



教育應用資訊科技發展研究中心

香港大學 教育學院

Designing learning for self-directed learning in STEM education

STEM 教育中自主學習的學習設計

Rachel KO, Centre for Information Technology in Education, HKU (香港大學 教育應用資訊科技發展研究中心)

Kelly CHAN, Centre for Information Technology in Education, HKU (香港大學 教育應用資訊科技發展研究中心)

Diana LO, Holy Angels Canossian School (天神嘉諾撒學校)

LTE --- 8 DEC, 2021



Centre for
Information Technology
in Education

Faculty of Education
The University of Hong Kong



提要：

用自主學習方法設計 K-12 STEM 課程主題給教師帶來了挑戰。學習設計工作室 (LDS) (<http://ldsstem.cite.hku.hk>) 旨在協助教師設計綜合 STEM 課程單元。LDS 為設計自主學習提供了結構化的操作指南，其中包含兩種最常見的探究學習：科學探究和工程設計。它還提供了可重用的設計樣板和課程單元設計，供教師參考。主講學校將透過以混合模式實施的 STEM 主題為例子，與HKU CITE 團隊成員一起分享學習設計過程和工作室 (LDS) 的分析。



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學習設計

電子學習? 社交環境? 如何學?

混合

分組

對話中學習

線上

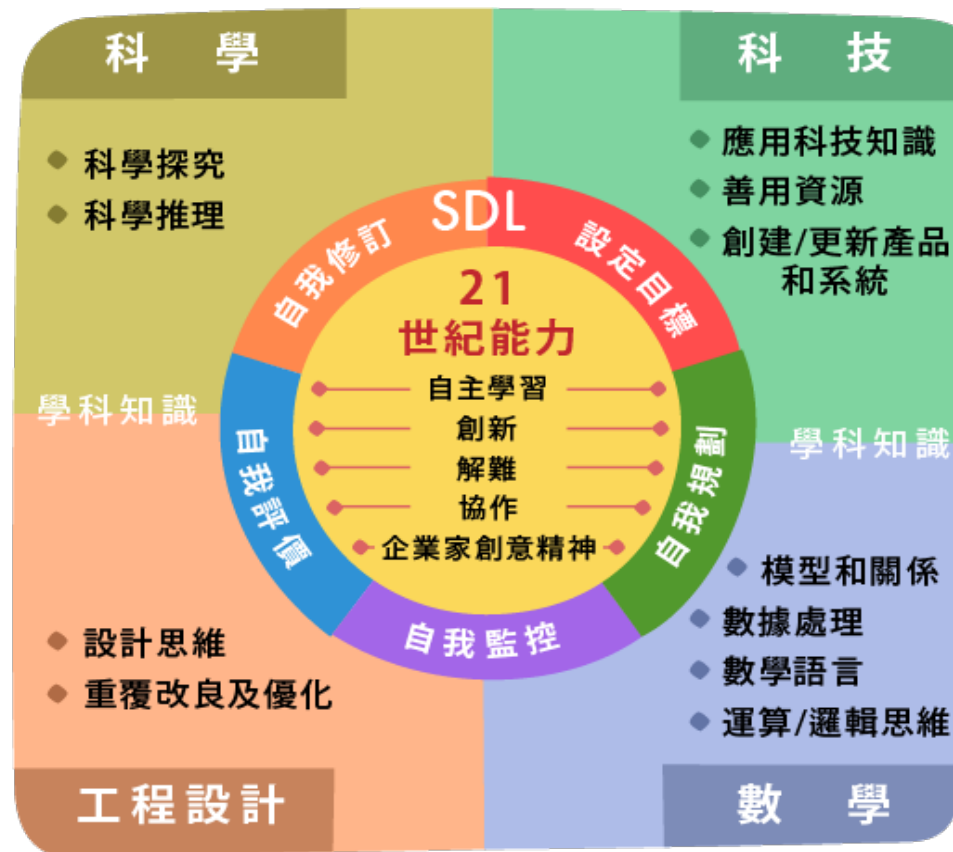
個人

搜尋資料
接收資訊及分析

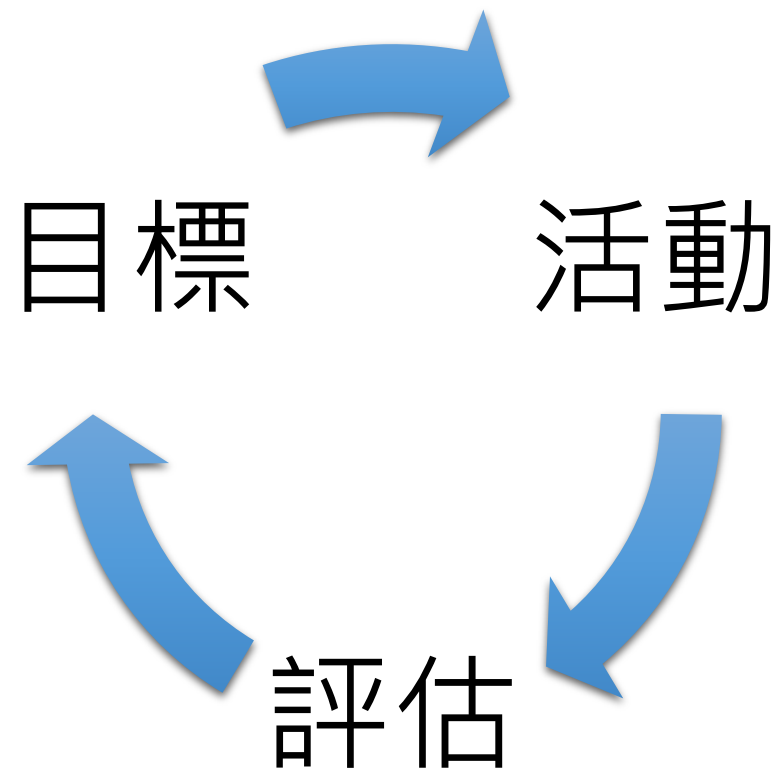


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設計目標: 自主學習STEM課程單元



設計原理：建設性一致



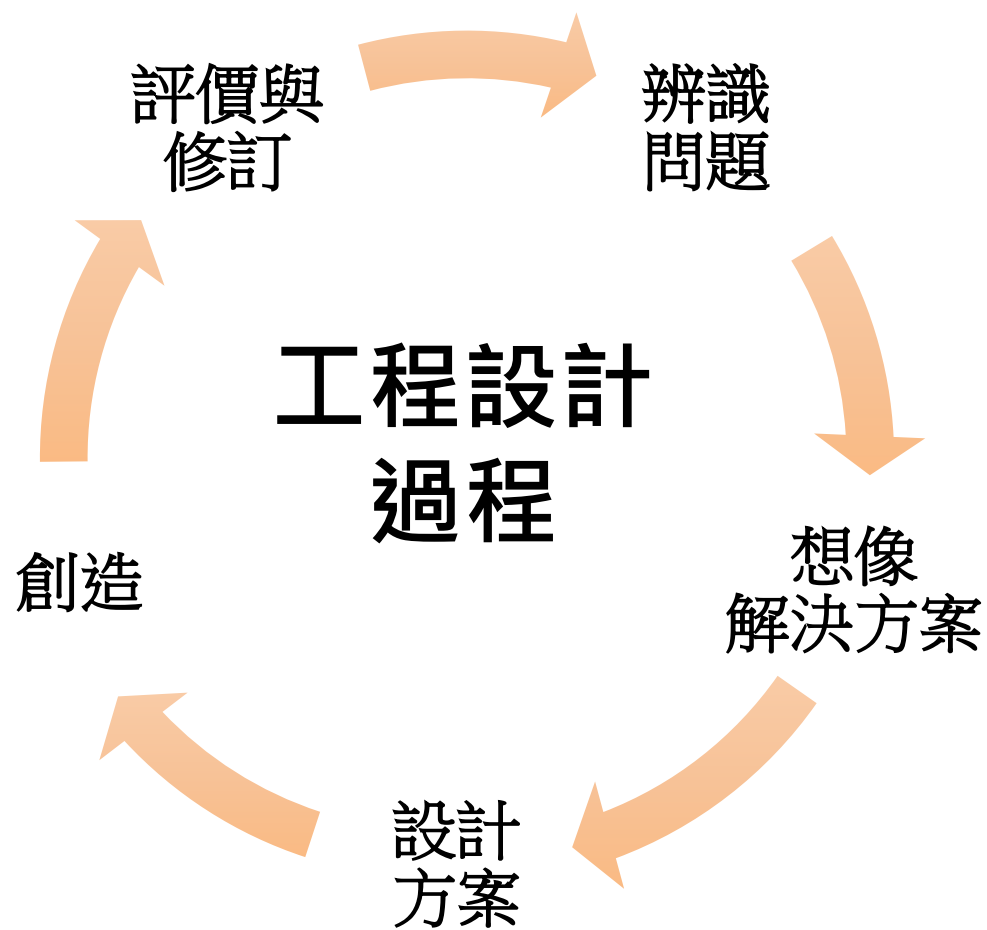
學習設計：建設性一致

Constructive alignment (Biggs, 1996)



