

Integrating Writing Frames into Inquiry-Based Instruction

Abstract

This paper presents a discussion of writing frames as a method of fostering scientific writing skills in the inquiry-based science classroom. Writing frames are described as templates that contain leads, cues, clues, and insights that collectively work together and provide a skeleton outline to scaffold writing tasks. The uses and benefits of writing frames for science instruction are discussed in light of the genres and dimensions of scientific writing, the American Association for the Advancement of Science goals, and the National Science Education Standards. A writing frame for an open inquiry activity is provided as a sample.

Introduction

According to the American Association for the Advancement of Science (AAAS, 2009), by the end of the 12th grade, students should know that the inquiry-based nature of the scientific process entails carrying out investigations that involve constructing hypotheses, discerning patterns, understanding and applying the different traditions of science, maintaining objectivity, constructing new ideas, verifying mainstream ideas, making observations and predictions, elaborating and discussing expected and unexpected findings, and being conscious of bias. Each of these actions requires students

not only to read science but also to write science. By composing these actions through writing, students communicate and express science content, cognitive processing skills, and inquiry skills. In addition to incorporating inquiry skills into science instruction, teachers also need to develop writing tasks that require students to practice the stylistic conventions commonly used by the scientific community (Bennett, 2003; National Research Council, 1996; 2000; Wellington & Osborne, 2001). This paper presents a discussion of writing frames as a method of fostering scientific writing skills in the inquiry-based science classroom.

Scientific Writing

Scientific writing is characterized by its own stylistic conventions or standard forms and has a particular language format, genres, and dimensions. Exposure to scientific writing in all of its forms aids in the development of scientific literacy and also familiarizes students with the language of science and genres of writing commonly used by the scientific community (Wellington & Osborne, 2001). A number of key features characterize the particularistic nature of scientific writing (Jones, 2000; Wellington & Osborne, 2001). First, it is a technical language that avoids any actor, the personal, the scene, the motives, temporality, colloquial forms, and metaphoric and figurative language. Second, it is written in the passive voice using both unfamiliar

and familiar words in unfamiliar contexts. Third, it is portrayed as objective knowledge. Lastly, it is portrayed as being dominated by causal explanations seeking to reflect real world phenomena.

Table 1 highlights the other two key features of scientific writing: the genres of scientific writing and the overlapping dimensions that underscore each type of genre. The genres of scientific writing are the textual representations of different types of knowledge (Jones, 2000) expressed as written arguments, discussions, explanations, experiments, expositions, procedures, recounts, and reports. The overlapping dimensions indicate the inherent cognitive processing skills exhibited when the different genres of scientific writing are used in the classroom. When writing in the classroom is an interpretative activity, students' writing exhibits their comprehension and appropriation of content and scientific process skills, and writing that exhibits students' developing critical thinking skills (reasoning, predicting, inferring, evaluating, concluding, judging, etc.) is characterized as a knowledge-transforming activity. Alternatively, when writing is a discursive activity, students' written text communicates their negotiated meanings and understanding of content.

Writing Frames

A writing frame is a template that contains starters/sentence beginners,

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key language information, connectives/cohesive links, and sentence modifiers that collectively work together and provide a skeleton outline to scaffold writing and provide a view of the overall writing tasks (Jones, 2000; Wellington & Osborne, 2001). The end product is a text that offers a structure for communicating ideas and newly constructed knowledge in a logical and coherent way.

According to Hoyle and Stone (2000), Jones (2000), and Kind and Taber (2005), writing frames scaffold the writing task by providing leads, cues, clues, and insights about how to organize the writing, and they also inform the student about the style of writing required. These scaffolds in turn are assisted by the starters/sentence beginners, key language information, connectives/cohesive links, and sentence modifiers that

adhere to the particular genre of writing characteristic of a particular content area. Collectively, the scaffold and the writing frame elements activate students' prior knowledge and enable students to organize and construct the written text.

Using Writing Frames in the Science Classroom

How do writing frames help in constructing scientific literacy in the classroom? First, the nature of writing frames, with its inherent elements, (starters/sentence beginners, key language information, connectives/cohesive links, and sentence modifiers) and leads can be modified to provide skeleton outlines for different genres of scientific writing used in the science classroom. By doing so, teachers can help students

to learn the stylistic conventions that are commonly used by the scientific community. Second, the key language information presented in writing frames help in activating prior knowledge about the topic of study and help teachers introduce students to the language of science inherent to that topic of study. Finally, the starters/sentence beginners, connectives/cohesive links, and sentence modifiers can indicate to students the nature of the activity (interpretative, knowledge-transforming, and/or discursive) required within that specific genre of writing. The following description of an inquiry-based lesson on osmosis and reverse osmosis exemplifies the use of writing frames for the different genres of scientific writing.

