Designing learning for self-directed learning in STEM education
STEM 教育中自主學習的學習設計

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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

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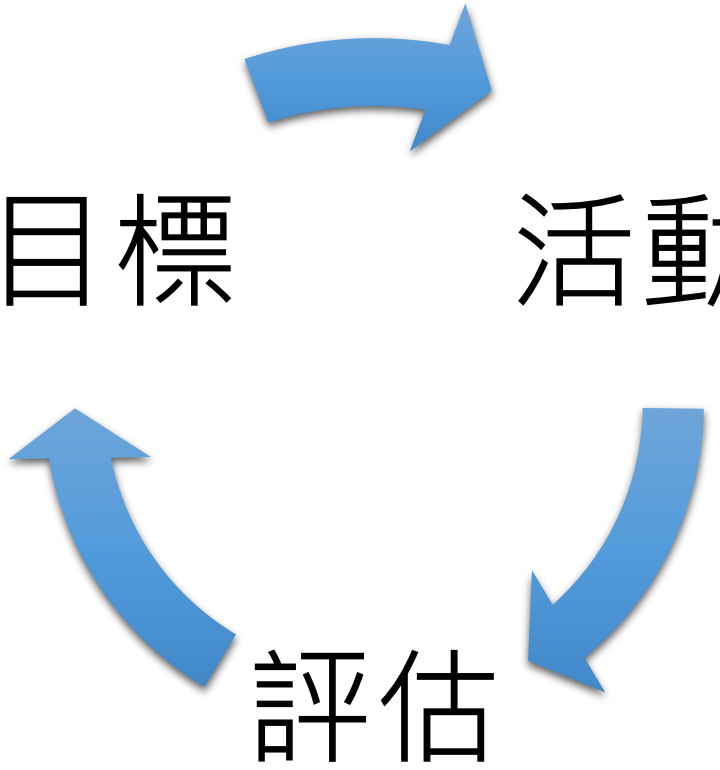
設計原理: 建設性一致



學習設計：建設性一致
Constructive alignment (Biggs, 1996)

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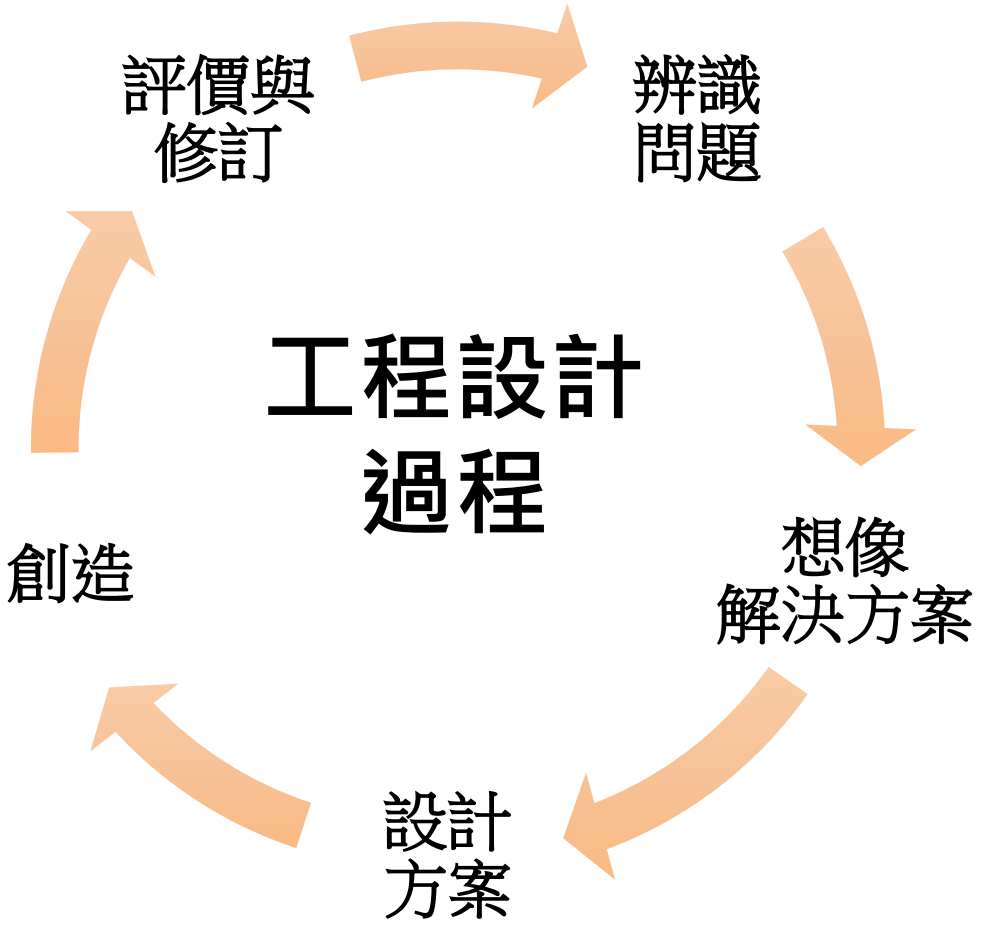
設計原理: 自主學習STEM---兩大實踐過程