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設計原理: 自主學習STEM---兩大實踐過程



學習設計工作室 Learning Design Studio(LDS)

冷氣機防堵塞/滴漏提示裝置



[https://ldsstem.cite.hku.hk/publicsharing/\\$2y\\$10\\$Y dpHFrZDgQ u96V XN 3j9pbOZsIV uBzIPbZSuA oy6onm84ym2wjXV W](https://ldsstem.cite.hku.hk/publicsharing/$2y$10$Y dpHFrZDgQ u96V XN 3j9pbOZsIV uBzIPbZSuA oy6onm84ym2wjXV W)



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Course Level Design Template: Engineer (Engineering Design + Self-directed Learning)

Topic

冷氣機防堵塞/滴漏提示裝置 (天神嘉諾撒學校)

School

天神嘉諾撒學校

School Level Curriculum Goal

透過參與改善或優化校園環境，加強學生對學校的歸屬感及解決困難的能力

Grade/ Level [?]

P6

Subject

常識科老師、數學科老師、資訊科技科老師 (IT支援同事)

Number of Session/Lesson [?]

4

Time Per Session/Lesson

45

min(s)

Technology [?]

iLAP (可能使用micro:bit、蜂鳴器)

Prior Knowledge

閉合電路、簡單機械

Description [?]

學生了解發生在校園內的問題後，化身成「改善校園工程師」，透過實踐工程設計循環，設計一個有效防止雀鳥停留冷氣機托盤的裝置，或防止樹葉等雜物堵塞冷氣機托盤去水口的裝置

Tags [?]

冷氣機托盤

防堵塞

滴漏

工程設計

改善校園

關愛校園

Course Information

Learning Outcomes

Curriculum Component

Session/Lesson Plan

Timeline

Evidence

Review

Course Information

Learning Outcomes

Curriculum Component

Session/Lesson Plan

Timeline

Evidence

Review

DISCIPLINARY KNOWLEDGE

- 使用簡單機械令製作可以活動的裝置
Discipline Type(s): (Technology) Bloom Taxonomy Level: Apply
- 有需要時應用光、聲或電的知識設計裝置
Discipline Type(s): (Science) Bloom Taxonomy Level: Apply
- 準確量度以致裝置能置於冷氣機或托盤上
Discipline Type(s): (Mathematics) Bloom Taxonomy Level: Apply

Disciplinary Knowledge

DISCIPLINARY SKILLS

- 設計一個有效防止雀鳥停留冷氣機托盤的裝置，或防止樹葉等雜物堵塞冷氣機托盤去水口的裝置
Discipline Type(s): (Engineering) Bloom Taxonomy Level: Create
- 通用iLAP平台作預習準備及紀錄
Discipline Type(s): (Technology) Bloom Taxonomy Level: Apply
- (可能)使用micro:bit或其他類型的感應裝置(如感光器)
Discipline Type(s): (Technology) Bloom Taxonomy Level: Apply
- 製作一個能固定在冷氣機或托盤上的裝置
Discipline Type(s): (Engineering) Bloom Taxonomy Level: Create
- 製作一個有效防止雀鳥停留冷氣機托盤的裝置，或防止樹葉等雜物堵塞冷氣機托盤去水口的裝置
Discipline Type(s): (Engineering) Bloom Taxonomy Level: Create

Disciplinary Skills

NON-DISCIPLINARY OUTCOMES

Apply self-directed learning strategies in the learning process and become a self-directed learner

Bloom Taxonomy Level:

