

Modeling with Technology: Mindtools for Conceptual Change (Book Review)

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David H. Jonassen
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David H. Jonassen is a Distinguished Professor of Education, School of Information Science and Learning Technologies at University of Missouri-Columbia. Dr. Jonassen has written extensively on the use of technology to engage critical thinking and problem solving to facilitate learning in his series of books on the use of Mindtools in Education. He is perhaps best known for conceptualizing the idea of “Mindtools” which, briefly described here, refer to the use of learning environments and particular types of software as cognitive tools to engage and support the learner in critical thinking and problem-solving.

Jonassen has given us a series of three books aimed at K-12 classroom teachers that describe how Mindtools aligns with a constructivist view of learning. The first edition, *Computers in the classroom: Mindtools for critical thinking* (1996) introduced readers to the term “Mindtools” to engage students in constructivist activities that support critical thinking and problem solving instead of teaching for memorization. This book was followed with *Computers as Mindtools for Schools: Engaging Critical Thinking*. (2000).

In his third edition *Modeling with Technology: Mindtools for Conceptual Change* (2006) Jonassen promotes the use of Mindtools for facilitating *conceptual change*. He states that his purpose is to convince the reader that “constructing models facilitates intense cognitive and social activities that result in conceptual change.” This review attempts to determine if Jonassen is successful in this purpose.

According to Jonassen, models are products of Mindtools that enable the learner to externalize, through visual representation, their mental abstraction of a construct (its components and their interrelationships). He states that “If you cannot build a model of what you think you know, then you do not really know it” (p. xiv). Jonassen uses nine different types of software (databases, spreadsheets, concept maps, expert systems, systems modeling tools, simulations, visualization tools, hypermedia, and electronic conferencing) to demonstrate how learners can model what they know. He proposes that through the process of model building with these tools, learners will externalize their conceptions, reveal their misconceptions, and thus lead to conceptual change.

The book is divided into three parts that address the *why*, *what*, and *how* models should be used to facilitate conceptual change. Part 1 provides a brief overview designed to educate the reader on model building as agents of conceptual change. Part 2 describes the types of phenomena that can be modeled. Here, readers are shown how to frame and present subject matter according to the different ways it can be modeled, for example as knowledge or a system, or a problem space. This perspective broadens the reader's view of the role of cognitive tools to include construction of models (literal and mental) of the phenomenon they are studying. Part 3 describes how Mindtools can model these phenomena. The description of each Mindtool is useful for readers who are unfamiliar with Jonassen's work. There is a separate section for each type of Mindtools used in model building –for example, an experience (story) may be modeled using hypermedia that represents the relationships between events. Each of these sections includes criteria for assessing models built with the tool. Assessment is an integral part of the teaching process therefore the inclusion of assessment criteria increases the utility of the book for teachers. A brief critique of each modeling tool will help teachers optimize their use and avoid problems. Finally, a step-by-step example of a classroom activity demonstrates how a Mindtool can be used to build a model.

In Chapter 1, Jonassen outlines a brief description of the field of conceptual change which he characterizes as a process in which a learner's prior conceptual knowledge conflicts with the presentation of new, anomalous phenomenon. If the learner's extant mental model cannot accommodate or assimilate new information then one of two things happens: the learner rejects the new information or the learner restructures their mental model to accommodate the new information. In the latter case, the generation of a new personal theory or mental model to explain the anomalous information is known as conceptual change. Jonassen believes this process is fundamental to learning. However, he goes on to create a model of this theory of conceptual change associated with cognitive conflict as a way of demonstrating the value of modeling conceptual understanding using a systems modeling tool called Stella. He then describes and constructs another model of conceptual change (that he calls a revisionist model) that de-emphasizes the need for cognitive conflict as a mechanism for invoking change. Unfortunately, the demonstration leaves the reader with the idea that it might be impossible to convey the concept of conceptual change using such a tool, as there is little support given to making meaningful comparisons between the two models. It was almost as if different people constructed the two different models and we missed the "learning" that was associated with constructing the alternatives. Therefore Chapter 1 concludes with a somewhat confusing and hence unconvincing proposition that constructing models facilitates conceptual change.

