Unit 6:

Using mind maps as a teaching, learning and assessment tool: water and the water cycle
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Learning outcomes</td>
<td>1</td>
</tr>
<tr>
<td>1 What is a mind map?</td>
<td>2</td>
</tr>
<tr>
<td>2 Developing your use of mind maps</td>
<td>3</td>
</tr>
<tr>
<td>3 Using mind mapping with your students</td>
<td>5</td>
</tr>
<tr>
<td>4 Adapting mind maps for the classroom</td>
<td>8</td>
</tr>
<tr>
<td>5 Summary</td>
<td>10</td>
</tr>
<tr>
<td>6 Resources</td>
<td>11</td>
</tr>
<tr>
<td>Resource 1: Teaching strategies – water</td>
<td>11</td>
</tr>
<tr>
<td>Resource 2: Further reading</td>
<td>12</td>
</tr>
<tr>
<td>7 Related units</td>
<td>13</td>
</tr>
<tr>
<td>References</td>
<td>13</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>14</td>
</tr>
</tbody>
</table>
Introduction

In TDU 1, *Using brainstorming to elicit prior knowledge about sound*, you examined the use of brainstorming as a means of generating and sharing ideas in the elementary science classroom. Mind mapping is a slightly different but complementary technique that is concerned with the organisation of ideas and concepts.

Mind maps are visual aids that assist students in understanding the relationship between different ideas. Using mind maps in the elementary science classroom can help your students make sense of scientific ideas by focusing on the ways they might be grouped and connected. As such, they provide an excellent means of reviewing and consolidating existing knowledge, while allowing for such learning to be extended by adding new concepts. They are particularly appealing to predominantly visual learners (see TDU 3, *Teaching life processes using explanation as a teaching strategy*), but all students can benefit from their use.

Mind maps enable students to communicate their ideas quickly and concisely in diagrammatic form. They allow teachers to monitor and assess their students’ understanding more efficiently so that they can address any of their misconceptions. This means that mind maps can be used for both learning and assessment purposes.

In this unit, you will be encouraged to develop your own skill in using mind maps before exploring their use in the elementary classroom. You will plan activities that will enable your students to develop simple mind maps that they can use to explore the properties of water.

Learning outcomes

After studying this unit, you should be able to:

- use mind maps as a teaching, learning and assessment tool
- support your students in developing their mind mapping skills.
1 What is a mind map?

Pause for thought

- How would you describe a mind map?
- Have you used mind maps as a learning or organisational tool yourself?
- Have you used them with students in the classroom?

At the centre of a mind map is a key concept, idea or question. This is then expanded into sub-concepts, which are grouped and connected through a system of branches. Often represented in circles or boxes, concepts and ideas are linked by words and phrases that explain the relationship between them.

Used as a teaching and learning technique, a mind map provides a visual illustration of the connections between ideas, as perceived by individuals or a group of people. Because mind maps are ways of demonstrating understanding, they are likely to differ from one person to another. They may also evolve in line with incremental changes to that understanding.

An example of a mind map is shown in Figure 1.

Figure 1 An example of a mind map about living things.

Description

An example of a mind map, which features a series of circles that are connected by arrows.

‘Rabbit’ is connected to ‘Animals’ with an arrow labelled ‘is an animal’.
‘Animals’ is connected to ‘Living Things’ with an arrow labelled ‘are’.

‘Cow’ is connected to ‘Animals’ with an arrow labelled ‘is an animal’.

‘Cow’ is also connected to ‘Grass’ with an arrow labelled ‘eats’.

‘Grass’ is connected to ‘Plants’ with an arrow labelled ‘is a plant’.

‘Plants’ is connected to ‘Living Things’ with an arrow labelled ‘are’.

End of description

Mind maps can be helpful for:

- making sense of concepts and the ways in which they are connected
- integrating new concepts with existing knowledge
- planning, organising and analysing
- communicating ideas, thoughts and information concisely and clearly.

2 Developing your use of mind maps

The following activities will encourage you to develop your own use of mind maps before using them in the classroom.

**Activity 1: Linking ideas**

This activity is intended to help you practise mind mapping by connecting concepts relating to the topic of the Earth’s water cycle.

Use the key words in the table below to form meaningful connections between the ideas in Figure 2, adding further ideas of your own if you wish. Consider using the mind map to support you with planning your lessons on this topic.
Figure 2 An incomplete mind map, based on the water cycle.