Goal setting

Self-planning

Self-monitoring

Self-evaluation

Revision

Non-Disciplinary Outcomes

培養創意與想像力 – 提出原創意念，經細心思考，找出解決困難的最佳方法

Bloom Taxonomy Level: Apply

培養合作精神及溝通能力 – 與他人互動及清晰地表達自己的意見

Bloom Taxonomy Level: Apply

Intended Learning Outcomes
預期學習成果

CURRICULUM COMPONENTS

DISCIPLINARY PRACTICE

PEDAGOGICAL APPROACH

CC1 Goal-setting through identify problem

Identify problem

Goal Setting

CC2 Goal-setting and planning through ideate solution

Ideate solution

Goal Setting
Self-Planning

CC3 Self-planning for the success criteria and rubric

Ideate solution

Self-Planning

CC4 Self-planning for the design solution

Design solution

Self-Planning

CC5 Self-planning through construct prototype

Construct prototype

Self-Monitoring

CC6 Self-evaluation and revision through test performance of the product 1.0

Test performance and optimize the product

Self-Evaluation
Revision

CC7 Self-evaluation and revision through optimize the product

Test performance and optimize the product

Self-Evaluation
Revision

CC8 Self-evaluation and revision through test performance of the product 2.0

Test performance and optimize the product

Self-Evaluation
Revision

- Course Information
- Learning Outcomes
- Curriculum Component
- CC1-Goal-setting through ide...
- CC2-Goal-setting and plannin...
- CC3-Self-planning for the suc...
- CC4-Self-planning for the d...
- CC5-Self-planning through co...
- CC6-Self-evaluation and revis...
- CC7-Self-evaluation and revis...
- CC8-Self-evaluation and revis...
- Session/Lesson Plan
- Timeline
- Evidence
- Review

CC 4 : Self-planning for the design solution

DISCIPLINARY KNOWLEDGE

- 有需要時應用光、聲或電的知識設計裝置
- Discipline Type(s): (Science) Bloom Taxonomy Level: Apply

DISCIPLINARY SKILLS

- 運用iLAP平台作預習準備及紀錄
- Discipline Type(s): (Technology) Bloom Taxonomy Level: Apply
- 設計一個有效防止雀鳥停留冷氣機托盤的裝置，或防止樹葉等雜物堵塞冷氣機托盤去水口的裝置
- Discipline Type(s): (Engineering) Bloom Taxonomy Level: Create

NON-DISCIPLINARY OUTCOMES

- Apply self-directed learning strategies in the learning process and become a self-directed learner
- Bloom Taxonomy Level: Self-monitoring

ADD LEARNING OUTCOME

Colour bars indicate task type

Design solution | Self-Planning

Learning Design Patterns & Tasks

Pattern 4: Self-planning through create design plans

Students work out a plan/draw sketch design to construct prototype

Construction: Conceptual / Visual Artefacts

- Apply self-directed learning strategies in the learning process and become a self-directed learner, 有需要時應用光、聲或電的知識設計裝置, 運用iLAP平台作預習準備及紀錄, Self-monitoring, 設計一個有效防止雀鳥停留冷氣機托盤的裝置, 或防止樹葉等雜物堵塞冷氣機托盤去水口的裝置.
- 20 mins
- Individual
- Out-of-classroom
- Worksheets,
- Individual
- Wiki, Discussion Forum, Lesson (Branching exercises),
- N/A
- N/A

學生在工作紙初擬裝置的設計, 需要註明物料、尺寸、功能及顏色(或直接填上顏色), 並上載至iLAP討論區 工作紙: 裝置設計初稿

Students receive feedback and comments from teachers and other students

Self-/Peer-assessment

- 運用iLAP平台作預習準備及紀錄, Self-monitoring, Apply self-directed learning strategies in the learning process and become a self-directed learner,
- 10 mins
- Individual
- Out-of-classroom
- Rubrics,
- Individual
- Discussion Forum,
- N/A
- N/A

學生在iLAP平台互相評處設計圖, 並留言給予意見

Students revise the design based on the feedback received.

Revision

- 10 mins
- Individual
- Out-of-classroom
- Worksheets,
- N/A
- N/A

學生收集意見, 並改良設計

Component Live Analysis

Details of task design

A task taxonomy for teachers to have a clear visualization of the profile of the learners' experiences

Directed Learning

Receiving & Interpreting Information Students work through prescribed content materials as instructed by the teacher

Practice Students work through prescribed tasks to apply learnt content/skills

Test/assessment Students take part in assessment activities

Exploratory Learning

Information exploration Students engage in information exploration through search, selection and evaluation

Exploration through conversation Students engage in exploration of issues with others through conversations

Tangible/immersive investigation Students engage in investigative explorations in physical or virtual settings