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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$10$YdpHFrZDgQu96VXN3j9pbOZslVuBzIPbZSuAoy6onm84ym2wjXVW

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

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

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
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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): (Mathametics) Bloom Taxonomy Level: Apply

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

運用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

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

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

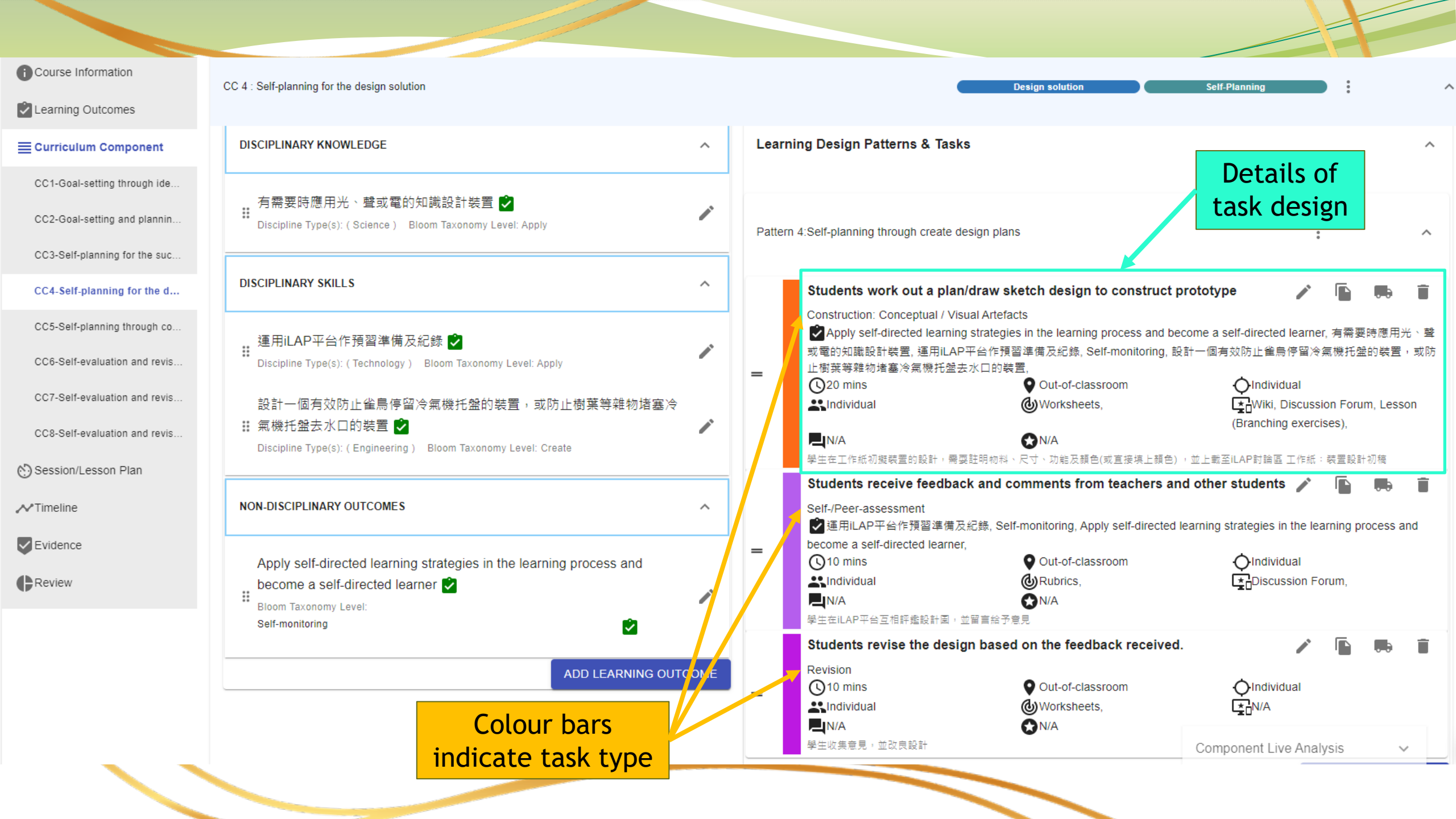
Disciplinary Knowledge

Disciplinary Skills

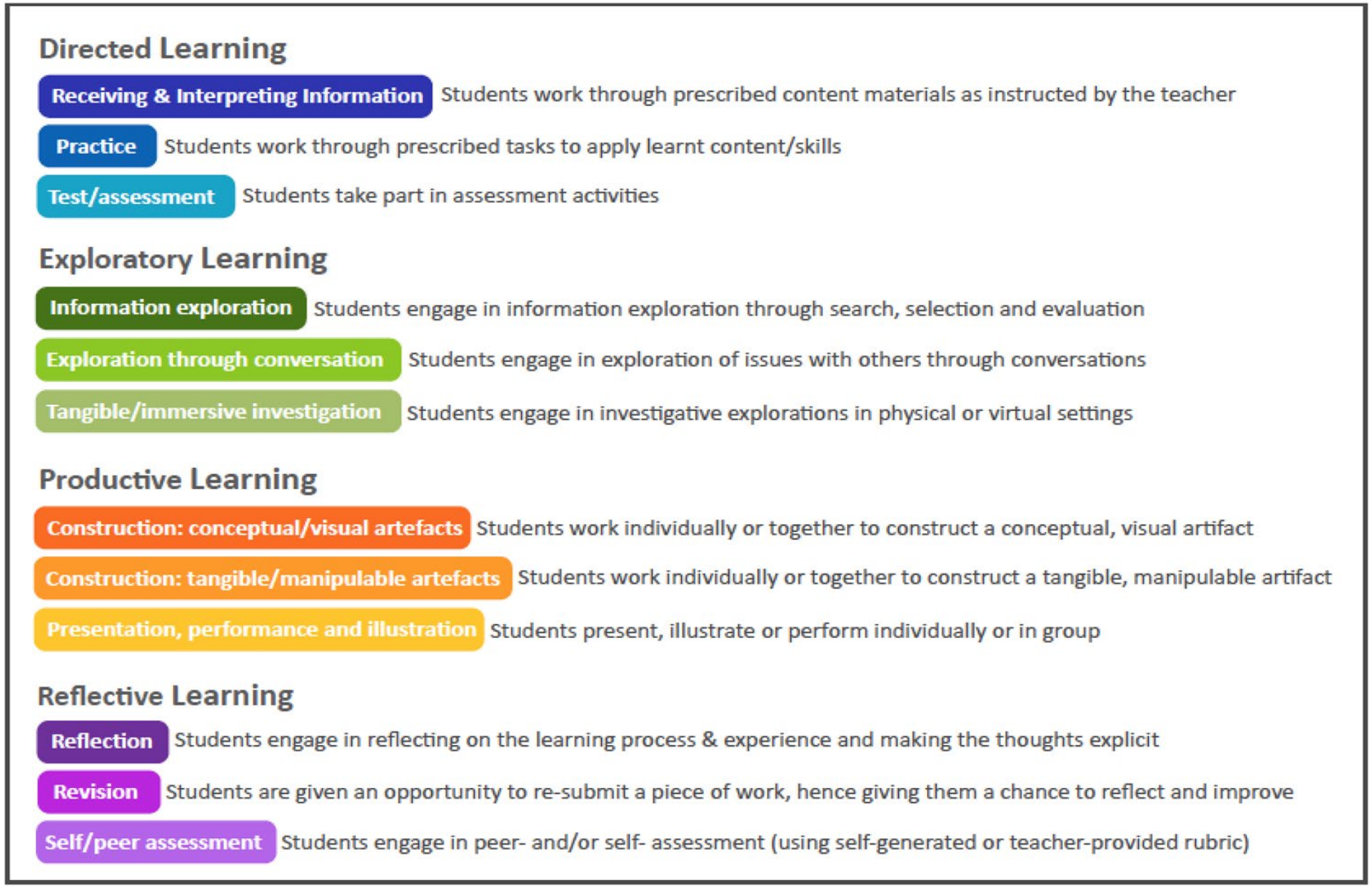
