Primary 4 Science: An Overview

In this KB Story, we follow Rachel* and her team of P4 Science teachers on their KB classroom journey. The team used Knowledge Forum 6 (KF6) for their PLC and reflection sessions. This story includes two topics, Life cycle and Matter. The KB sessions for the life cycle focused on applying what students had learnt in the topic itself, whilst the sessions for matter focused on discovering new knowledge and theories.

Figure 1. KB framework on life cycle

Teacher designs activities to get students to generate ideas
Rachel posted the story of the extinction of dodo birds on KF6 and provided a guiding question. She instructed her students to generate theories in response to the question.

Students read the short story and generated their theories on the extinction of the dodo birds on KF6.

Students generated ideas with the help of the guiding question and the scaffold ‘My theory’.

Life Cycle
Teacher designs activities and provide space for students to generate ideas
The team of teachers wanted to provide a real and authentic problem for students to explore. They agreed on presenting the story of how Dodo birds went extinct for their students to generate ideas on KF6.

Teacher provides scaffolds for students to connect ideas
Rachel posted the story of the dodo bird on KF6 and provided the following guiding question: ‘Using what you have learnt in the life cycle of animals, explain what could have led to the extinction of the dodo bird’. She also provided the scaffold ‘My theory’ to guide her students in their idea generation. Her students proceeded to generate their theories on KF6.

Teacher works with class to refine ideas and explanations
Rachel printed the notes on KF6 by her students and separated them individually. She instructed her students to find similarities between the notes and to categorise them accordingly. Her students categorised their notes according to the various stages of the Dodo bird’s life cycle. Rachel also encouraged them to build on the ideas of their classmates on KF6.

Rise-above
By organising the different ideas into categories, the class could see the big ideas more clearly. They were able to identify the various factors that affected the different stages of life of the dodo bird. Rachel was also able to create a rise-above note by consolidating the ideas in the ‘adult’ stage of categorisation. This allowed students to achieve new synthesis of ideas and acquire a deeper understanding of the topic.
Matter

Teacher designs activities and provide space for students to generate ideas

The team of teachers planned to have their students carry out experiments and learn about new theories through observation of the experiments. This would prompt students to examine every day phenomena and generate ideas to explain them. It also provided students with a real, authentic problem to explore. The classes carried out two experiments in total – one for each KB lesson. The first lesson focused on introducing students to matter and investigating the properties of air.

Teacher provides scaffolds for students to connect ideas

Rachel guided her students in carrying out the experiment in groups. After which, her students were required to fill in their theories and questions in a worksheet provided. Rachel then instructed her students to post an idea and a question as a group on KF6, using the scaffolds ‘My theory’ and ‘I need to understand’ respectively.

Teacher works with class to refine and improve ideas and explanations

Next, Rachel instructed each group to respond to posts by other groups by pointing out missing information or by asking questions. They were also encouraged to respond to the questions of other groups. Through this process, students refined the existing ideas in the discourse.

The second lesson on matter aimed to investigate the properties of air and focused on idea generation.

Teacher to understand students’ development and provide a space for students to conduct self-assessment

At the end of the topic, Rachel asked for questions that her students would like to clarify on KF6. This created an opportunity for her to understand the progress of her students and answer any questions that her students had.
Primary 4 Science

i. Knowledge Building in the Classroom

Central to the Primary Science Curriculum Framework is the inculcation of the spirit of scientific inquiry in students. Students are nurtured as an inquirer, where they are encouraged to be curious and explorative. Teachers are leaders of inquiry, where they facilitate the inquiry process and impart scientific knowledge to students. The aim of the Science Curriculum is hence to enable students to enjoy and value science as a tool to help them explore their world. The conduct of inquiry was founded on three integral domains:

   a) Knowledge, Understanding and Application
   b) Skills and Processes
   c) Ethics and Attitudes

A Knowledge Building (KB) Classroom provides a collaborative learning environment conducive for the development of scientific inquiry (as detailed above), with the help of the Knowledge Forum 6 (KF6). Through the use of trigger activities or inquiry questions, students are engaged in a scientific discourse dealing with real and authentic problems – where they are able to explore the topic at hand through idea generation and idea development. Scaffolds are provided by teachers in this inquiry process in order to guide the students’ exploration, with the scaffolds facilitating the students’ idea improvement process and hence allowing them to deepen their understanding of the problem. As such, we can see how the KB classroom facilitates the achievement of the goals of the Science Curriculum.

