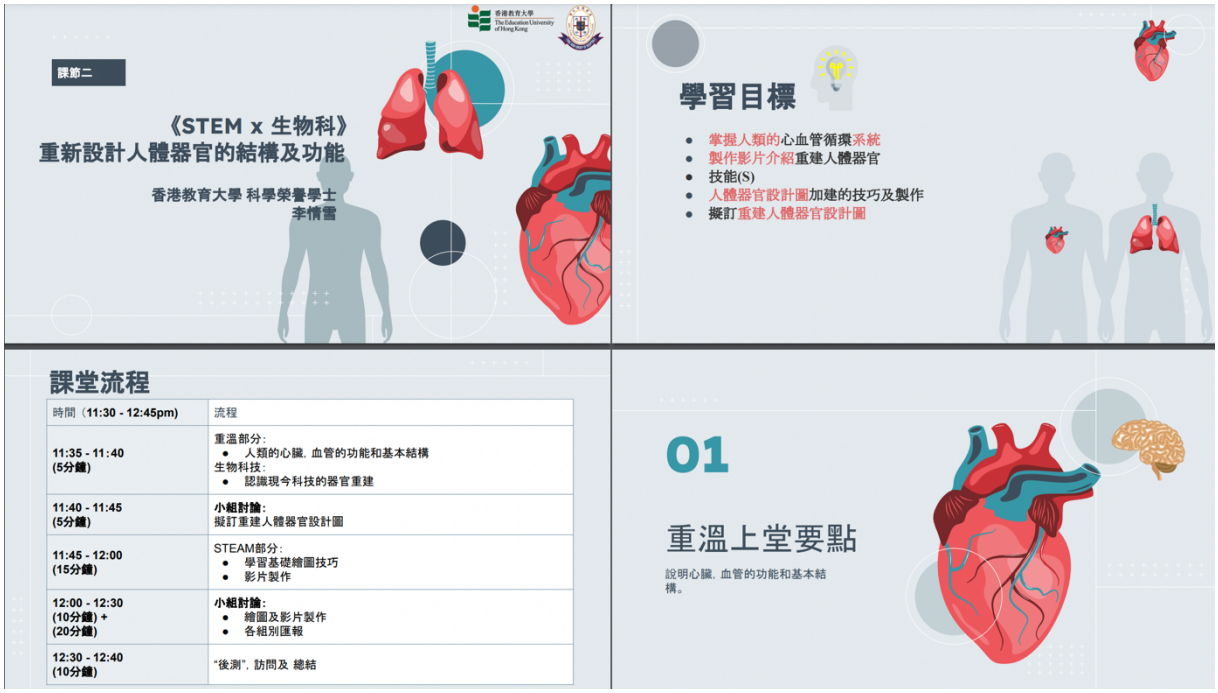
P.53-56

P.57-60

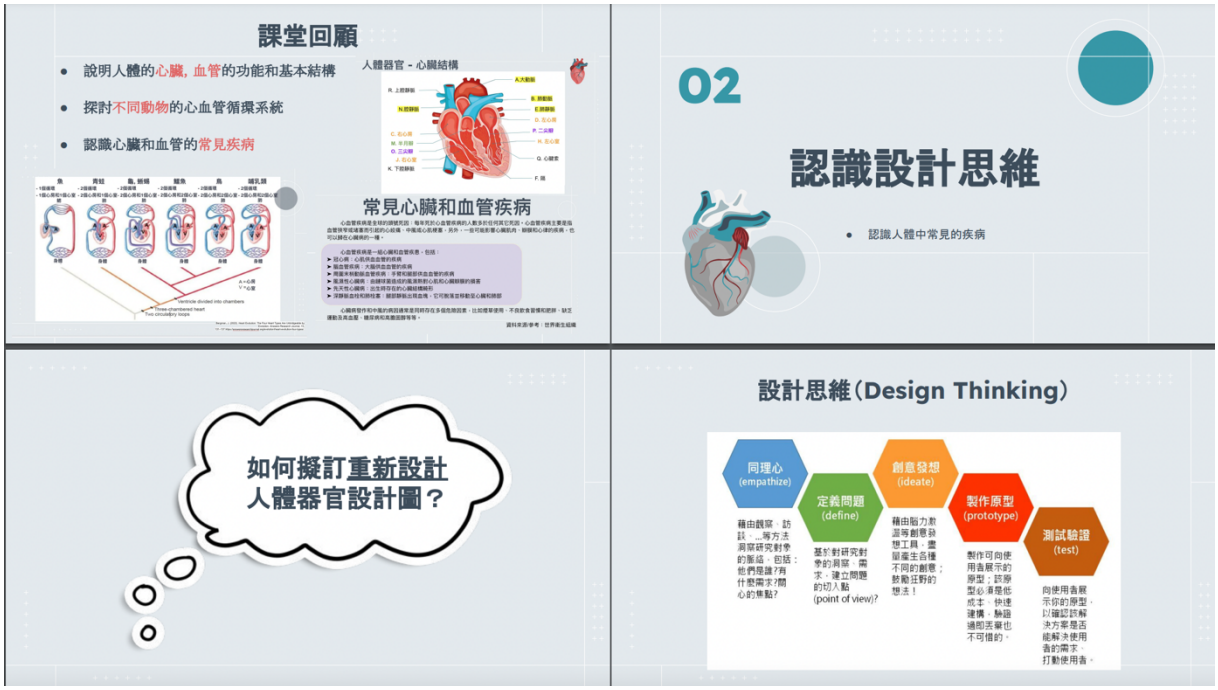
P.61-64

8.9 Appendix 5.2: Lesson_2 PowerPoint

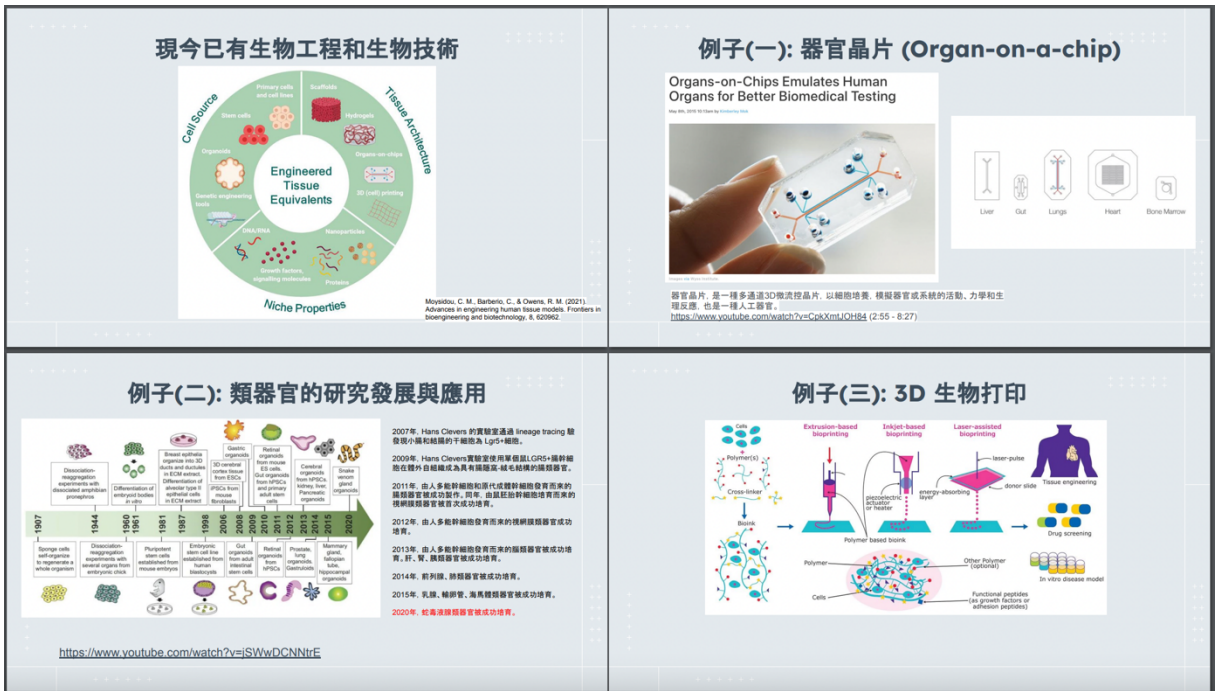
- Apps (MediBang Paint, Mental Canvas) with the apps drawing guideline