Productive Learning

Construction: conceptual/visual artefacts Students work individually or together to construct a conceptual, visual artifact

Construction: tangible/manipulable artefacts Students work individually or together to construct a tangible, manipulable artifact

Presentation, performance and illustration Students present, illustrate or perform individually or in group

Reflective Learning


Reflection Students engage in reflecting on the learning process & experience and making the thoughts explicit


Revision Students are given an opportunity to re-submit a piece of work, hence giving them a chance to reflect and improve


Self/peer assessment Students engage in peer- and/or self- assessment (using self-generated or teacher-provided rubric)

< 冷氣機防堵塞/滴漏提示裝置 (天神嘉諾撒學校)

天神嘉諾撒學校


 Course Information


 Learning Outcomes


 Curriculum Component


 **Session/Lesson Plan**

 Timeline


 Evidence

 Review

Lesson1 

Lesson2 

Lesson3 

Lesson4 

View All

 ADD NEW

Lesson1

In Class Duration - 45

Pre-Class

Estimated Learning Time: 0 min(s)

No Learning Task In Pre-Class

In-Class

Targeted Learning Time: 45 min(s)

Estimated Learning Time: 45 min(s)

=

Component #1 - Students observe the scenario of the design problem through stimulus

=

Component #1 - Students present their findings on user needs to the whole class

=

Component #1 - Students work on the information collected and select the most prominent problem needed to be addressed.

=

Component #2 - Students revise the design problem based on the feedback received.

Post-Class

Estimated Learning Time: 20 min(s)

=

Component #2 - Students search and study existing solutions to the users needs.





冷氣機防堵塞/滴漏提示裝置 (天神嘉諾撒學校)

天神嘉諾撒學校

Resources Tools

- Course Information
- Learning Outcomes
- Curriculum Component
- Session/Lesson Plan
- Timeline**
- Evidence
- Review


A detailed timeline layout for planning learning task and required tools and resources

	Lesson1		
	Pre-Class	In-Class	Post-Class
	30min 60min 90min	30min 45min	30min 60min 90min
 Individual		 Studen...	 Students search ...
 Group			
 Peer			
 Whole Class		 Students ob... Studen... Studen...	
 Swap Area			



- Course Information
- Learning Outcomes
- Curriculum Component
- Session/Lesson Plan
- Timeline
- Evidence**
- Review

以學校的冷氣機作引入，設訂目標設計一個裝置防止上述情況堵塞出口位置

Types of Evidence Samples Added: 

DISCIPLINARY PRACTICE

No Linked Disciplinary Practice

PEDAGOGICAL APPROACH

No Linked Self-Directed Learning

LINKED CURRICULUM COMPONENTS

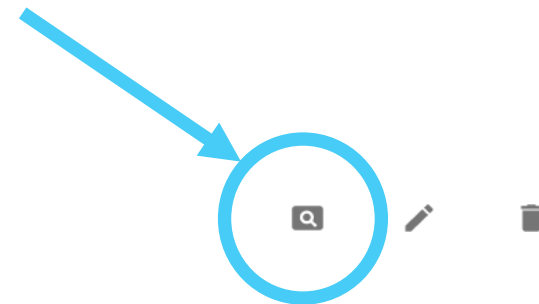
CC1: Goal-setting through identify problem

LINKED LEARNING OUTCOMES


No Linked Learning Outcomes

LINKED TASKS

Students observe the scenario of the design...



學生觀看影片了解冷氣機盛水盤情況和搜集相關資料

Types of Evidence Samples Added: 

DISCIPLINARY PRACTICE

No Linked Disciplinary Practice

PEDAGOGICAL APPROACH

No Linked Self-Directed Learning

LINKED CURRICULUM COMPONENTS

CC1: Goal-setting through identify problem

LINKED LEARNING OUTCOMES

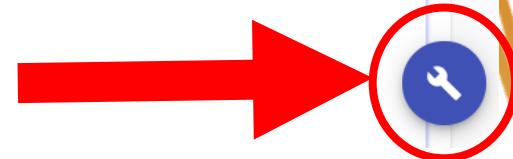
Apply self-directed learning strategies in the ... Goal setting

LINKED TASKS

Students work on the information collected a



Press this button and choose the dashboard.