Non-Disciplinary Outcomes

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
Design solution
Self-Planning
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
Learning Design Patterns & Tasks
Details of task design
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
Out-of-classroom
Individual
Individual
Worksheets,
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
Out-of-classroom
Individual
Individual
Rubrics,
Discussion Forum,
N/A
N/A
學生在iLAP平台互相評鑑設計圖，並留言給予意見
Students revise the design based on the feedback received.
Revision
10 mins
Out-of-classroom
Individual
Individual
Worksheets,
N/A
N/A
N/A
學生收集意見，並改良設計
Component Live Analysis
Colour bars indicate task type

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



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

- Course Information
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- Timeline
- Evidence
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Resources Tools

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				Wiki: Studen...		Google Apps + Chat...: Students search ...		
Group								
Peer								
Whole Class				Wiki: Students ob...	Discussi...: Studen...	Choice (...: Studen...		
Swap Area								

Lesson1 | Lesson2 | Lesson3 | Lesson4 | All Lessons | + ADD LESSON

- 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

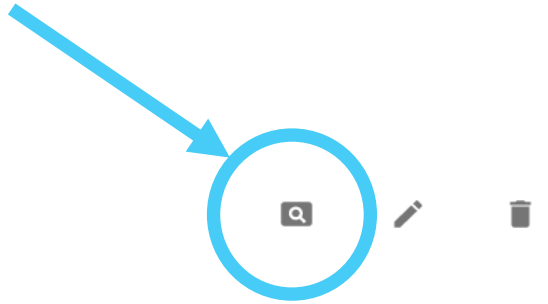
CC1: Goal-setting through identify problem

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盘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

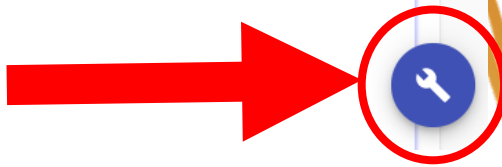
LINKED LEARNING OUTCOMES

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.