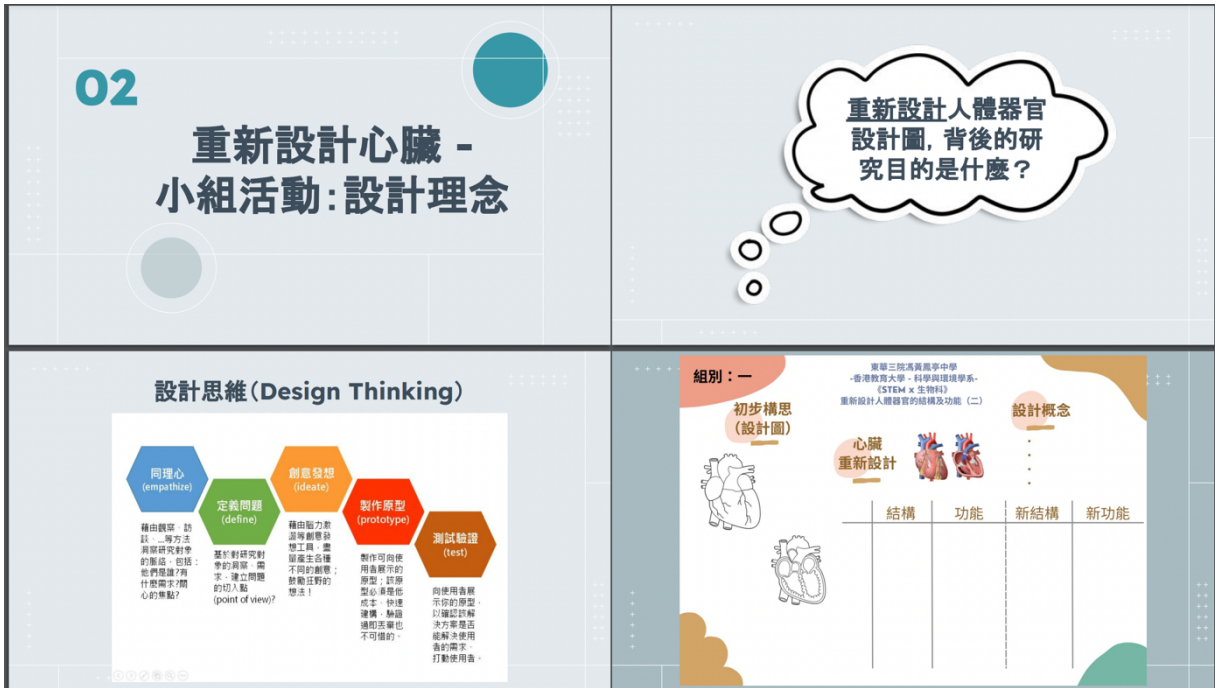
P.1-4



P.5-8



P.9-12



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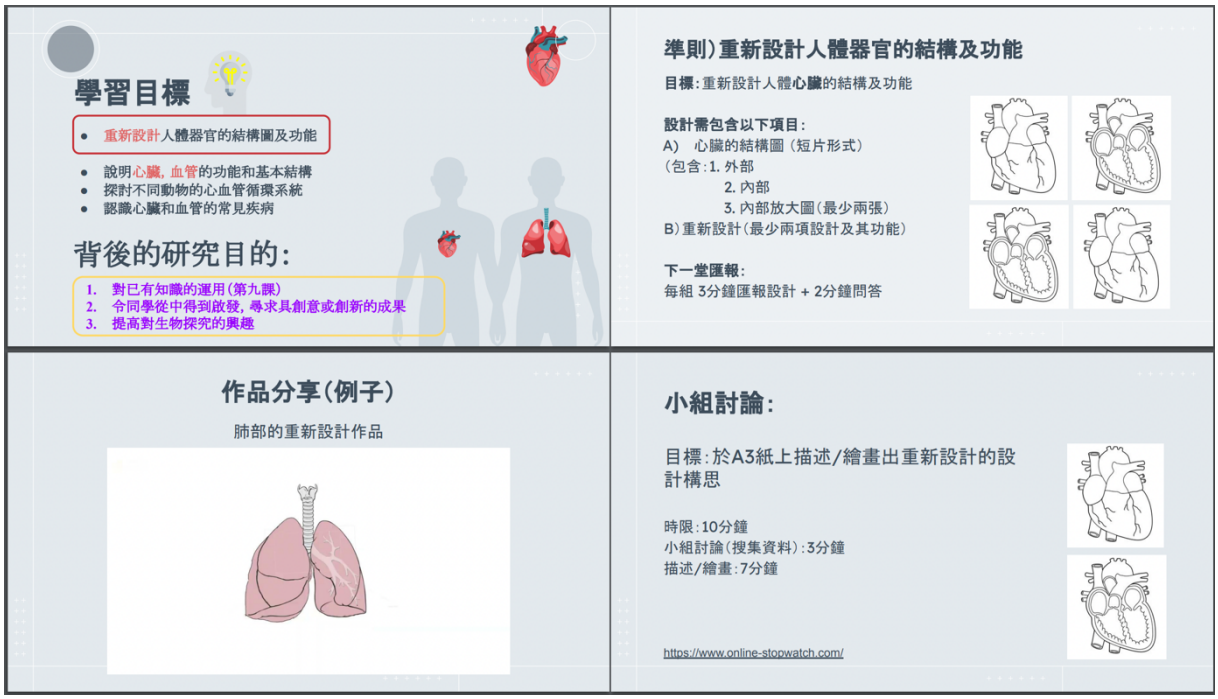
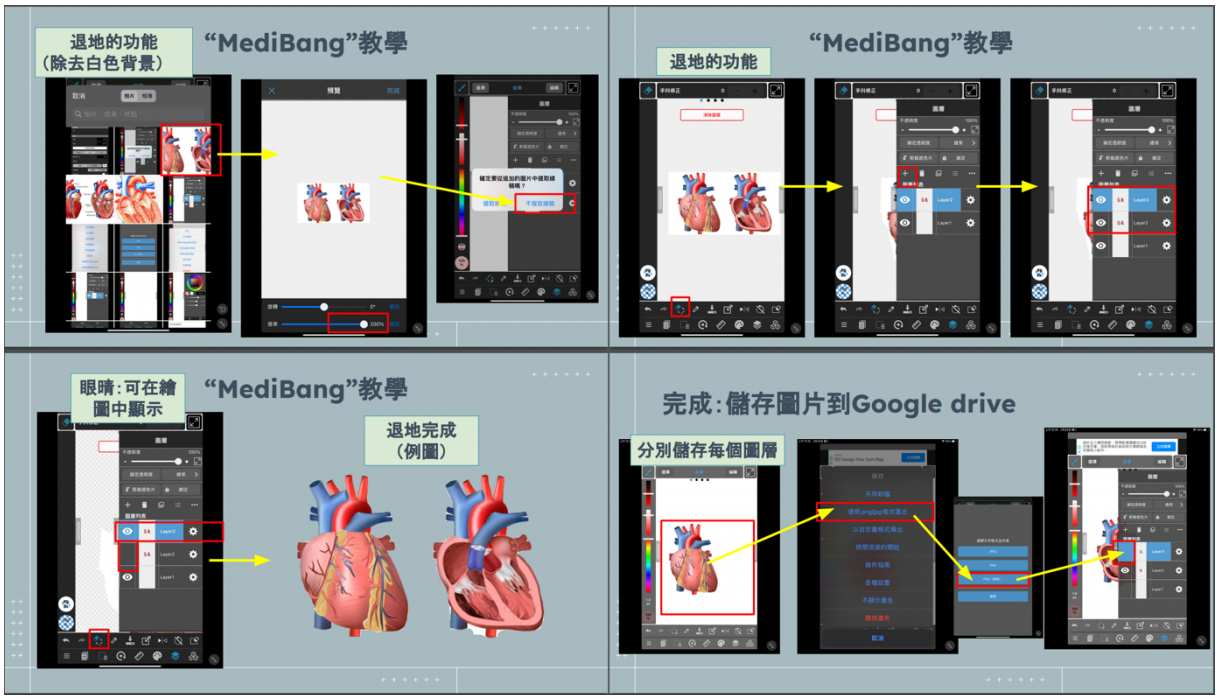