In this story, we will follow Rachel on her KB classroom journey with her class on the two topics of the Life cycle and Matter.

ii. Fostering a Knowledge Building Culture

Rachel and her team of P4 Science teachers used KF6 for their lesson planning and reflection sessions. The following is an example of their PLC sessions on KF6:

Figure 1: View containing the teachers’ classroom planning process

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Teacher designs activities to get students to generate ideas

This lesson focused on the topic of the life cycle. The team of teachers designed a lesson with the aim of piquing their students’ interest and allowing their students to apply what they had learnt about the topic earlier. They also wanted to provide a real, authentic problem for their students to explore. The following shows the trigger activity that the teachers proposed:

The Dodo bird inhabited the island of Mauritius in the Indian Ocean, where it lived undisturbed for so long that it lost its need and ability to fly. It lived and nested on the ground and ate fruits that had fallen from trees.

Then one day, in 1505, the Portuguese became the first humans to set foot on Mauritius. Later, pigs and monkeys were brought to the island along with the sailors. Many of the ships that came to Mauritius also had uninvited rats aboard.

The last Dodo bird sadly died out in 1681.

Qn: Using what you have learnt in the life cycle of animals, explain what could have led to the extinction of the dodo bird.

Figure 2: Proposed trigger activity

Initiating activity and providing scaffolds for students to connect ideas

In class, Rachel started the KB classroom process by posting the story of the Dodo bird and the guiding question on KF6. She instructed her students to generate theories with the help of the guiding question and the scaffold ‘My theory’. Her students then proceeded on to post their notes on KF6.

The following are some examples of what her students posted in response to the question:

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The students generated ideas relating to the trigger question and produced a variety of different ideas. Using ‘My theory’ as a scaffold, the students were able to produce ideas in different perspectives. For example, some students wrote that the Dodo birds went extinct as they did not have enough food, whilst others wrote that they were hunted to extinction.

After the lesson, Rachel and her team of teachers did a reflection session on KF6 where they shared the notes posted by their students. One teacher reflected that students were excited to build onto the ideas surfaced as they had much to clarify. The teachers also had to be quick in reading the students’ ideas, despite the many notes being posted in the view. A teacher recommended pausing the class instead to look out for promising ideas in the process.

Rachel and her team went on to plan for the next lesson on KF6, a continuation of the previous lesson. The following shows the lesson plan of the subsequent lesson. It aimed to get the students to build onto each other’s notes and for the class to create a rise above note.

**Lesson flow:**

- Print out the notes that are made in each of the view
- Separate out the notes by single posts
- Try to group the posts in advance
- Get pupils to find the similarity in the posts then get them to find the appropriate categories: egg stage eaten, young stage eaten, adult stage eaten (cannot reproduce), lack of food
- Try to do a rise above with the class by pulling similar notes together
- By Week 10, get pupils to do a build on by asking qns, provide a better theory to their friends.

**Remarks:**

- Try can try to post some qns to demo what it should look like
- Tasmanian Tigers --> HA classes

**Figure 4: Lesson planning**
Teacher works with class to refine and improve ideas and explanations

In the second lesson on the Dodo birds, Rachel printed the notes on KF6 contributed earlier by her students and separated them individually. She instructed her students to find similarities between the individual notes and group them into appropriate categories, such as by the different stages of the Dodo bird’s life cycle. They were also encouraged to post build-on notes to the ideas on KF6. The students proceeded to categorize the notes and to contribute their build-on ideas as well.

The following are some build-on posts by the students:

![Build-on note example](image)

**Figure 5: Examples of student build-on notes**

By using the scaffolds ‘A better theory’ or ‘I need to understand’, the students engaged in the elaboration and refinement of ideas by proposing better ideas to explain the problem and enquiring to understand more about the problem.