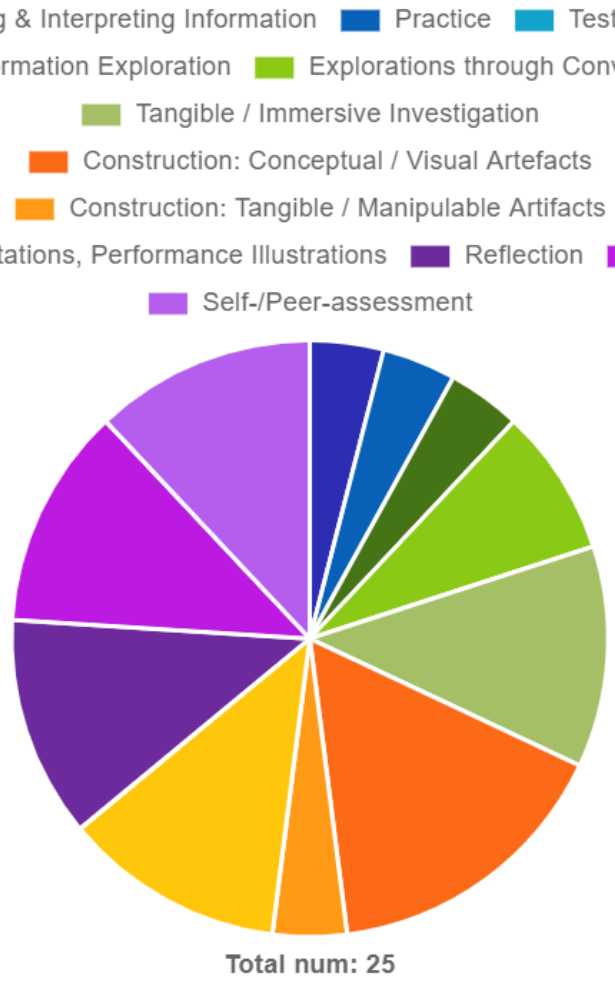


Course Analysis

Distribution of time spent on learning task types

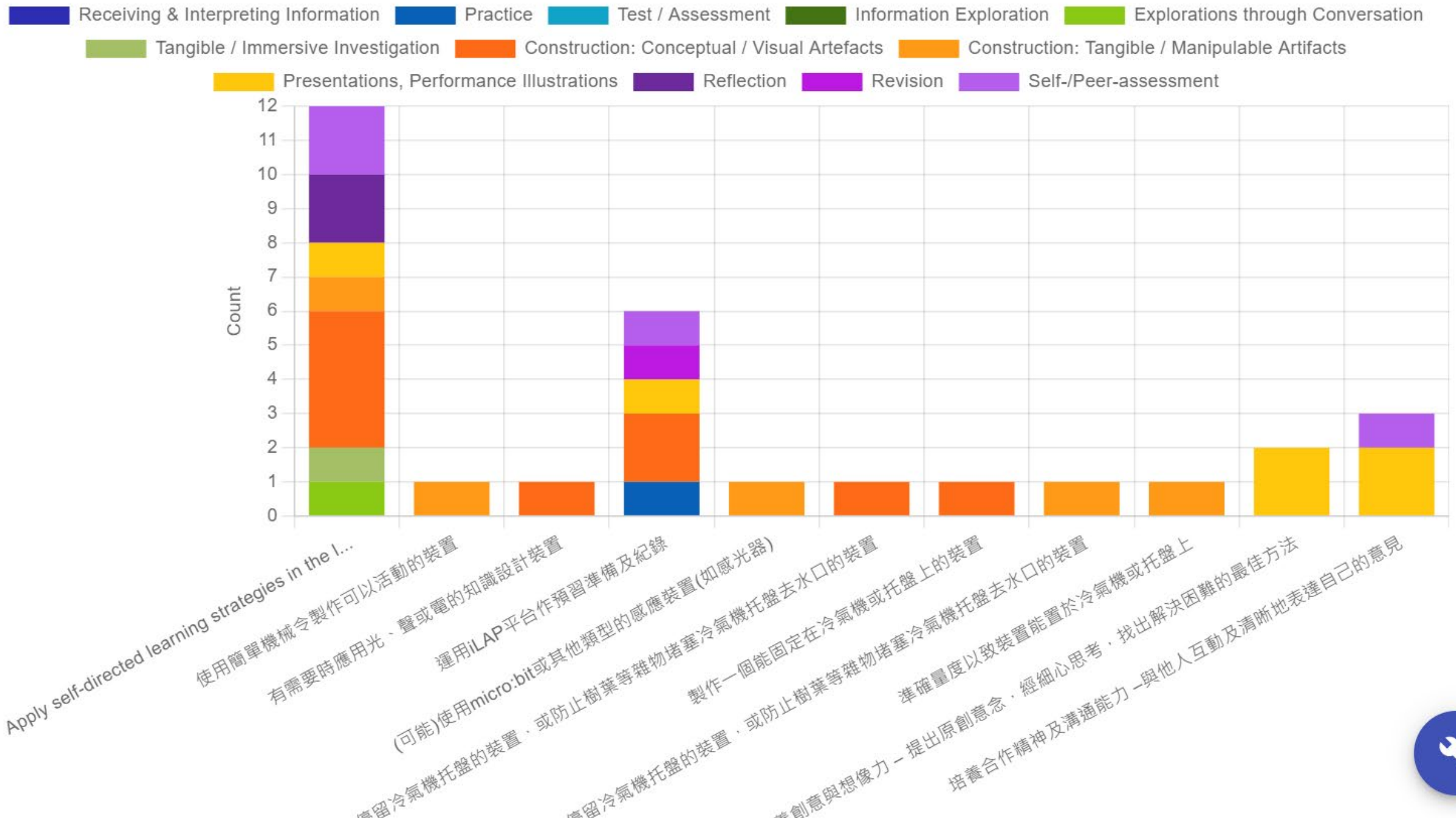
Total time: 370min

Distribution of number of learning task types