P.17-20

P.21-24

P.25-28

P.29-32



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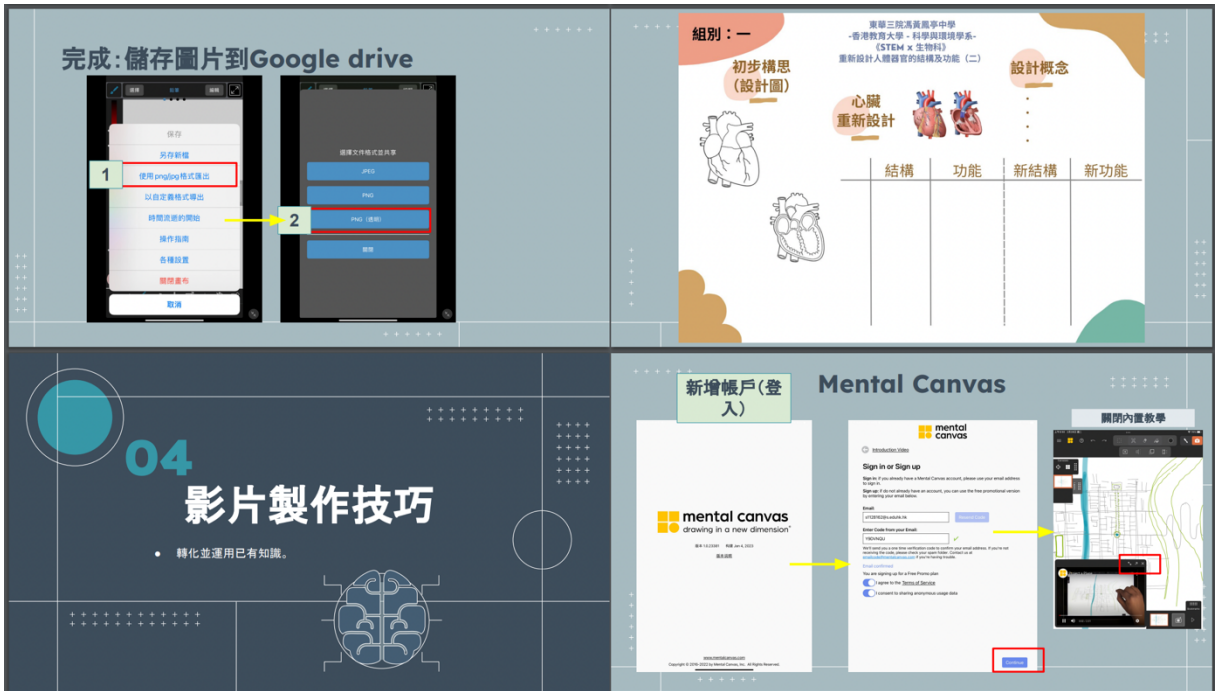

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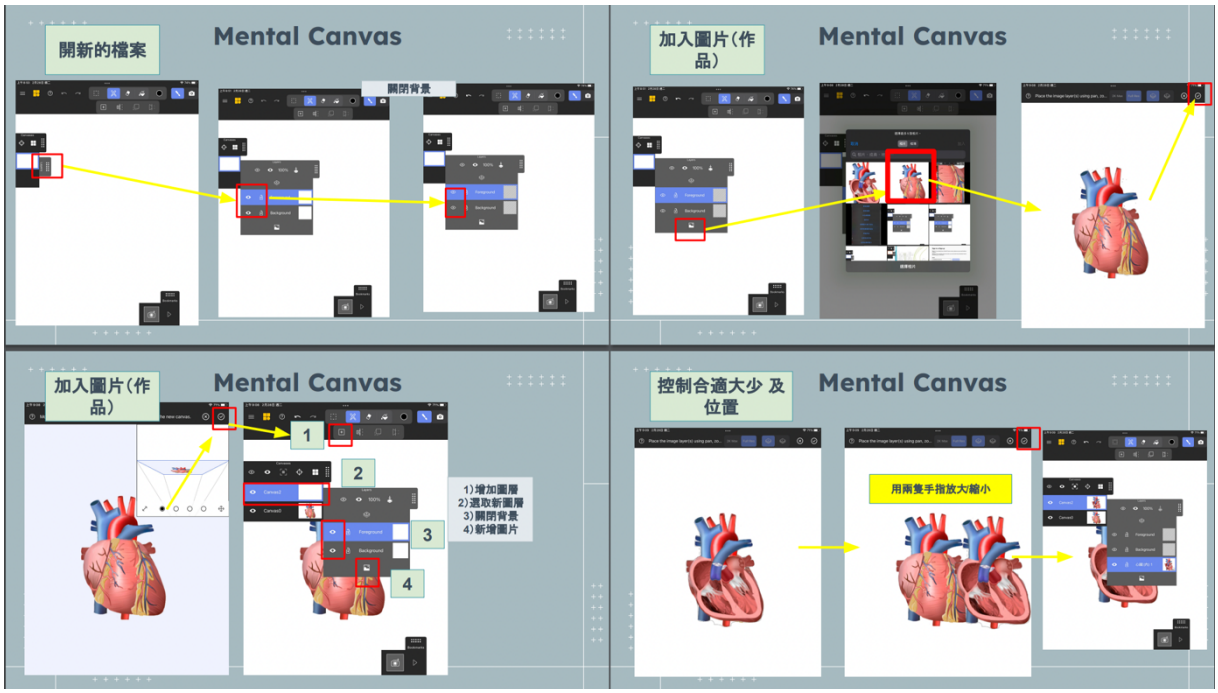