Table 1: Genres and Dimensions of Scientific Writing

Genres	Textual Representation	Dimensions		
		Interpretative	Knowledge-Transforming	Discursive
Arguments	Presents a particular point of view	✓	✓	✓
Conclusion	Presents the final view based on arguments, information, viewpoints and evidence	✓	✓	✓
Discussions	Presents arguments and information from differing viewpoints based on evidence	✓	✓	✓
Explanations	Presents the concepts, cause and effect, procedures, purposes and objectives, relationships, processes, consequences, and other notions used in giving of understanding	✓	✓	✓
Experiments	Presents the documentation of an inquiry activity	✓		
Expositions	Presents arguments for a position on a controversial topic	✓	✓	✓
Procedure	Presents the documentation of the step-by-step instructions carried out in an inquiry activity	✓		
Recounts	Presents the events to inform about an activity	✓		
Reports	Presents organized information synthesized from textbooks and other resources	✓		

Open Inquiry-Based Lesson Sample

For this activity, investigating osmosis and reverse osmosis in the classroom, five genres of scientific writing, each with its own writing frame, are used. These include the report that helps students to recount their prior knowledge of osmosis, the experiment that students use to document the step-by-step instructions carried out in the inquiry, the explanation that students write to communicate their understandings, the discussion that links current understandings of osmosis and emerging understanding of reverse osmosis, and the writing frame for arguments that students use to communicate their current understanding of reverse osmosis. Figure 1 shows the writing frames and their critical elements (starters/sentence beginners, key language information, connectives/cohesive links, and sentence modifiers). Before you use the writing frame, model and discuss the selected writing frame, its critical elements, and its potential for assisting in the genre of scientific writing required for inquiry activity. In addition to discussing the use of the writing frame, use this time for student queries and also to activate prior knowledge that is required for the inquiry.

Benefits

Writing frames help in inquiry-based lessons in a number of ways. First, they act as a translator that helps students to focus on the genre of scientific writing. Second, writing frames provide an expansive range of roles that assist teacher intervention during inquiry. That is, writing frames open up students' thoughts

Figure 1: A Writing Frame for an Open Inquiry Activity: Comparing Osmosis and Reverse Osmosis.

Part 1	Writing Frame: Report	
	Osmosis	Reverse Osmosis
	Osmosis is important in living organisms because For osmosis to happen we need Osmosis can be described as the When the net exchange of water is zero	Is reverse osmosis important in living organisms? For reverse osmosis to happen we need Reverse osmosis can be described as the Will the net exchange of water be zero?
Part 2	Writing Frame: Experiment	
	Aims: What is the aim? What is the hypothesis? Method: What are the steps for the experiment? What are the apparatus needed for the experiment? Results: What is the mode (table, graph, charts, diagrams, etc.) used to display the data? What are the other observations we need to record? What are the variables to consider? What are the safety precautions? What is the nature of the data to be collected?	Aims: (You do not have to carry out this experiment) How would you design an experiment to show reverse osmosis? Method: What are the steps for the experiment? What are the apparatus needed for the experiment? Results: What is the mode (table, graph, charts, diagrams, etc.) used to display the data? What are the other observations we need to record? What are the variables to consider? What are the safety precautions? What is the nature of the data to be collected?
Part 3	Writing Frame: Discussion	
	Discussion: Evidence shows that Additional evidence include	Discussion: Discuss your views on reverse osmosis in the Explanations and Conclusion sections of your report.
Part 4	Writing Frame: Explanations	
	Explanations: I want to explain why An important reason for why this happens is that The next reason is that Another reason is that This shows that Therefore, we can infer that	
Part 5	Writing Frame: Conclusions	
	What do the data show? What are the data, explanations, arguments, and information that support your final view? After considering the data, explanations, arguments, and information, I think that reverse osmosis is Reverse osmosis differs from osmosis in the following ways	

through their pre- and post- writing phases and help teachers to diagnose, guide, collaborate, and model students' construction of content and scientific processes. Third, writing

frames expose students to the linguistic patterns inherent to that genre of scientific writing.

Although the scripting inherent in the writing frame may seem

technical in nature, it does help students to focus on the objectivity that is required in scientific writing. If teachers prefer their students to present their subjective views, they can choose to use science journals to supplement the inquiry activity. These journals can be framed by questions such as, "How would I have done it differently? Why?" The leads in the writing frames assist in scaffolding and developing understanding of new ideas by activating students' prior knowledge about the content and about scientific writing without stifling intellectual independence. Furthermore, unlike copying, writing frames engage students in cognitive processing that is more advanced than simply replicating provided information.

Conclusion

The National Science Education Standards (National Research Council, 1996; 2000) propose and challenge science teachers to plan and guide inquiry-based science instruction. Most of this inquiry-based science instruction requires students to exhibit scientific literacy. By using writing frames during

inquiry-based science instruction, teachers can focus on developing their students' comprehension of the language of science and the genres of scientific writing while simultaneously focusing on their students' "doing science."

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