Rise-above

Figures 6.1 to 6.4 show student artefacts from the categorization of KF notes. The students categorized their notes according to the respective stages of life of the Dodo bird.
To conclude the session on life cycle and the dodo bird, Rachel created a rise-above note, using the compiled notes of the adult stage of the dodo bird’s life cycle:
After examining different ideas and points of view, Rachel and her students were able to synthesize the multitude of ideas brought forth by the students, and to organize the ideas in a more coherent manner as well. They were able to identify the various factors that affected the different stages of life of the dodo bird. Clearer and deeper understanding of the topic was also achieved, as students identified big ideas in their creation of a Rise-above note.

After the session, Rachel and her team of teachers held a reflection session on KF6. This was an overall reflection on the KB lessons held in Term 1. The teachers reflected on the following questions:

The following shows a response by a teacher:
The teacher noted that students were more engaged in class and that KF6 provided a platform for more reserved students to share their thoughts and ideas. Other teachers also noted that students had to be guided to see how each stage of the life cycle was affected and how it led to the extinction of the Dodo bird. Whilst the students were generally able to convey that different stages of the Dodo bird’s life cycle were affected, prompts from teachers were required in order for students to progress deeper into the inquiry process - such as weighing the differing impacts of changes in the life cycle on the survival of the Dodo bird species.

Figure 8.1: Analysis reflecting quality of ideas and questions by students

Majority of the notes fell into the categories of questioning and reasoning. In addition, they were mostly factual and lacked depth of thought. However, there were some ideas that demonstrated connection and synthesis of ideas. The high number of explanation seeking questions and raw ideas could also mean that students were initially uncertain on how to apply what they had learnt about the life cycle to the case of the Dodo birds.
This observation was supported by the post-lesson analysis, which reflected a high number of raw ideas surfaced by students. Despite some students having attempted to refine ideas through use of the ‘A better theory’ scaffold, the qualitative analysis in Figure 8.2 seemed to suggest that the class did not manage to progress towards higher-order thinking. However, this could be due to the fact that the synthesis of ideas had occurred as a class, with the teacher creating the Rise-above note.

The scaffold tracker indicated that the scaffold ‘My theory’ was utilized the most, suggesting that most students were engaged in idea generation, instead of idea improvement. This could be due to the ‘My theory’ scaffold being provided by the teacher. More scaffolds could be introduced in later stages of the discourse, in order to encourage students to build onto the ideas generated.

In this session, students generated a diversity of ideas. Many students also managed to connect two different ideas together in their posts, thus leading to a web of interconnected ideas.

Figure 8.3: Word network analysis reflecting the connection between different concepts surfaced during the discourse

**Teacher designs activities to get students to generate ideas**

Moving on, the next session started on the topic of Matter. Like before, Rachel and her team planned for their KB lesson on KF6. The following shows the lesson objectives and proposed trigger activity by the teachers:
Lesson's S10:
- State matter has mass and occupies space
- Investigate that air occupies space

Teachers will:
- conduct activity 6 in the lab.
- give pupils the opportunity to conduct the experiment in groups.
- distribute the group idea worksheet to pupils to key in their ideas on why the tissue paper did not get wet and a qn that they are wondering about.
- get pupils to form a group idea on the paper and a question that arises from this idea.
- type the group ideas in the KF platform at the end of the day as the pupils will not have time to key it in. (Not sure if the tablets can be brought into the Sci lab to key in the ideas)

The students were to carry out an experiment as a group and observe its outcome. This would allow them to examine every day phenomena through experiments and produce ideas to explain the phenomena. They would then write down their ideas and questions in a worksheet as shown below, before connecting and consolidating these ideas as a group and posting their group ideas and questions on KF6. Figures 10.1 and 10.2 show the Group idea worksheet that students had to complete after completing the experiment.

Exercise 3: Some help for pulling ideas together...
1. Read all the ideas, questions and information. This is important to read your friends' idea carefully so you know how they can help you improve your ideas.
2. Next compare the ideas:
   a. Are they the same? If they are, don't write them down, they show through in your individual idea box.
   b. Are they different? Different ideas are important to help you improve your ideas.
      i. Do you agree with that particular idea?
      ii. Do you think you can find evidence to support that idea?
      iii. Do you agree with the explanation of the idea?
Initiating activity and providing scaffolds for students to connect ideas

In class, Rachel guided her students to carry out the experiment as a trigger activity and provided the above worksheet for each group to fill in their ideas and questions after observing the experiment. Aside from the worksheet, Rachel also posted the following note on KF6 and instructed her students to post their group idea and question with the use of the scaffolds 'My theory' and 'I need to understand'.