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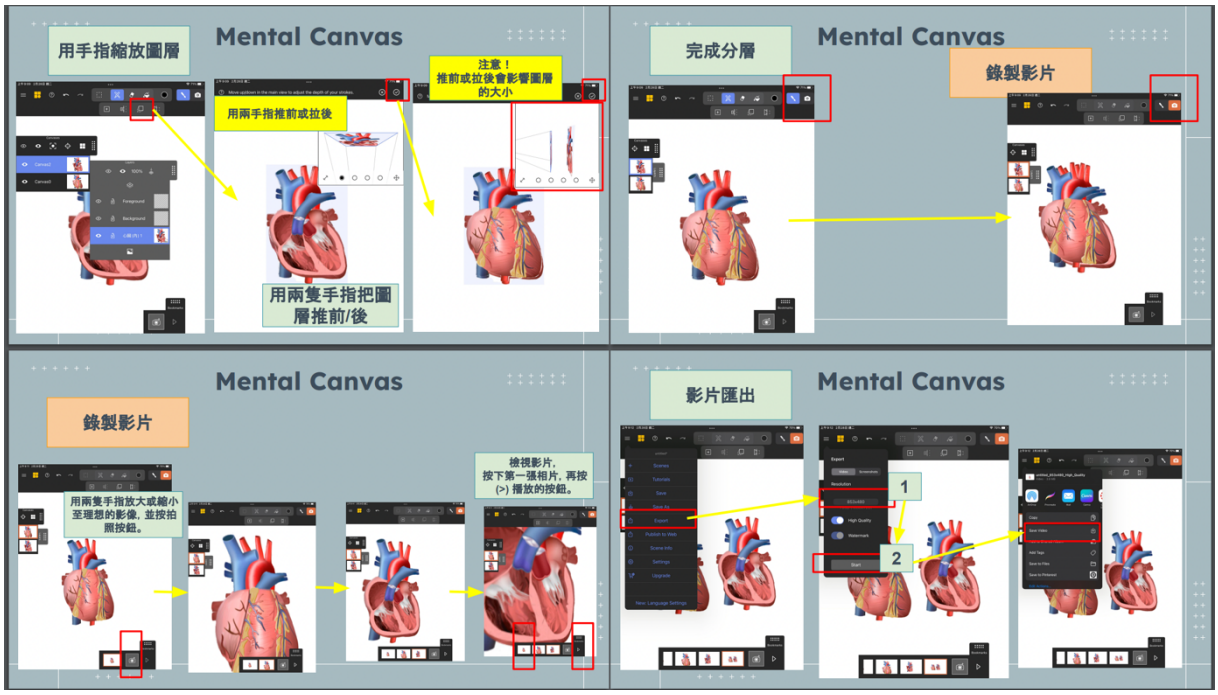

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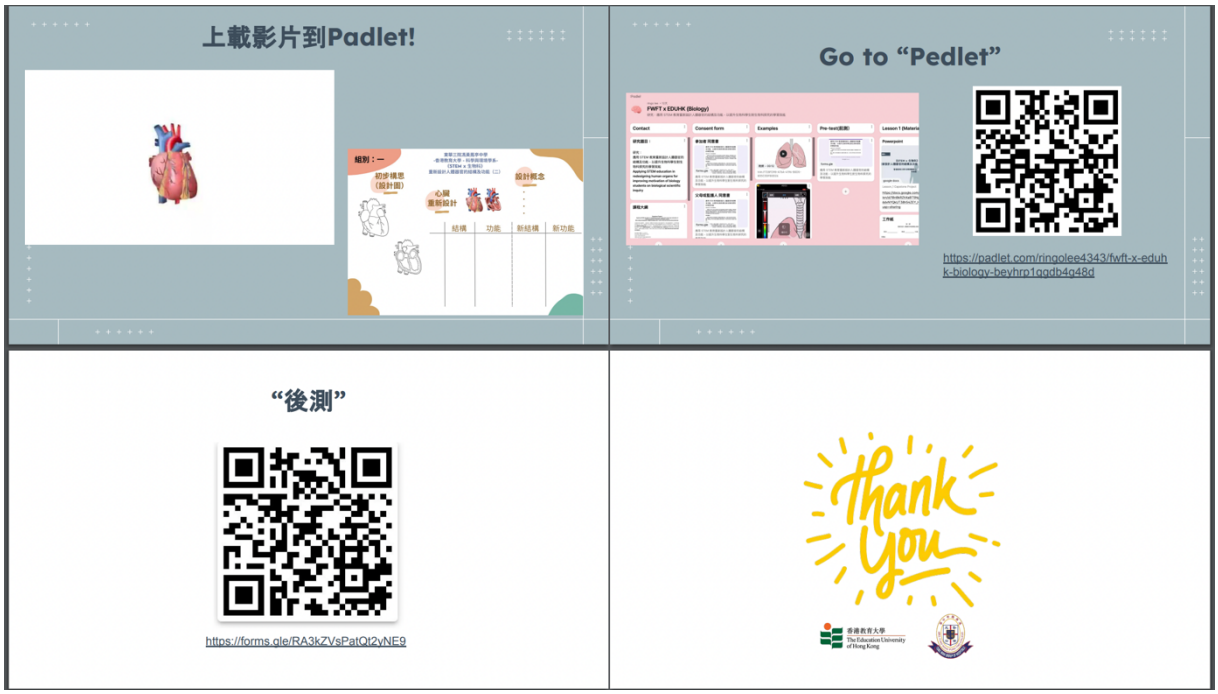
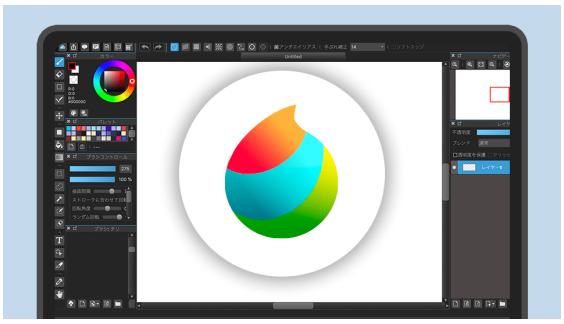
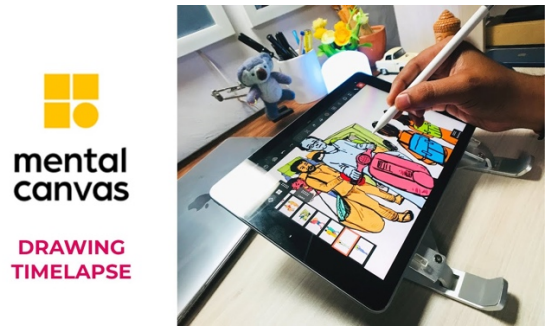