Course Analysis

Curriculum
Component
Analysis

Session/Lesson
Analysis

Course Analysis

Distribution of time spent on learning task types



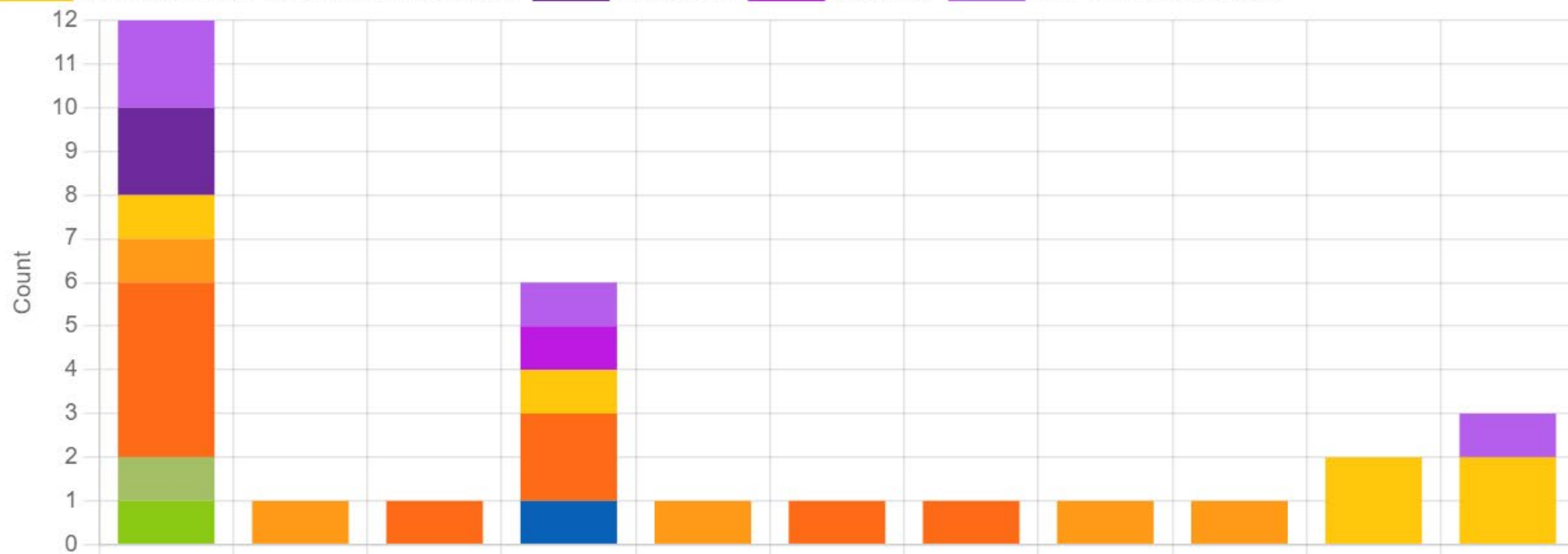
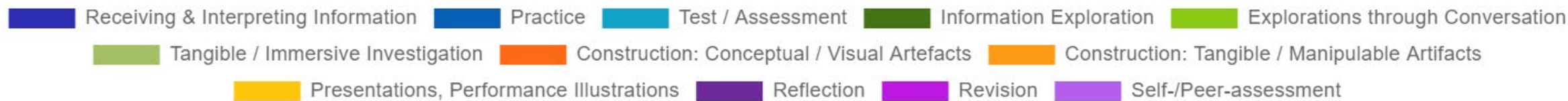
Total time: 370min

Distribution of number of learning task types



Total num: 25

Breakdown of number on assessment tasks by task type for each learning outcome



Apply self-directed learning strategies in the l...

使用簡單機械令製作可以活動的裝置

有需要時應用光、聲或電的知識設計裝置

運用iLAP平台作預習準備及紀錄

(可能)使用micro:bit或其他類型的感應裝置(如感光器)