Description

This is a drawing of an incomplete mind map, based on the water cycle. The central box is labelled 'Earth's water cycle', from which there are three unlabelled boxes. The unlabelled boxes are connected to boxes titled 'Water', 'Atmosphere' and 'Plants'. From 'Plants', there are three boxes attached, labelled 'Trees', 'Uptake' and 'Soil', with an unlabelled box inbetween each one. From 'Water', there are three boxes attached, labelled 'Streams and rivers', 'Oceans and lakes' and 'Snow and ice', with an unlabelled box inbetween each one. From 'Atmosphere', there are three boxes attached, labelled 'Rain', 'Clouds' and 'Sun', with an unlabelled box inbetween each one. In the bottom left of the figure there is a table of words, which are 'Evaporation', 'Storage', 'Infiltration', 'Precipitation', 'Condensation', 'Run off', 'Water vapour', 'Condensation', 'Transpiration', 'Sublimation', 'Groundwater', 'Evapotranspiration'.

End of description

Activity 2: Using mind maps outside the classroom

Try making a mind map to organise a family event or sort out a family problem.

Write the key issue at the centre and organise the related issues around it.
Mind maps can be used very effectively for both personal and professional purposes, but it may take a little time to get used to using them. Look for opportunities to practise using mind maps either alone, with colleagues or with your family.

3 Using mind mapping with your students

In order for mind maps to be of value to your students, they need to be trained to use them. If you are introducing mind maps to your students for the first time, it is best to base this on a topic that you are confident they have a sound knowledge of.

Activity 3: Introducing mind mapping

Here is an approach that introduces the topic of water using mind maps. You could follow all the steps as a lesson plan or amend them as you wish.

1. Place a glass of water on the desk in front of the class and explain to your students that you are going you help them create a map of everything they know about water.

Write ‘water’ in the centre of the board and draw a box around it.

2. Ask your students to imagine they don’t know anything about water. What kinds of questions might they ask to understand its qualities and uses?

Here are some possibilities:

- What does water look like?
- What does water feel like?
- What does it smell or taste of?
- What are its uses?
- What are the sources of water?
- How does water behave?

3. As they suggest these and other questions, capture their main ideas in the form of key words. Write these around the central word ‘water’ and draw a circle around them. Some examples might be ‘sources’, ‘taste’, ‘uses’, ‘behaviour’, etc.

4. Now choose one of these ideas and create sub-topics around it. For example, if you take the idea ‘Uses’, gently probe further to get the students to suggest ideas such as drinking, washing, transport or irrigation. These words, each in its own circle, should then be written around the word ‘uses’.

5. At this point you may wish to introduce a further set of concepts around one of these sub-topics. The sub-topic ‘drinking’ lends itself to concepts such as ‘purification’.
6. You could also invite ideas relating to other main ‘branches’, such as ‘sources’, encouraging your students to expand their thoughts and suggestions.

7. Now ask your students to work alone, in pairs or in groups, and create their own versions of the water mind map, adding more ideas and branches to each sub-topic. Give them up to 20 minutes to do this activity.

8. Once your students have understood how to make a mind map, you can introduce the added complexity of inserting and labelling linking phrases. You might wish to do this in a subsequent lesson, if time is short.

9. Using the starter mind map on the board for reference, ask your students to suggest words or phrases to connect the main ideas to the sub-topics by considering the nature of the connections between them. These connections may be overriding organisational themes, or just specific micro-relationships. You may need to give your students an example or two to guide them with this.

10. Ask your students to return to their maps and add further linking lines between ideas that connect. Ideally the students should use a different coloured pens or pencils to draw their linking lines, and write the connecting phrases on them (Figure 3).

Figure 3 An example of a student’s ‘water’ mind map.

Description

This is an image of a hand-drawn mind map. In the centre there is a circle with ‘water’ written in it. Branching from the centre there are boxes with ‘life’, ‘forms’, ‘uses’, ‘water cycle’, ‘problems’ and ‘types’. Branching from ‘life’, there
are the labels ‘plants’ and ‘animals’; from ‘forms’, there are the labels ‘liquid’, ‘steam’, and ‘solid’; from ‘uses’, there are the labels ‘swimming’, ‘factories’, ‘farming’, and ‘homes’; next to ‘water cycle’ there are drawings of the sun and a raining cloud; from ‘problems’, there are the labels ‘waste’, ‘pollution’ and ‘drought’; and from ‘types’, there are the labels ‘drinking’, ‘ground’ and ‘surface water’, which itself has two branches, labelled ‘lake’ and ‘river’.