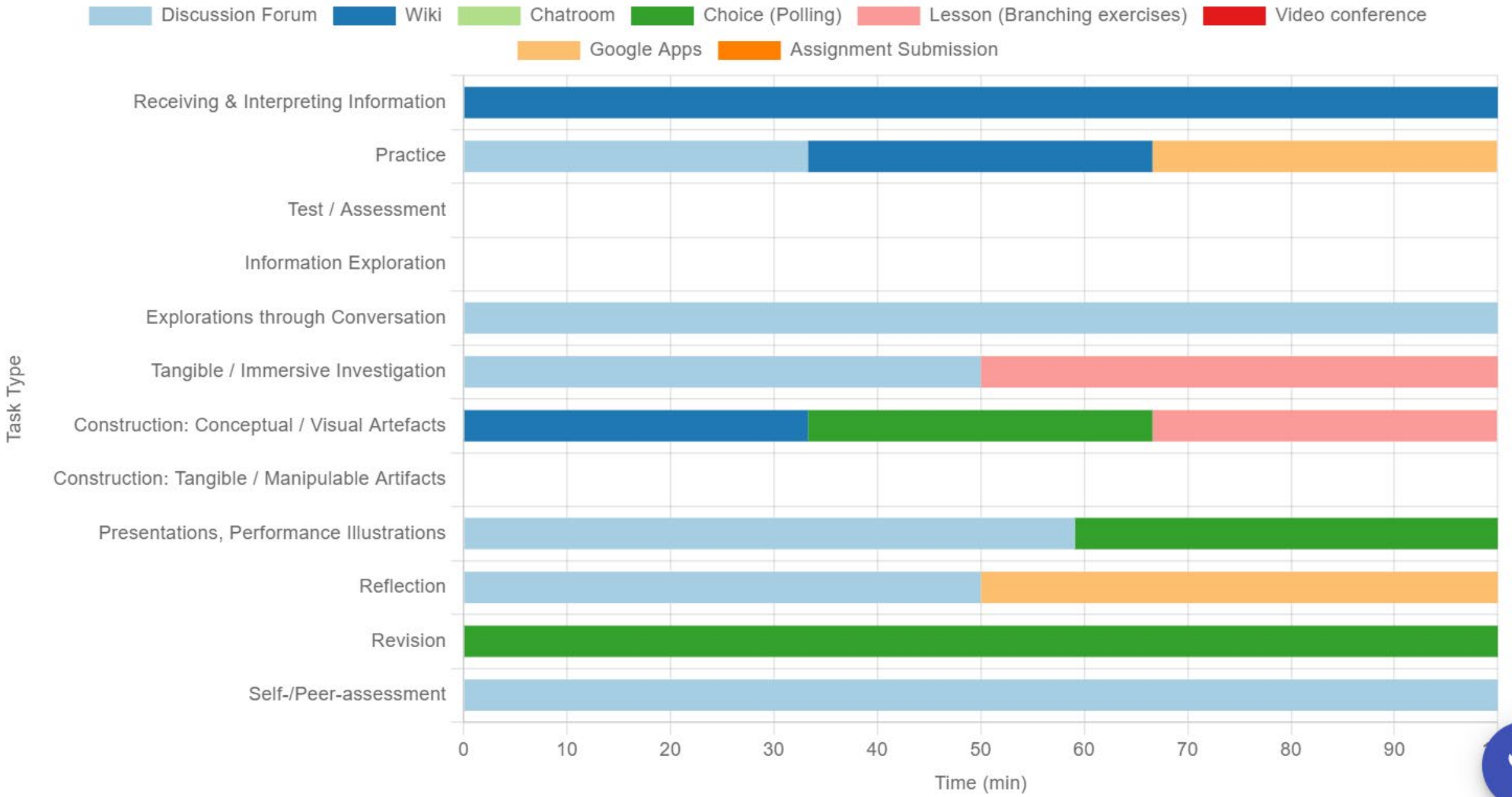


Total num: 25

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



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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CITE學習設計資源庫