Indicate your group idea and group question when you build on this post. Use the scaffolds:

- My theory
- I need to understand

Your title should be a summary of your post with your group members names.

Figure 11.1: Rachel’s instructions to her class
The students proceeded to carry out the experiment and post their group ideas and questions on KF6. By providing these scaffolds, students were encouraged to think of explanations for what they had observed and questions that they had regarding the experiment. The following contain responses from three different groups:

My theory - is the air ascaped through the hole, allowig the water level to rise up and wet the tissue paper.

I need to understand - why does the bubble rise up so the water can rise and touch the tissue on top of the cup.

My theory - is that air escapes through the hole. And when the bowl is insert in the basin, water flows in. As such, the tissue got wet.

I need to understand - how the bubbles formed?

My theory - is that the water touched the tissue water because there was a hole in the cup and let the air escape and water is let in.

I need to understand - why does water still get into the cup even though the air is still occupying the space in the cup.

Figure 11.2: Student responses to the trigger experiment

**Teacher works with class to refine and improve ideas and explanations**

After posting their group ideas and questions, Rachel tasked each group to respond to another group’s ideas, either by indicating that some information was missing or by posting a question that they had for another group, using the scaffolds ‘This theory cannot explain’ or ‘I need to understand’, respectively. Rachel also instructed her students to build onto other ideas by giving their own theory.

The following are some build-on posts by the students:
In their attempt to generate theories and answer questions, students were elaborating and refining existing ideas. They were also integrating new ideas with existing ideas and improving on the ideas of their peers. By improving on ideas, students were able to create and gain new knowledge collectively.

The next lesson continued on the topic of matter and focused on investigating the properties of solids.

**Teacher designs activities to get students to generate ideas**

Once again, Rachel and her team of teachers planned their lesson on KF6. The following shows the lesson plan and guiding questions:

*Follow up lesson (Activity 3: Investigating Properties of Solids)*

The experiment is repeated by replacing the marble with a cube of the same volume into the cylinder of water.

Q1) What do you observe about the water level after placing the cube inside the cylinder of water?

Q2) Explain your observations.

Figure 12: Lesson planning for the second ‘Matter’ session

The experiment involved placing a marble in a cylinder of water and noting the change in volume. Next, a cube of the same volume replaced the marble in the same cylinder of water. The students had to observe the change in water level again and explain their observations. By designing an activity that encouraged students to compare between the two experiments and draw conclusions, it encouraged them to draw connections between the experiments, facilitating the development of their theories.
**Initiating activity and providing scaffolds for students to connect ideas**

The class began with Rachel guiding her students in carrying out the experiment as the trigger activity. She told her students to observe the experiment carefully and note the outcome. Her students proceeded on to carry out the experiment.

After conducting the experiments, Rachel posted the following guiding questions on KF6 and provided the scaffolds ‘My theory’ and ‘I need to understand’ for them to use in structuring their responses. She instructed her students to post their answers to the questions on KF6 for their homework.

1) How will the water level change?
2) Show comparison to the marble experiment.
3) Explain your answer.

Use these scaffolds:

- **My theory**
- **I need to understand**

Your title should be a summary of your post with your name.

*Figure 13.1: Question prompt by the teacher*

The scaffold ‘My theory’ encouraged her students to generate their own ideas and explanations for the phenomena and the ‘I need to understand’ scaffold encouraged them to think of questions that they wanted to clarify. Providing inquiry questions and scaffolds were helpful in steering students to the desired thought processes. For example, here, the questions encouraged students to compare between the two experiments, make connections and then draw conclusions from what they saw.

The following are some responses from the students:

- **My theory** - is that since the cube has the same volume as the cube, the water level will be the same as when the marble was dropped.

- **I need to understand** - if the cube has the same volume as the marble, does it also has the same mass as the marble?

- **My theory** - is that the water level will rise up as the marble made the water level rise up so the cube most likely will make the water level rise up.