End of description

1. Circulate around the room as your students work on their maps. Encourage them to look for ways of cross-linking concepts in one area of the map with those in other areas. Suggest that they may add as many additional concepts as they wish to make their maps unique and personally meaningful, and stress that there is no one ‘correct’ answer.
2. Once the mind maps are complete, ask the students to share their maps with their classmates so that they can reflect on the different ways that they have organised and connected the information.
3. Finally, collect the maps and examine them to identify any gaps or misconceptions in the students’ awareness of the field. This will help you to plan your subsequent lessons relating to the topic.
4. Sticking mind maps on the walls of the classroom makes an attractive display, while encouraging students to appreciate one another’s work. If you don’t have the space to display them all, select a few each time, making sure you display everyone’s work over a longer period.

Pause for thought

How did your students respond to drawing a mind map? Do they require further support to develop their skill in using them? What did the mind maps tell you about your students’ understanding of the topic? How could you use this information to plan your next lesson?

Mind maps can be used to organise information relating to many different science topics. Initially your students will need your guidance and a starting template to develop their thinking. But as they become more confident, they will be able to use them more independently.

Comprehensive and continuous evaluation (CCE)
How might you know if your students have or have not developed a coherent understanding of an elementary science topic?

Classroom tests are one way of assessing your students’ knowledge, but mind maps are much more revealing in demonstrating the scope and complexity of their understanding.

Mind maps can be used before and after exploring a topic to show you how your students have progressed and how their ideas have developed over time.

4 Adapting mind maps for the classroom

The following activity can help you assess how far your students have understood the topic of the water cycle.

**Activity 4: A fill-in-the-blanks mind map**

Create a mind map of the water cycle, with links between the concepts. (You may want to refer to **Figure 2** to do this.) Write in some of the words but leave other spaces blank. Create a list the missing words and phrases in the corner, as has been done in Figure 2.

- Hand out worksheets of the incomplete mind maps.
- Instruct your students to complete the mind map using the words and phrases provided. Allow them 15 minutes to complete the task
- Collect the worksheets and use these to assess your students’ learning.

In assessing your students’ mind maps, you might consider the following questions:

- To what extent have the students identified the most important concepts?
- How logical is their grouping of concepts into main ideas and sub-topics?
- How sophisticated and sound is their linking of concepts?
- Do any of the ideas and links suggest that the student has significant misconceptions?

As the teacher, you are best placed to select the method that provide you with the information you want about what the students understand, so that you can plan your teaching sessions to meet their learning needs more accurately. Can you think of other ways of adapting a mind map for different purposes in the elementary science classroom?
Discussion

Here are some possibilities. Did you think of any more?

- **Select and fill-in mind mapping:** Create a mind map and then remove about one third of the concept labels. These deleted concepts are placed in a numbered list on the map and students choose among them.
- **Fill-in mind mapping:** Construct a mind map and then remove all of the concept labels, while keeping the links. Ask the class to fill in the labels in a way that makes structural sense.
- **Selected terms mind mapping:** Provide a list of concept labels and ask students to construct their maps using only these labels. The focus here is on the linking relationships, and building the students’ appreciation of the complexity of the topic.
- **Seeded terms mind mapping:** Provide your students with a small set of concept labels (five to ten) and invite them to construct a mind map using these, along with an equal number of blank labels that they can use for their own ideas, based on their knowledge of the topic.
- **Guided choice mind mapping:** Present your student with a list of approximately 20 concept labels from which students should select a given number to construct their mind maps.

How could you use mind maps with your younger students? How could you support students who are struggling with using mind maps?