In Chapter 2, Jonassen offers some very useful categories for thinking about modeling and learning, that is modeling domain knowledge, modeling systems, modeling problems, modeling experiences (stories) and modeling thinking (cognitive simulations) that he later is able to map onto to particular technologies and tools. However, there was only a tenuous connection between the process of modeling and the process of conceptual change other than his assertion that learning is enhanced by modeling, and therefore conceptual change occurs.

Chapter 3 provides a provocative discussion of the issue of assessing learning. Jonassen falls back on discussions on critical thinking from the previous edition and the need for assessing higher order learning outcomes, suggesting simple rubrics for general processes for knowledge construction, self-regulation, collaboration and critical thinking. Little is provided that helps with the complexity and labour-intensive nature of assessing conceptual change by considering changes in model construction. The strength of the book for teachers is contained in Part Two: Chapters 4-8 where Jonassen provides solid descriptions and examples of the modeling categories he suggested in Chapter 2. The chapter includes an intriguing discussion of modeling experiences where he describes a fascinating student ethnography project called Learning Constellations.

In Part Three Jonassen attempts to map the types of modeling with the actual tools, and in most cases this is a useful and engaging set of chapters. However, there is little connection with these tools and the theory of conceptual change, other than his own stated relationship between constructing models and conceptual change. Elementary teachers are less likely to find the use of complex applications such as expert systems or the more recent agent-based modeling tools.

Jonassen's latest work provides teachers with another context in which to use Mindtools thus extending their use in the classroom. The book is divided into three parts that address the *why*, *what*, and *how* models should be used to facilitate conceptual change. Part 1 provides a brief overview designed to educate the reader on model building as agents of conceptual change. Part 2 describes the types of phenomena that can be modeled. Here, readers are shown how to frame and present subject matter according to the different ways it can be modeled, for example as

knowledge or a system, or a problem space. This perspective broadens the reader's view of the role of cognitive tools to include construction of models (literal and mental) of the phenomenon they are studying. Part 3 describes how Mindtools can model these phenomena. The description of each Mindtool is useful for readers who are unfamiliar with Jonassen's work. There is a separate section for each type of Mindtools used in model building—for example, an experience (story) may be modeled using hypermedia that represents the relationships between events. Each of these sections includes criteria for assessing models built with the tool. Assessment is an integral part of the teaching process therefore the inclusion of assessment criteria increases the utility of the book for teachers. A brief critique of each modeling tool will help teachers optimize their use and avoid problems. Finally, a step-by-step example of a classroom activity demonstrates how a Mindtool can be used to build a model.

The generous use of visual aids adds explanatory power to a fairly academic text. Most graphics are screenshots of models created by Mindtools such as databases, spreadsheets and concept maps. However, there are many screen shots of models built with the system modeling software STELLA™, a visualization tool for modeling dynamic systems. Unfortunately, the notation and semantics of the notation used by STELLA™ is likely not commonly known to Jonassen's intended audience and therefore undermine the clarity of these models to the reader.

Although Jonassen identifies his readers as classroom teachers, this book, as well as the prior two, is also used as course texts for both undergraduate and graduate courses in education—in particular instructional technology. The academic language and references to the research literature are indicative of its suitability for graduate students and researchers in instructional technology and instructional design. While the academic nature of the book does not preclude its utility to classroom teachers, a solid familiarity with the function of Mindtools in a constructivist environment is recommended in order to follow the ideas presented. Busy classroom teachers generally value books that provide methods accompanied by practical examples. Jonassen attempts to fulfill the needs of both but teachers may find the text too academic.

We conclude that Jonassen is successful in his description of how models may be used as tools for promoting conceptual change. However, the visual and conceptual complexities of the cognitive conflict and revisionist theory models presented in Chapter 1, combined with their ambiguous comparison may leave the novice reader unconvinced about the ability of such tools to effectively represent mental models. We recommend that the author reconsider how these theories of conceptual might be more effectively represented and their differences explained.