P. 49-52

8.10 Appendix 6: Apps for IPad use only (MediBang Paint, Mental Canvas)

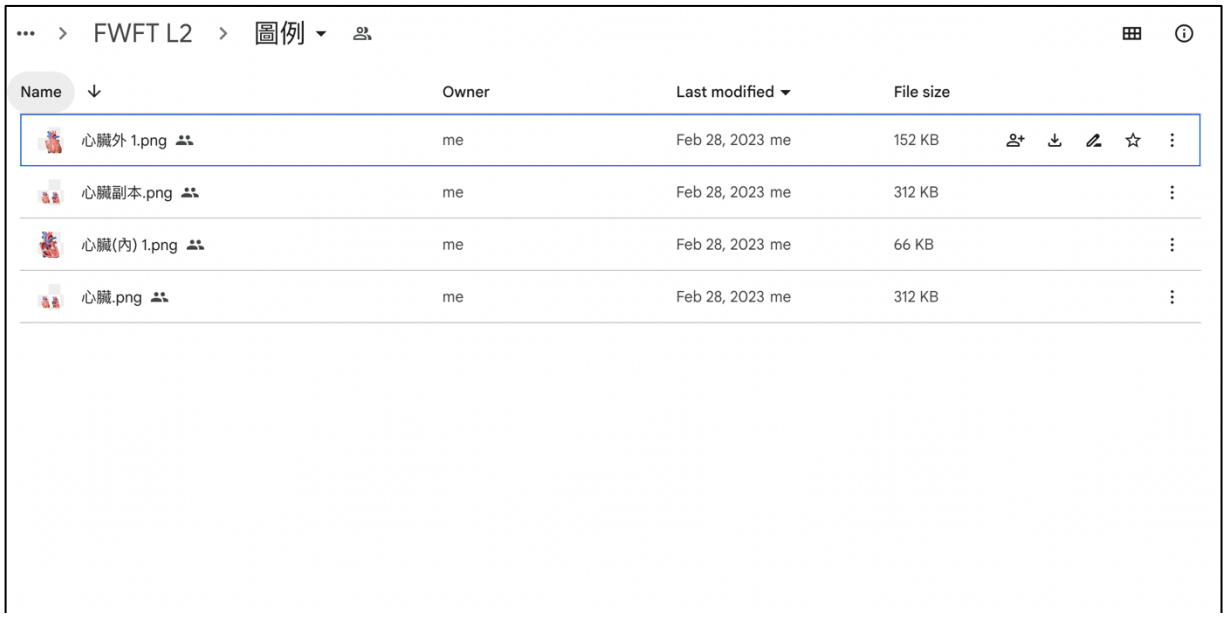


MediBang Paint



Mental Canvas

8.11 Appendix 7: Technical support materials



8.12 Appendix 8a: Course outline for the testing group

Capstone Project:
Applying STEM education in redesigning human organs for improving the motivation of biology students on biological scientific inquiry
應用 STEM 教育重新設計人體器官的結構及功能，以提升生物科學生對生物科探究的學習效能

本課程《STEAM教育 - 重新設計人體器官的結構及功能》涵蓋科學、科技及藝術教育三大學習領域的學習元素，共有二個課題。每堂均設有動手活動或實驗讓學生進行自主探究學習。在課題1.1中認識**人體器官的結構和功能**，在2.1至2.2 是STEM應用活動，學生透過綜合知識和技能，在教師的講解及協助下製作**人體器官重新設計**，並匯報**設計的結構及功能**，**課程希望**能加強科學配合科技的應用能力。讓學生運會已有知識、同學之間的互相合作及創作思維以**提高生物科學生對生物科學探究的積極性。**

試行課堂：課題 1.1, 2.1及2.2
研究對象: 選修生物科的中學生
年級：中四的同學(24名)
堂數：兩堂(每堂大約60分鐘作研究)
工具: 平板電腦，觸控筆

		主題 (Science)	學習重點
課題	1.1 15/2	描述人體器官的結構和功能 Ch.9 心臟，血管	• 前測 (對已有知識的掌握) • 基礎人體器官心臟，血管器官的結構和功能 • 檢視器官3d圖 • 觀察不同動物的心臟，血管結構 (例如：牛及豬的心臟，血管等) • 人體常見的心臟疾病
		主題(Science, Technology and Art)	**學習重點**
課題	2.1 15/2 + 28/2	擬訂重建人體器官設計圖 人體器官設計圖加建的技巧及製作	• 讓學生創作出新結構及功能的器官 • 利用IPad設計圖技巧 -> 平面繪圖【Mental Canvas + MediBang】 • 接觸3D drawing / 平面繪圖的技巧及製作
	2.3 28/2	重新設計器官設計作品匯報及展示	• 解釋重建器官的結構，並加入新功能 • 展示知識的運用 • 後測 (對已有知識的掌握) • 問卷(部份同學會隨機抽樣，接受訪問)

P.1

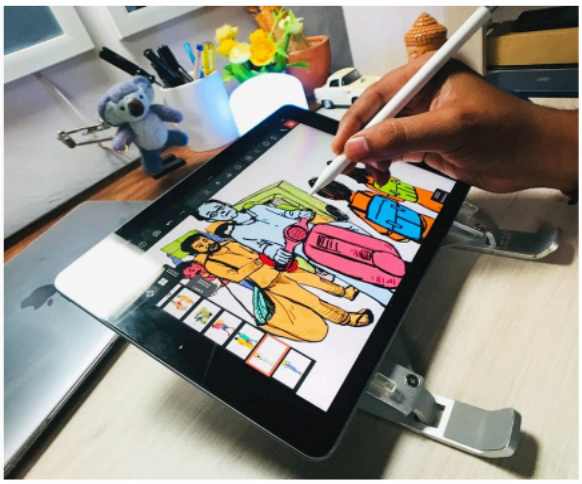
- 課堂日期及時間:
- 第一堂:
  日期: 2023年02月15日
  時間: 上午 08:30 - 09:45
  地點: 東華三院馮黃鳳亭中學(生物室)

- 第二堂:
  日期: 2023年02月28日
  時間: 上午11:30 - 12:45
  地點: 東華三院馮黃鳳亭中學(生物室)

