Gifted Education School Network 2022/23

KLA/ Cluster: STEAM education

Lesson Design

Acknowledgement: This lesson example was adapted/adopted from the tryout by Mr YU Sze-chun of Carmel Pak U Secondary School

School	Carmel Pak U Secondary School
Level	Secondary 2
Topic	Candle Investigation
Lesson Duration	90 minutes (Gifted Pull-out lesson)
Learning Objectives	Knowledge - To apply the concept of combustion to an unfamiliar situation. Skills - To propose, evaluate and revise hypotheses that explain a puzzling phenomenon. - To analyse and interpret data collected from experiments for hypothesis testing Attitude - To develop curiosity and interest in science - To appreciate the process of scientific inquiry
Prior knowledge of students	(1) Students have learnt before about fire triangle, in which burning requires fuel, oxygen and high temperature. (2) Students have learnt before about carbon dioxide has higher density than oxygen and can displace oxygen such that burning will be stopped by removing oxygen from the fire triangle.
Highlights of this lesson	This lesson is designed to support gifted/ more able students to propose predictions and formulate hypotheses that explain an unexpected result from a classic three candles experiment. The experiment provides counter-intuitive results and allows students to explore the concept of gases and their properties. Using the predict-observe-explain instructional sequence, students first predict which candle would go out first with explanations. They then observe the behaviour of the candles in the covered glass jar and analyse the data to revise their initial explanations to formulate hypotheses that explain the phenomenon. Students design and conduct experiments to test their hypotheses. The lesson aimed to strengthen gifted/ more able students' scientific inquiry skills such as observation, data analysis and hypothesis testing, and to foster their higher-order thinking skills and creativity.
Differentiation Strategies employed	Inquiry-based learning Higher-order questionings

Activities	Rationales and Tips for Implementation
(A) Prediction The teacher ignites three candles of different lengths and asks students to predict which candle would go out first after a bell-jar covered the three candles. Students think individually and share their predictions in groups of 3 to 4 students. The teacher asks students to give explanations for their prediction.	To activate students' prior knowledge/ personal experience about burning, the teacher asks students to proposing a prediction for what would happen after a bell-jar is covered. Students are asked to give their own evidence for their prediction. It is anticipated that some students would think the shortest candle would go out first because it has the least amount of fuel (candle) while some students would think the candles would go out at the same time because the candles share the same amount of oxygen as covered in a glass jar. The teacher should elicit students' **reasoning** behind their choices and maintain a **non-judgemental** and **open** environment to articulate student thinking.
(B) Explanation After sharing students' individual views, the teacher distributes 4 or 5 different evidence cards out of the 9 evidence cards in 4 different groups and students in each group are asked to come to a consensus for choose the most probable evidence card to support their prediction. Evidence cards 1 to 5 are distributed to two groups (i.e. group 1 and group 3) and evidence card 4 to 9 are distributed to another two groups (group 2 and 4). Students will focus on their own group discussion since the group seating next to them are having different sets of evidence cards. Students use the evaluation grid as a tool to classify and evaluate the evidence that support or reject their proposed prediction. The teacher invites students to share why they pick up certain evidence cards but not the others.	The rationale for distributing some evidence card after the prediction phase with their individual explanation is to arouse **discussion** and **argument** in each group. Students can make inquiry based on the cards provided that may support or against their original predictions. Students discuss within the group and come to a **consensus** for their group predictions and explanation.
(C) Observation The teacher covers the bell-jar to the three candles. Students take record to their observations as many as they can. Teacher classifies students' observation in two part: quantitative observations and qualitative observations.	All the 9 evidence cards are distributed in all the groups of students and students are asked to choose the evidence cards to support what they observed after performing the experiment. Students **evaluate** the evidence collected during the lab demonstration, their own prior knowledge and the information in the

<table>
<tr><td>Students, work in small group, to discuss what they observed and formulate hypotheses that explain what they see. The teacher gives each group all the 9 evidence cards for students to support student thinking.</td><td>evidence cards to identify the relevant evidence and eliminate the irrelevant evidence for revising the hypothesis that explain why the longest candle would go out first.</td></tr>
<tr><td>(D) Explanation
After students formulating their revised hypotheses, students are asked to design and conduct an experiment that can test for their hypotheses, which is hot air will rise and the carbon dioxide shall rise to the top in the bell-jar in the second investigation.

Each group are provided with some CO_2 indicators, blu-tack and water bottle caps. Students analyse and interpret data collected from the experiment and discuss to see if their hypotheses get support or rejected.</td><td rowspan="2">The teacher should encourage students performing confirmatory test for their hypothesis based on the provided materials. It can stimulate students' creativity in experimental setup design.

Possible investigations
1. Comparing the CO_2 concentration at different heights after the glass jar is covered to the three burning candles.
2. Comparing the burning time of individual candles of different length when it is covered in a glass jar.
3. Compare the burning time when the three candles are of the same length but are placed at different height.
4. Compare the burning time of the three candles when a small electric fan is operated in the glass jar and that without the small electric fan.
Students then develop logical and evidence-based explanation based on their investigations. It can enhance gifted/ more able students' higher-order thinking skills and creativity.</td></tr>
<tr><td>(E) Summary
The teacher leads a class discussion to reflect on the experiment and its relevance to the topic. The teacher then summarizes the key concepts and takeaways from the lesson.</td></tr>
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