保留冷氣機托盤的裝置，或防止樹葉等雜物堵塞冷氣機托盤上的裝置

製作一個能固定在冷氣機或托盤上的裝置

準確量度以致裝置能置於冷氣機或托盤上

培養合作精神及溝通能力—與他人互動及清晰地表達自己的意見

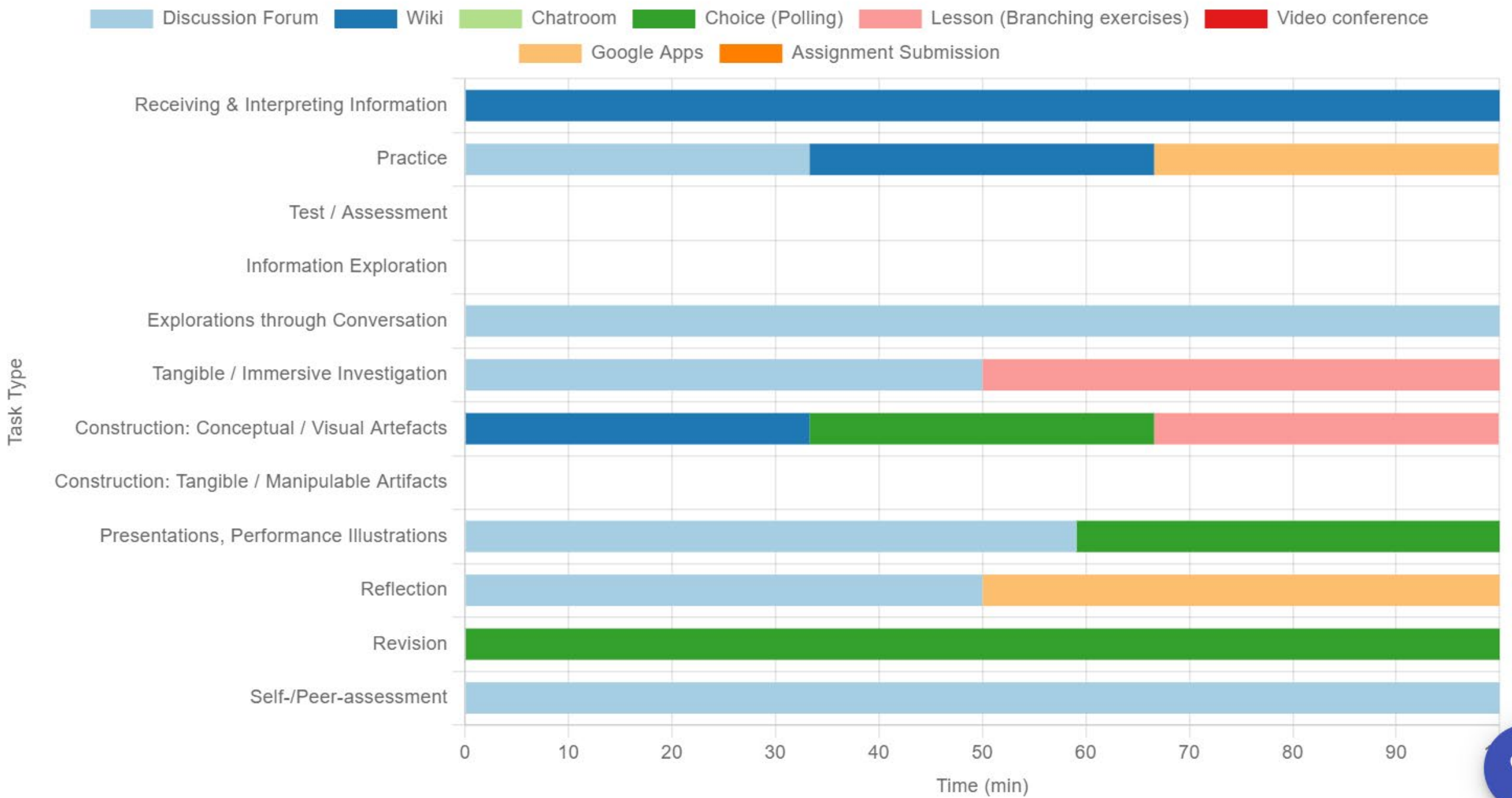
提出原創意念，經細心思考，找出解決困難的最佳方法

提出原創意念，經細心思考，找出解決困難的最佳方法

提出原創意念，經細心思考，找出解決困難的最佳方法



Breakdown of time spent (in %) on synchronous learning tasks using each type of e-learning tool for each task type



In-STEM project website:

<https://instem.cite.hku.hk/>



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STEM學習設計

以下是在香港中小學課堂所實施的 STEM 學習設計清單。其中20個是從全方位自主學習推展校本STEM課程計劃（2019-2021年）參與學校的老師課堂實踐中選出。這些例子強調如何在工程設計過程和科學探究的STEM 學科實踐背景下，以自主學習為教學法來設計 STEM 課程。部份學習設計甚至提供了證據來說明學生在 自主學習STEM 課堂中的學習成果。透過分享這些學習設計，我們希望展示STEM教育中的設計思維和教學策略，供教師和教師教育工作者參考。