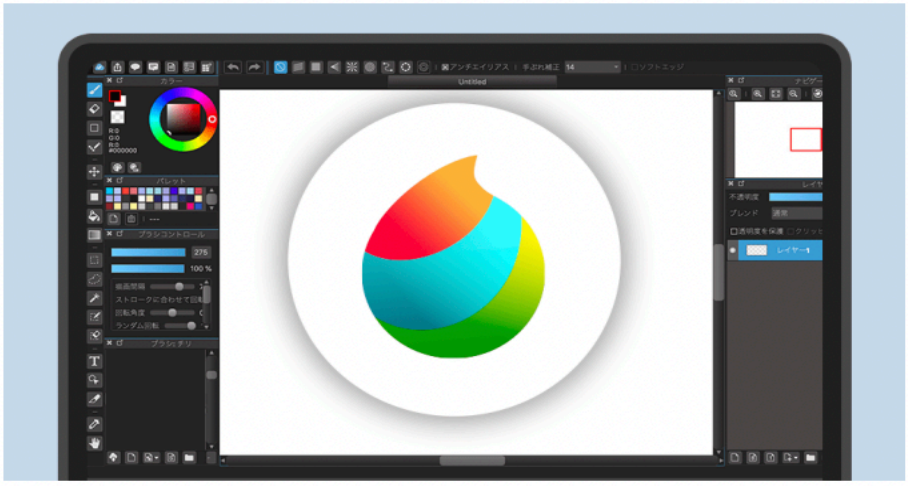
- **Mental Canvas**

mental canvas

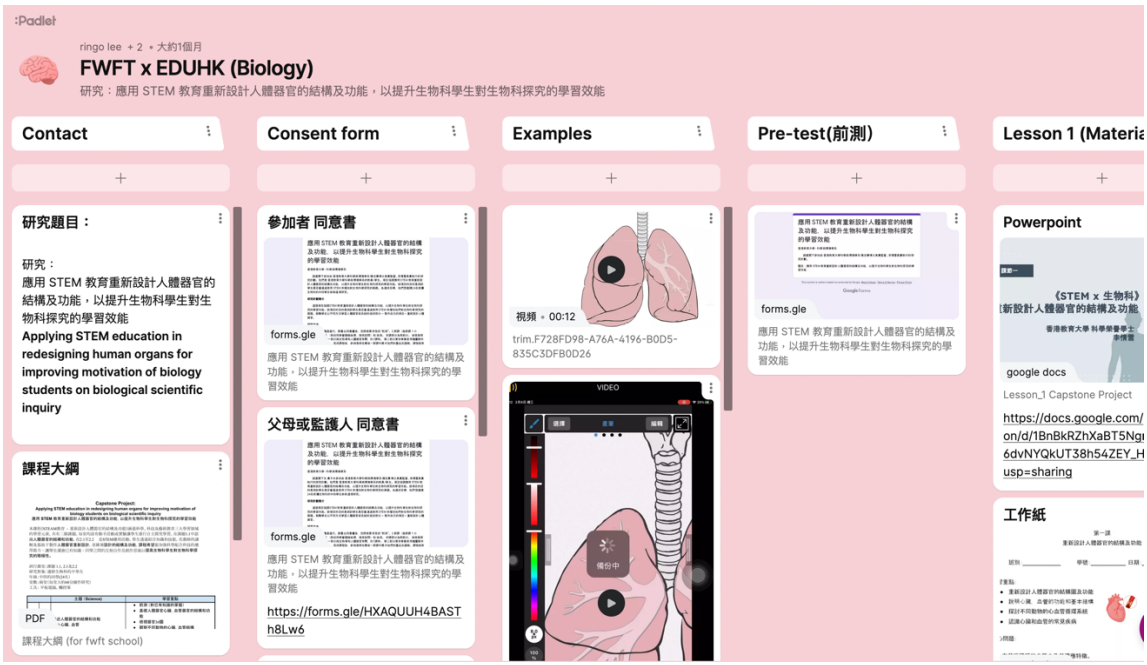
DRAWING TIMELAPSE



- **MediBang**



8.13 Appendix 8b: Padlet.com



https://padlet.com/ringolee4343/fwft-x-eduhk-biology-beyhrp1qgdb4g48d

8.14 Appendix 9.1: Design process from each testing group

<table>
<tr><th>Group No.</th><th>Design process</th></tr>
<tr><td>1</td><td> 
<table><tr><td>Design process from Group 1:

https://youtu.be/c3wFfdBDSV0</td><td></td></tr></table></td></tr>
<tr><td>2</td><td>  </td></tr>
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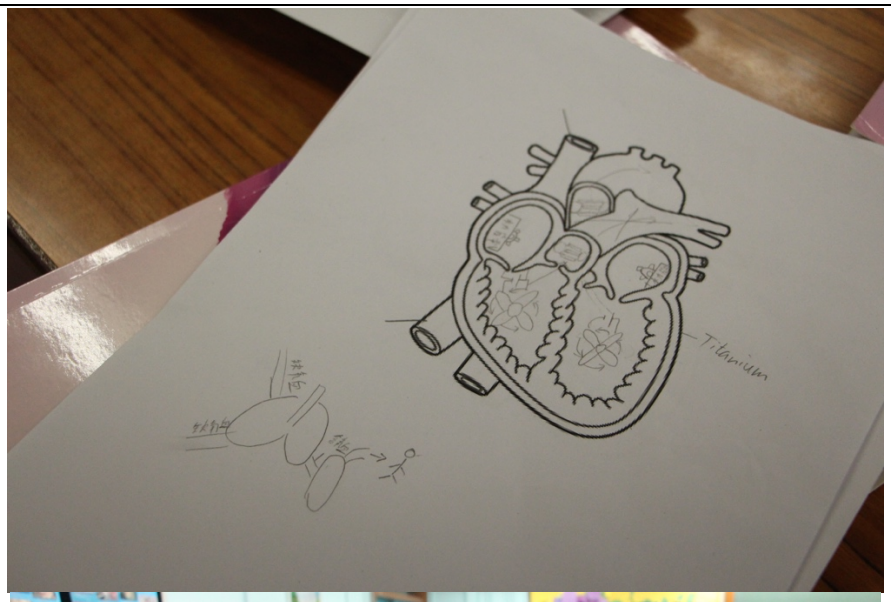
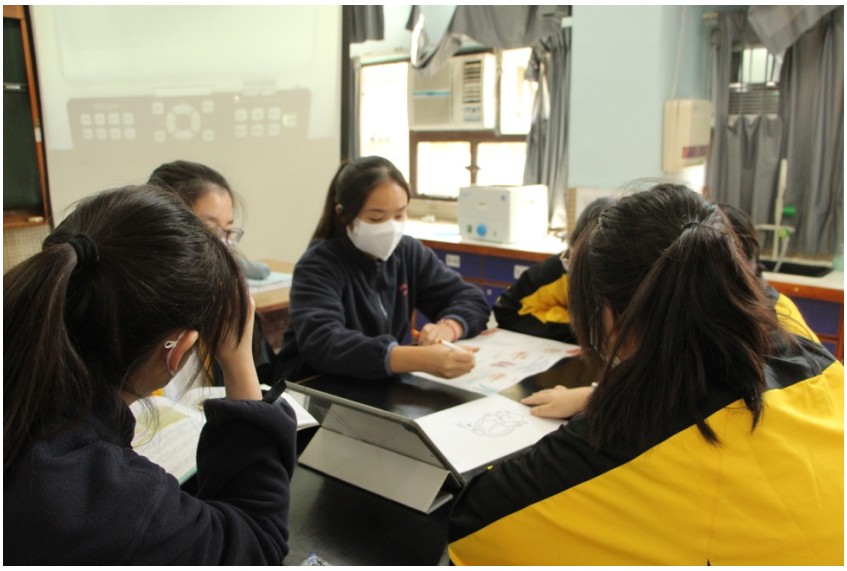
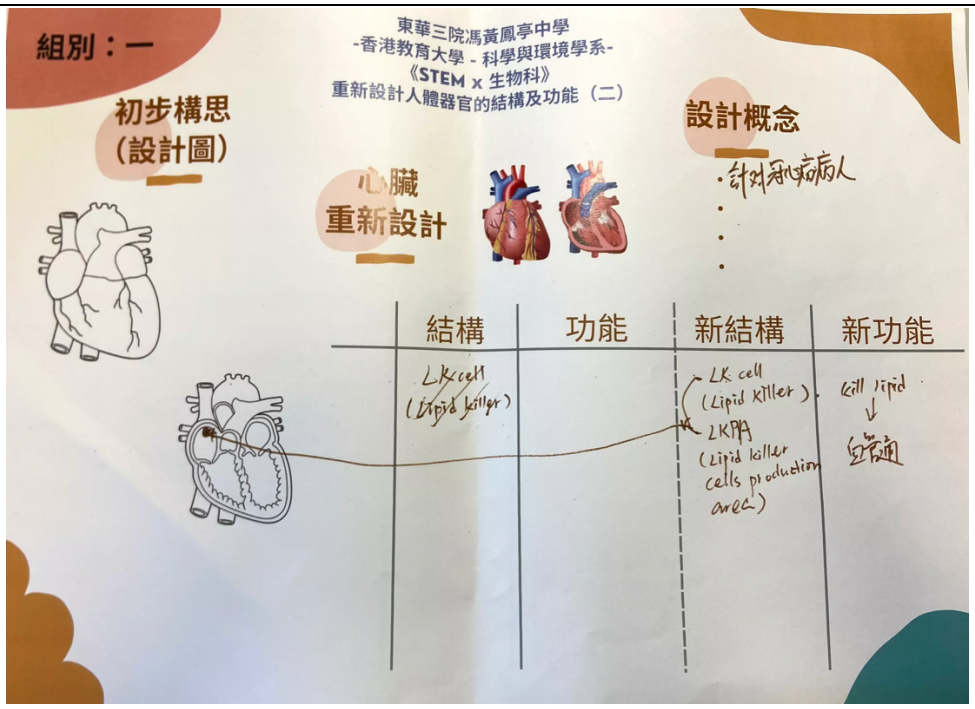
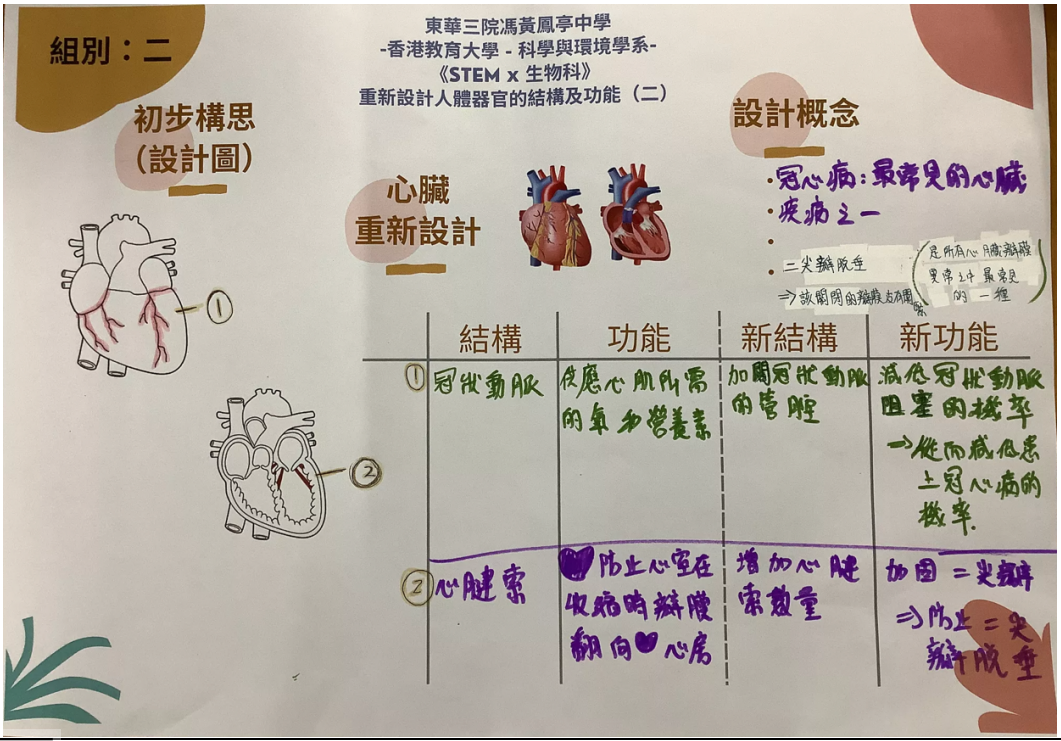
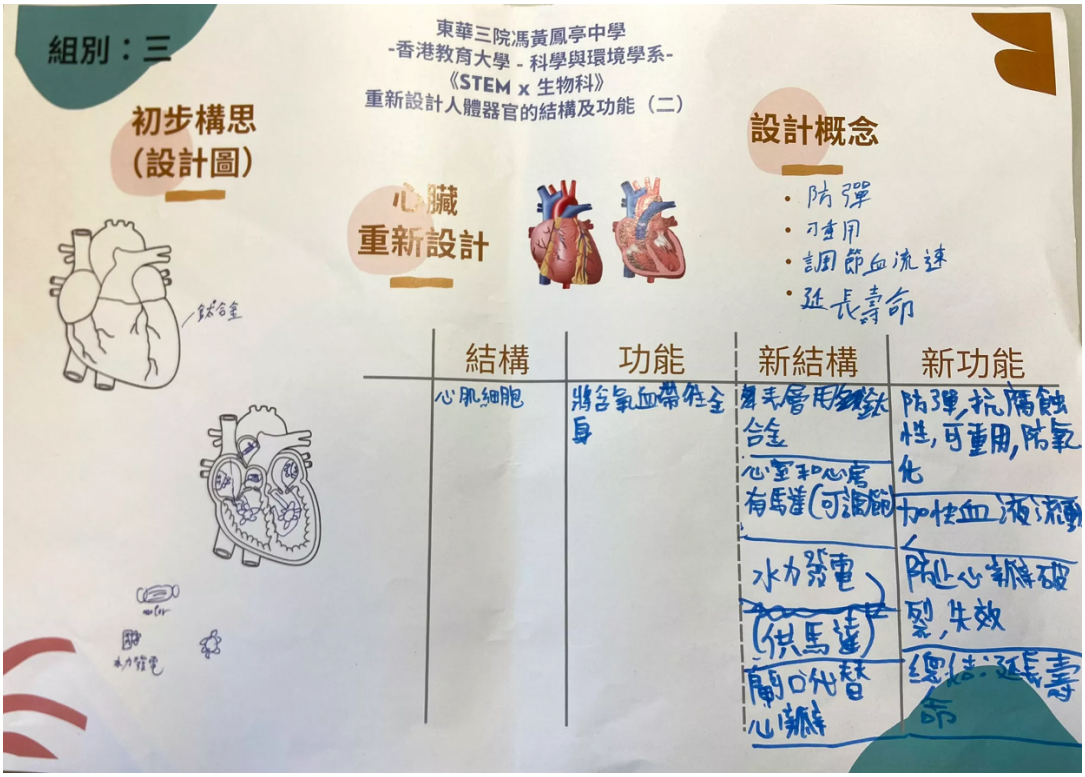
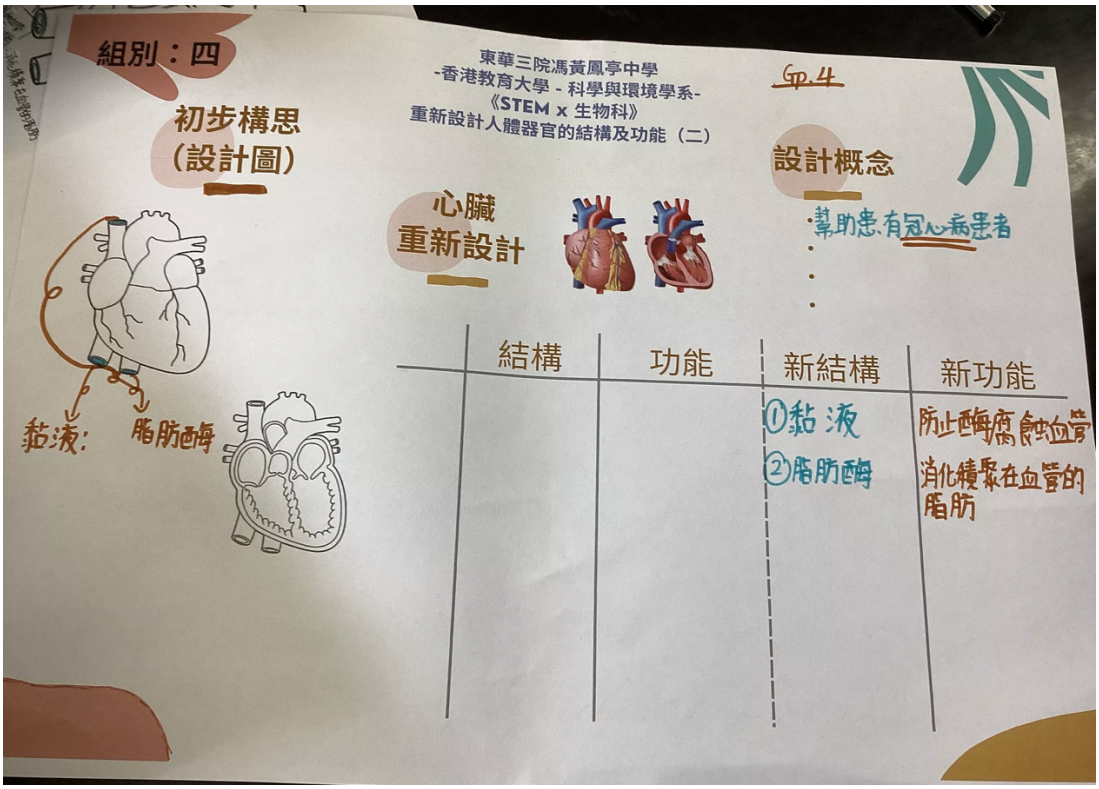
3	 