STEM學習設計

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

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https://forms.gle/RNb8xC7JRPdumnVp8

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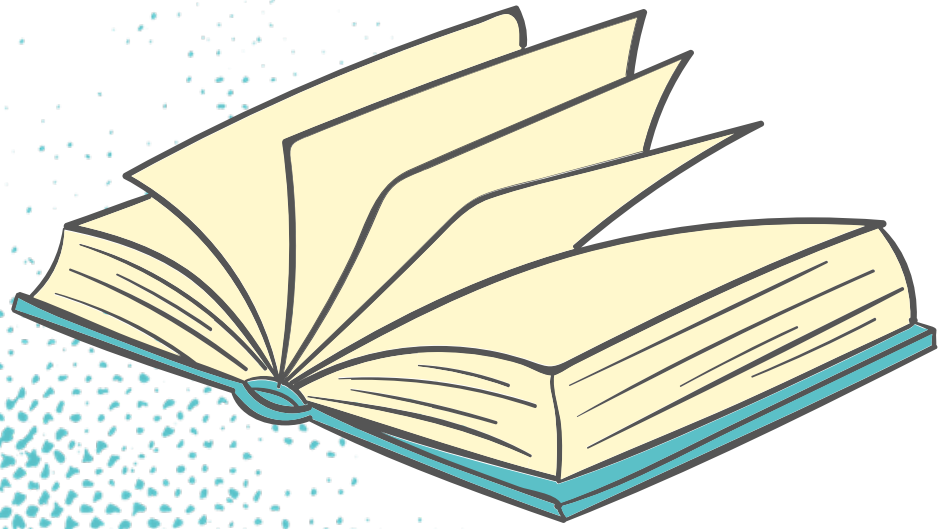
"what we know is a drop,
what we don't know is an ocean."

-Sir Isaac Newton



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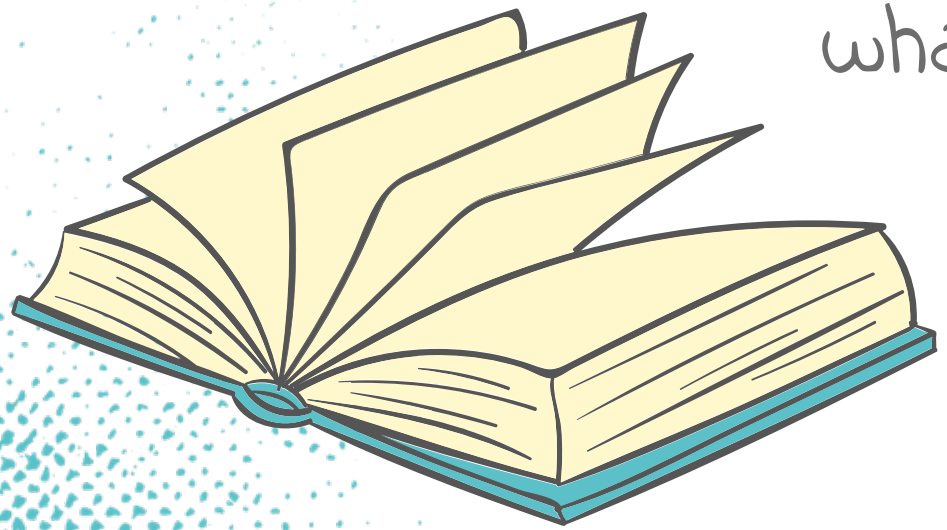
"what we know is a drop,
what we don't know is an ocean."

-Sir Isaac Newton

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



Thank you !

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THANK
YOU