Conceptual change

Learners’ response to contradictory information

Misconceptions can get in the way of teaching efforts and increasingly pose a significant challenge to science teachers. To discern exactly what science education literature can teach us about learners’ response to anomalous data, Professor Patrice Potvin, from the University of Québec in Montréal, Canada, has carried out a critical and systematic review of science education research literature. In this study, he investigates conceptual change, examines the responses of learners to contradictory information, and identifies factors that favour conceptual changes.

The internet, TV and print news, and other science outreach channels, offer a variety of contrasting theories, interpretations, and opinions that contribute to the public understanding of science. How people respond to such contradictory, anomalous information is an important social issue, and one that has become increasingly central due to the pandemic. Dr. Patrice Potvin, Professor of Science and Technology Education at the University of Québec in Montréal, explores the response of learners to contradictory information in his critical and systematic review of science education research literature.

Potvin explains that investigations into such responses in science education are not new. In the 1970s, researchers’ attention was drawn to the recurrent errors made by science students, and these studies revealed that many were of a ‘representational origin’. Often referred to as misconceptions, these representations are personal models or theories borrowed or developed by learners in their efforts to understand scientific phenomena. These misconceptions can obstruct teaching efforts and even today they are one of the utmost challenges faced by science teachers. Often, they contradict aspects of the scientific knowledge to be learned. Moreover, they can be incredibly robust and difficult to change.

CONCEPTUAL CHANGE

Conceptual change describes the phenomenon where these misconceptions are ‘unlearned’ in favour of target scientific conceptions. Existing conceptions are usually presumed to be changed through the restructuring of elements of the existing concepts, in the form of beliefs, ideas, or ways of thinking, to develop fundamentally new concepts. Over the past four decades, at least 86 models of conceptual change in science learning have been proposed. The literature supports the hypothesis that a need for change, usually driven by some form of dissonance, must first exist for change to occur. Potvin describes how this need is usually thought to be obtained when learners feel, suspect, or acknowledge the shortcomings of their initial conceptions. Additionally, the more significant the conflict, the greater the chance of the change occurring. Most of the time, cognitive conflict is understood as the mandatory first step on the path to successful change and it forms the central mechanism of most conceptual change models.

THE COGNITIVE CONFLICT PROCESS MODEL

From the many frameworks that appear in the literature, Potvin chose to frame his review with one of the simplest and most cited frameworks, the cognitive conflict process model (CCPM). This model comprises three phases. Firstly, a preliminary stage, where a learner believing in a preconception is exposed to an anomalous situation. If the learner believes that this situation is genuine, they proceed to the next stage. Secondly, a conflict stage where the learner recognises the situation to be anomalous and experiences a cognitive or conceptual conflict that can constitute many dimensions, including interest and anxiety. This has the potential to trigger cognitive reappraisal. Thirdly, the learner moves on to a resolution stage when they may or may not come to a decision regarding their initial preconception.

THE RESEARCH QUESTIONS

To find out what science education literature can teach us about learners’ response to anomalous data, Potvin performed a literature review to uncover what is said about each of the three CCPM phases. He aimed to reveal the possible outcomes, or resolution, of the process, what happens during the conflict stage, and the preliminary conditions and variables that favour desirable outcomes. In addition, he asks a fourth important question: ‘What critical synthesis can we propose in light of these revelations and of recent and contemporary developments of the conceptual change field?’ In other words, what overarching themes and processes are discernible from the many studies into conceptual change?

A search for only peer-reviewed journal articles was performed on Google Scholar, ERIC, and PsycInfo. The first 70 articles listed with the greatest ‘relevancy’ according to the online criteria were selected from each of the three databases. Following an overview reading, studies that did not provide an objective account of what happens at the exact moment science learners are exposed to discrepant information were excluded. A wide-ranging analysis of the 86 remaining contributions was carried out, to support a better understanding of CCPM-related events which facilitate positive conceptual changes.

POSSIBLE RESPONSES AND OUTCOMES

Examining the possible responses revealed that learners’ responses are not limited to accepting/rejecting contradictory data. Potvin’s synthesis of various taxonomies of cognitive responses to anomalous data found 11 types of responses. Learners might be unaware of the phenomenon where misconceptions obstruct teaching efforts and increasingly pose a significant challenge to science teachers.

The cognitive conflict process model describes the process by which a learner comes to a resolution regarding an initial preconception.

Cognitive conflict is usually thought to be the mandatory first step on the path to successful change.
of the contradiction, they may choose to ignore it, reject it, or exclude it as being outside the domain of the theory. They may be uncertain about its validity or its interpretation. They may suspend the contradiction to avoid dealing with it immediately. Alternatively, 'belief dissonance' involves a decrease in the learners' conviction towards existing conceptions. Learners may reinterpret anomalous data to preserve their original theory. Peripheral change may occur with learners accepting the anomalous data, but only making minor modification to their current theory. Theory change, however, is ultimately the desired outcome, can exist before a conflict can be generated. Cognitive abilities and epistemological beliefs can also influence outcomes. Resolutions of conflict are therefore challenging processes to achieve, but studies suggest that if students are already aware of the processes by which scientific progress usually happens, they may view anomalous data as less threatening. Researchers have observed that students who are uninterested or unsuccessful often have difficulty dealing with anomalous data. It also appears difficult to anticipate the level

Research Objectives

Professor Patrice Potvin researches conceptual change within the context of science education.

Detail

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Bio

Patrice Potvin is a professor of science and technology education at the Université du Québec à Montréal (UQAM). Author of more than 400 publications and communications, he is director of the Science and Technology Education Research Team (EREST) and member of the Royal Society of Canada.

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References


Personal Response

What, in your opinion, is the most significant finding in your review of the research into the response of learners to contradicting information? I believe it has already been said in the text: that an initially available alternative conception (plan B) is an important condition in the success of conceptual change.