	Design process from Group 3: https://youtu.be/BBrnbTD1Qow	
4		
	Design process from Group 4: https://youtu.be/st_NigDkpf4	

8.15 Appendix 9.2: Product from each testing group

Group No.	Product from each testing group
1	
2	

	Testing group Product Group 2: https://youtu.be/MxBmqOoc9CE
3	 **Testing group Product Group 3 (Presentation):** https://youtu.be/6jo8d3PU89U

4	

Testing group Product Group 4: **https://youtu.be/rCXTTxPECfw**	

8.16 Appendix 10: Interview data and result

訪問及語錄
針對課程的回應：
1. 參加完整個課程，你喜歡哪一個活動？為甚麼？整個活動最深刻是什麼？

同學A) 我最中意就係可以係到用個apps去畫個心果段。因為以前上堂唔會有既，平時都只係睇下模型睇下片。

同學B) 這是一門創新課程，我中意關於動物心臟的部分。因為以為所有動物的心臟結構都與人類一樣，但原來不同。不同動物都進化了一套最適合自己的心臟。我最喜歡的部分是將人類心臟的結構與不同動物進行比較。 我意識到並不是所有的動物體內都有兩個循環系統。

同學C) 我最喜歡自我創作的一部分，因為比較新穎和有趣，認識同樣增加了。原來心臟的功能和構造可以有不同的構造。我認為能成功地實現了我們探究心臟結構的新想法。

2. 在課程中，有甚麼體會？有什麼得著和反思？

同學A) 令我認識到唔係全部生物既構造都不同唔似人類有2套循環系統，也學習到人類的器官不是完美也有缺點。

同學B) 最困難是要重新設計人類心臟這部分，因為人類心臟都由長時間進化到現在的模樣，但我覺得現化人生活令到心臟病等疾病發生的機率比以往高，很難再改良心臟結構。

同學C) 我發現做生物學研究很有趣，我可能會嘗試閱讀更多有關香港人體器官和生物技術的資料。

3. 你認為課程是否有新奇、創意性的教材？能否增加你對生物科學探究的興趣？

同學A) 都算既。因為都係要我地自己去設計返，去改良返個心啦。

同學B) 我覺得給我們了解其他生物心臟結構的部分對重新設計心臟結構有幫助。另外心臟晶片也啟發了我，現今科技發達，我也可以有天馬行空的想法。

同學C) 我認為原創性十足，利用我們所學-心臟結構，並轉化知識，相當有趣。都能提升。

4. 重新設計心臟的課程，能否增加你對生物科學探究的興趣？

同學A) 有的。因為都想探究多些生物。有。心臟既結構。有趣，另外其他動物心臟的結構可以再深入了解。

同學B) 有！但除了心臟結構外，我希望可以了解其他器官的結構。但今次課程只著重心臟。

同學C) 有助我增加。原來世界上生物分別可以十分大，例如魚與人；或青蛙與人的心臟都大為不同。十分有趣！

課程前/後：
5. 透過重新設計器官，最能提升什麼？

同學A) 創意。可以更加深入了解我地心臟結構。很有創意！ 課程中，我最喜歡的部分是我可以使用該應用程序重新設計心臟結構。

同學B) 應該是想像力方面。聽取其他同學的想法後覺得自己也可以將天馬行空的想法放到這個課程內。

同學C) 可以提升我哋想像力同工作的速度。因為只有2堂時間，就要完成條片，加Presentation對於我是高難道挑戰。希望下一次堂數可以增加一下！

-完-

-The End-