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Explaining as a teaching strategy

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Abstract
An explanation is a statement or set of statements that clarifies the reasons, causes, context, or principles that underpin a particular phenomenon. The word derives from the Latin term explicatus, which means to provide reasoning for. Explanations are central to the discipline of science as one of the goals of the discipline is to provide explanations that lead to a deeper understanding of various phenomena. In plain English, explanations elucidate why things work, what something is, or how things happen. They often provide cause and effect relations, include a time sequence, and use action verbs. An explanation usually has five parts: (i) naming or specifying the concept, (ii) describing elements or components of the concept in an appropriate order, (iii) explaining how the elements relate or connect to each other, (iv) providing an example, and (v) summarizing with a concluding statement. It is a fundamental expectation in most school science curricula that students should be able to explain science concepts. For example, the Australian National Curriculum states: "Science provides an empirical way of answering interesting and important questions about the biological, physical and technological world. The knowledge it produces has proved to be a reliable basis for action in our personal, social and economic lives" (ACARA 2012, p. 3). Similarly, the US National Science Education Standards calls for more than "science as process," in which students learn such skills as observing, inferring, and experimenting. Inquiry is central to science learning. When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explana- tions. In this way, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills.

Keywords
strategy, teaching, explaining

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Synonyms

Argument; Claim; Proposition; Slowmation

An explanation is a statement or set of statements that clarifies the reasons, causes, context, or principles that underpin a particular phenomenon. The word derives from the Latin term explicatus, which means to provide reasoning for. Explanations are central to the discipline of science as one of the goals of the discipline is to provide explanations that lead to a deeper understanding of various phenomena. In plain English, explanations elucidate why things work, what something is, or how things happen. They often provide cause and effect relations, include a time sequence, and use action verbs. An explanation usually has five parts: (i) naming or specifying the concept, (ii) describing elements or components of the concept in an appropriate order, (iii) explaining how the elements relate or connect to each other, (iv) providing an example, and (v) summarizing with a concluding statement.

It is a fundamental expectation in most school science curricula that students should be able to explain science concepts. For example, the Australian National Curriculum states: "Science provides an empirical way of answering interesting and important questions about the biological, physical and technological world. The knowledge it produces has proved to be a reliable basis for action in our personal, social and economic lives" (ACARA 2012, p. 3). Similarly, the US National Science Education Standards calls for more than "science as process," in which students learn such skills as observing, inferring, and experimenting. Inquiry is central to science learning. When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. In this way, students actively develop their understanding of science by combining scientific knowledge with reasoning and thinking skills (1996, p. 2).

Types of Explanation

There are many types of explanations, including deductive-nomological, functional, historical, psychological, reasoning, rationalization, consequential, causal, and argumentation. In line with the commonly acceptable deductive-nomological model, a scientific explanation has two parts: (i) the explanandum is the phenomenon that is to be explained and (ii) the explanus is the evidence, reasoning, or details to explain the phenomenon. According to Hempel (1965), "the explanus must be a logical consequence of the explanandum" and "the sentences constituting the explanus must be true" (p. 248). So the explanandum identifies the concept or phenomenon being explained, and the

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explanus provides the evidence or reasoning. For example, someone may ask a question about a weather phenomenon such as "what is a tornado?" which is an explanandum, and a reply could be "an intense low pressure system that has rapidly rotating air like a spout," which is an explanus.

Another type of explanation is based on the notion of argumentation (Toulmin 1969). An argument has four components: (i) a claim which is an assertion or conclusion about a particular phenomenon, (ii) evidence which is the data that supports the claim, (iii) warrant which is the status of the evidence so that it is adequate and valued by others, and (iv) reasoning which is the line of thought linking the claim and evidence.

Teaching Strategies to Promote Explanations.

Four examples of teaching strategies aimed at promoting explanations:

1. Making the Explanation Explicit

   One way is for teachers to make what is required in an explanation explicit according to a five-step procedure (McNeill and Krajcik 2008): (i) making the framework explicit by being clear to students the type of structure of explanation needed; (ii) modeling and critiquing explanations whereby teachers show students examples of good explanations; (iii) providing a rationale for creating explanations so that students know why they need to be clear about their reasoning; (iv) connecting to everyday explanations meaning that the reasoning is based on common sense; and (v) assessing and providing feedback to students meaning that will only improve their explanations if they get explicit suggestions on the strengths and weaknesses of their reasoning.

2. Writing Scientific Explanations

   It is important that students are provided with frameworks for explaining science concepts. These have been called informative texts and can have the following parts: (i) write an introduction clearly stating the problem or question, (ii) write a sequence of steps or results which may involve providing evidence, (iii) write an implication, and (iv) write a conclusion.

3. PEEL (Project for Enhancing Effective Learning)

   One of the central goals of PEEL (a community of practicing teachers, primarily based in Australia) is to devise and implement practical teaching strategies to support student learning (Baird and Northfield 1992). Many of these strategies relate to improving student explanations, whereby teachers collect and reshape ideas from students, offering a "story" and providing students with new words to be practiced. Some of the suggested strategies are:

   - POE (Predict, Observe, Explain): Students predict what is going to happen when they see a demonstration, observe what happens, and then explain the phenomena individually or in groups.
   - Concept maps: Students summarize a discussion with a conceptual diagram or map. A concept map typically organized around a central term or idea, with other related terms extending from it.
   - Postbox: Group members each write an explanation of a concept on a piece of paper. These are passed around the group or swapped with other groups, and then each group decides which is the best combination of suggestions for the explanation.

4. Digital Representations

   Increasingly students are using their own digital technologies such as mobile phones, iPads, and computers to create digital representations to explain science concepts. They can make podcasts (audio explanation), video (audio and image), as well as animations (see slowmation) to explain science concepts. These can be shared with others by uploading to Internet sites such as YouTube or "60 s Science" or "Scientific American." See www.digiexplanations.com for examples and instructions for how to make five forms of digital explanations.

Conclusion

Explaining how the world works or why something happens is a key feature of the discipline of science. Students at universities and in schools should be encouraged to explain science in their own words as a way to develop conceptual clarity in their own understandings. When students plan for an explanation, they should take into account the purpose, audience, context, and medium so that what they are explaining becomes clearly understandable by others.

Cross-References

Argumentation
Concept Mapping
Concept Maps
Explanation
Project for Enhancing Effective Learning (PEEL)
Slowmation

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