顯示 100 項結果

搜尋:

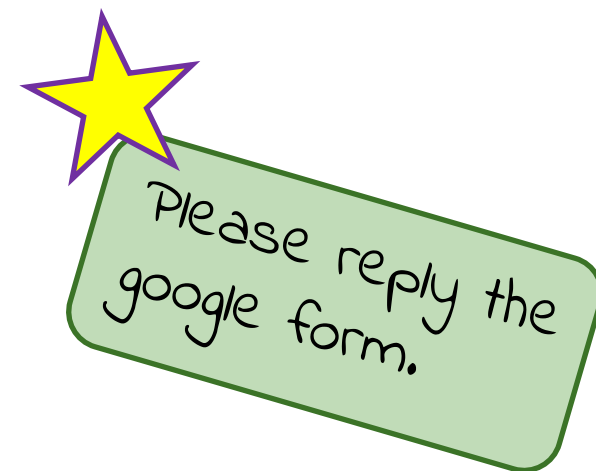
級別	STEM主題	課題	學校
小四	環境與環境保護, 食物和水	潔淨的水 與 濾水器與水質偵測器製作	九龍城浸信會禧年(恩平)小學
小四	社區關懷, 改善生活 / 產品	智能襪架	聖公會青衣邨何澤芸小學
小四	改善生活 / 產品	外用冷氣機	九龍婦女福利會李炳紀念學校
小四	改善生活 / 產品	外賣保溫箱	仁德天主教小學
小四	改善生活 / 產品	智能遊樂場: 電動籃球機	嘉諾撒小學(新蒲崗)
小四	環境與環境保護	黏合劑	嘉諾撒聖瑪利學校
小四	改善生活 / 產品	預防颱風	嘉諾撒聖瑪利學校
小四	食物和水	魚菜共生	天主教善導小學
小四	環境與環境保護	諾厄方舟	天主教善導小學
小四	改善生活 / 產品	走馬香薰燈	天神嘉諾撒學校
小四	食物和水	水質探測器 (過濾)	聖公會基恩小學

<https://instem.cite.hku.hk/zh/stem-learning-design-zh/>



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Interested with CITE?



<https://forms.gle/RNb8xC7JRPdumnVp8>



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“ what we know is a drop,
what we don't know is an ocean. ”

-Sir Isaac Newton

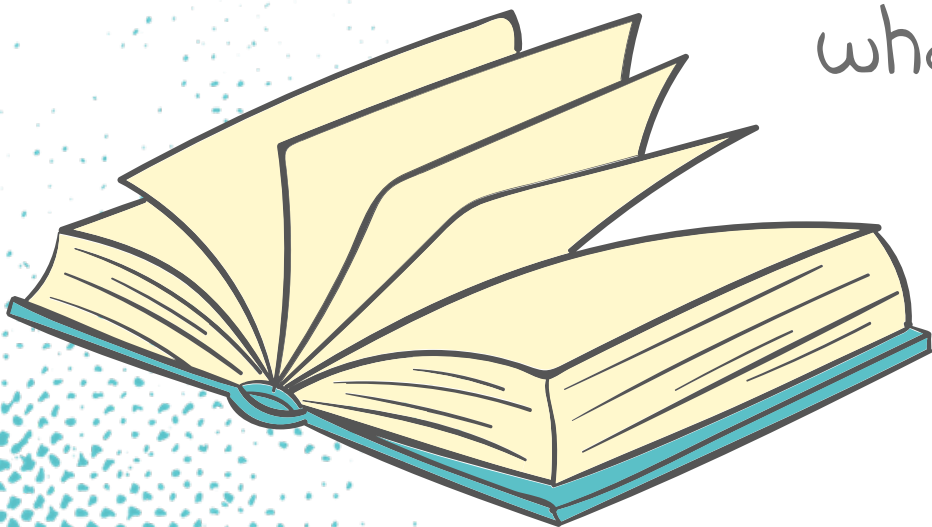


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“ what we know is a drop,
what we don't know is an ocean. ”

-Sir Isaac Newton

“ what we do is a drop,
what inspire our students is an ocean. ”



Thank you !



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THANK
YOU