- **I need to understand** - if the type of marble affects the water level of the experiment.
Most students noted that the water level remained the same. However, some students did not compare between the results of both experiments and failed to observe that the water level did not change since both the marble and the cube had the same volume. They simply stated that the water level would rise as it has volume. Therefore, Rachel could have used more specific questions and scaffolds to guide the students. She could also have held a longer discussion in class to ensure that her students were clear about what comparisons they had to make. In this session, Rachel also collated the questions made by students and would address them at the end of the chapter.

**Teacher to understand students’ development and provide space for students to conduct self-assessment**

Before concluding the topic, Rachel posted a question on KF6 to seek out any leftover questions that her students may have on the topic of Matter. By asking whether students had any queries, Rachel sought to understand the development of her students and evaluate the progress of KB in class. It also allowed her to understand what her students were unclear of and how she could clarify their doubts.

Rachel posted the following question on KF6:

![Figure 14.1: Clarification of concepts by teacher](image)

The scaffold ‘I need to understand’ guided her students to think about questions that they might have. Her students responded on KF6 and the following are some examples of the questions posted by her students:
Rachel’s students posted many questions regarding the topic and sought to clarify their doubts. There were also some questions that demonstrated out-of-the-box thinking, for example, whether electricity was matter. The scaffold allowed students think about their own understanding of the topic and gave them the opportunity to ask questions. This also provided Rachel an opportunity to identify problems of understanding and address queries from her students.

We can also see some students replying to the questions of their peers:

Some students managed to build on to the ideas of the peers and also provided more information. We can see here that the students were now more used to the knowledge building culture and the use of KF6.

On KF6, the team of teachers held a reflection on the lessons on Matter. The following shows the questions that they reflected on:
3 things that have gone well in your KB lessons these 3 weeks.
2 things that you think you can do better.
1 thing that you would like stop doing.

Figure 15.1: Post-KB teacher reflection

The following shows Rachel’s response:

3 things that have gone well in your KB lessons
- Pupils were able to write group ideas by combining their usual individual ideas.
- Pupils learnt how to improve other group’s ideas as a group.
- Pupils asked more interesting questions like "Why is it that solids and liquids cannot be compressed? How are they different from the gases?"

2 things that you can do better
- Pupils need to be given the opportunity to do rise above for thier posts.
- Pupils qns should be collated and addressed in a more timely way.

1 thing that you would like to stop doing
- I should give them more time to question their peers so that they can reflect and improve on their answers.

Figure 15.2: Rachel’s response to the above questions

As noted by the teachers, their students were generally able to generate ideas from trigger activities or questions, and combine their individual ideas into a group idea as well. They were also able to improve on and build onto other ideas posted on KF6. Furthermore, they were able to generate relevant and interesting questions, as shown below and also similarly reflected in the KBdex analysis in Figure 16.1.

Figure 16: Examples of relevant & explanation-seeking questions by students
As opposed to the first two views, in the 3rd view, the students surfaced a much wider variety of ideas. This can be seen from the fewer thick lines in their word network, reflecting uniqueness in the ideas generated. Though serving as a point of conceptual clarification in this KB classroom, this final round of questions could also be used to identify problems of understanding in other KB classrooms.

Figure 17.1: Word network analysis on all 3 views used for the topic of 'Matter'
Post-lesson analysis reflected a moderate amount of idea development, with scaffold usage suggesting that the students had not progressed to synthesis of ideas as well. However, this could have been a result of the lesson structure.

Similarly noted by Rachel in her reflection, she suggested that they could give students the opportunity to synthesize their classmates’ ideas and do a Rise-above – given that earlier efforts at idea synthesis had largely been teacher-led.
She also suggested that teachers collate their students’ questions and address them more efficiently, such that they could provide more time for students to embark on idea improvement on their own. This would allow students to have the opportunity to examine different perspectives and consolidate information. By doing so, they could move on to achieve new knowledge and understanding of the topic.

In summary, we can see how the KB classroom facilitates the development of an inquiry-based learning – one of the aims of the Primary Science Curriculum. This is done through the adoption of a collective, collaborative pursuit of knowledge based on real and authentic problems.