Here are some ideas you might have listed:

- With younger students, and students who need support, you should put together a simple mind map as a class or small group. For simplicity, images can be used instead of words. Students might be able to stick these onto the map themselves. Alternatively, the teacher can write the students’ ideas and thoughts. Ideas and concepts can be colour-coded, helping them to identify the links between them.
- As students get older, they can be given a simple question as the basis of the mind map. Students can then be given additional words or phrases on pieces of card to support the development of their ideas. Teachers can offer support by asking carefully worded questions.
- Older students can be encouraged to revisit mind maps and add ideas as their learning progresses through a topic. Using a different-coloured pen each time will allow teachers to track the students’ additions.
- Older students should also be encouraged to use maps to plan, track and develop their ideas independently. They should be given opportunities to identify how their ideas have developed while studying a particular topic. They can also use mind maps to help them identify areas of weakness in their knowledge and consider and what to focus on next.
5 Summary

Mind maps are a useful teaching and learning tool. They can be used to help students externalise their ideas, organise them and present the relationships between them.

They can help teachers to assess their students’ conceptual development and understanding, identify misconceptions or gaps, and facilitate learning by building new knowledge onto existing knowledge.

When teaching your students mind mapping as a technique, it is best to use information that is familiar to them and to model the process, before encouraging them to start to use the technique for themselves. You can support them by providing half-completed mind maps and lists of key words.

Mind maps can be utilised in all topic areas related to the elementary science and are an excellent way of visually representing the relationship between scientific concepts.
6 Resources

Resource 1: Teaching strategies – water

Strategies for teaching science vocabulary

In order for students to develop scientific literacy, they need to gain knowledge of science content and practice scientific habits of mind. Knowing science vocabulary supports the development of these understandings. Some of the strategies to enhance science vocabulary are given below.

Make a word wall

A word wall serves multiple purposes. It is an ongoing, organised display of key words that provides visual reference for students throughout a unit of study or a term. These words are used continually by teachers and students during a variety of activities. Effective word walls:

- support the teaching of key words and subject-specific terminology
- promote independence in reading and writing by building vocabulary
- provide visual clues and reference for language learners
- help students remember connections between words and concepts.

Building a word wall can be easily integrated into daily activities. Key words or terminologies that relate to the lesson or unit of study can be added gradually as they are introduced. A word wall should be organised in a way that is useful to students, with additions reflecting the skills or concepts being taught. Often, word walls are organised alphabetically, with words printed on card stock and taped or pinned to the wall or board. Try to be creative in designing a word wall so that it engages the students and enhances their learning. As a teacher you should encourage the students to use the language of science in their verbal and written communication.

Reading science text cards

Text cards help students interact with words and their meanings. Science text cards can be created by writing statements about science concepts on index cards. Working individually or in small groups, students discuss the statements before sorting. A number of different formats can be used:

- **Matching pairs**: The students are given a stack of cards and are asked to match a term with its associated function, symbol, image, etc.
- **Sequencing**: For cyclic concepts such as the water cycle or the seasons of a year, create one card for each stage in the cycle. The students arrange the cards in a circular formation to represent the stages of the cycle.
• **True or false:** These cards have statements about water that are true or false. Students are asked to sort them into the two categories; if there are any statements that the students are unsure about, they are put into the middle for discussion with other groups or the whole class to share ideas and understanding. If many of your students do not understand or cannot explain why a card is true or false, this tells you what to plan for your next session.

**Using explanation and demonstration to assist learning**

When you teach your students about water, there are complex processes that need to be carefully explained so that they can understand concepts or ideas that are new to them. Where these explanations are supported by the use of visual aids, this can assist in clarifying and illustrating explanations, for example the water cycle. Using artefacts or other methods can also assist in the explanation process by showing the students something so that they understand better. ‘Evaporation’ and ‘condensation’, for example, are abstract terms for students that they find difficult to conceptualise and remember. If the students see the process happening in front of them, they are more likely to understand and apply their learning.

**Resource 2: Further reading**

‘Concepts maps – a visual study tool’ (nooluoit, 2011)

‘Constructing your first concept map’ (Cañas and Novak, 2009)

‘Concept maps – a learning & study strategy’ (Keith Patton, 2011)
7 Related units

- TDU 1, Sound: eliciting prior knowledge through brainstorming
- TDU 3, Teaching life processes: using explanation as a teaching strategy
- TDU 8, Observation for teachers and students
- TDU 14, Discussion dialogue

References


Acknowledgements

The content of this teacher development unit was developed collaboratively and incrementally by the following educators and academics from India and The Open University (UK) who discussed various drafts, including the feedback from Indian and UK critical readers: Jane Devereux, Christine James and Kavita Grover.

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Grateful acknowledgement is made to the following:

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Figure 3: the work of unnamed student.

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