

# **Easier Said Than Done: A Case Study of Instructional Change Under the Best of Circumstances**

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This paper presents the partial results of a case study of an experienced university physics instructor as he attempted to change his instructional practices. Although this instructor appeared to have all of the prerequisites for successful change, he still encountered difficulties. Four factors were identified that limited his ability to change: (1) an implicit instructional model constrained thinking; (2) a lack of how-to and principles knowledge of instructional strategies limited successful implementation; (3) overly optimistic initial planning led to discontinuance; and (4) a desire to work within perceived external constraints limited options.

## **Introduction**

Physics education researchers have compiled a substantial amount of evidence that student learning can be improved if physics instructors stop using traditional instruction and start using research-based instructional strategies. Some instructors find this evidence convincing and attempt to change their instruction. Some of these instructors are successful and some are not. Unfortunately, little is known about the details of the change process. The goal of this study was to better understand the change process and to identify factors that can impede the change process for instructors who want to improve their instruction.

## **The Case**

Dr. Holt (a pseudonym) is a tenured faculty member who has taught physics at a research university in the upper Midwest for 20 years. He was selected for study because he was planning to change his instruction in the second semester introductory calculus-based physics (electricity and magnetism) course in an effort to improve student learning. The class consisted of about 70 students, mostly engineering majors, and met in a stadium-style lecture room for 50 minutes each weekday. In addition to the lecture, there was a weekly 2-hour lab.

Dr. Holt appeared to have all of the requirements for successful change. He was dissatisfied with his previous experiences teaching this course. He believed that changing his instructional practices could have a significant impact on student learning. He had taken the

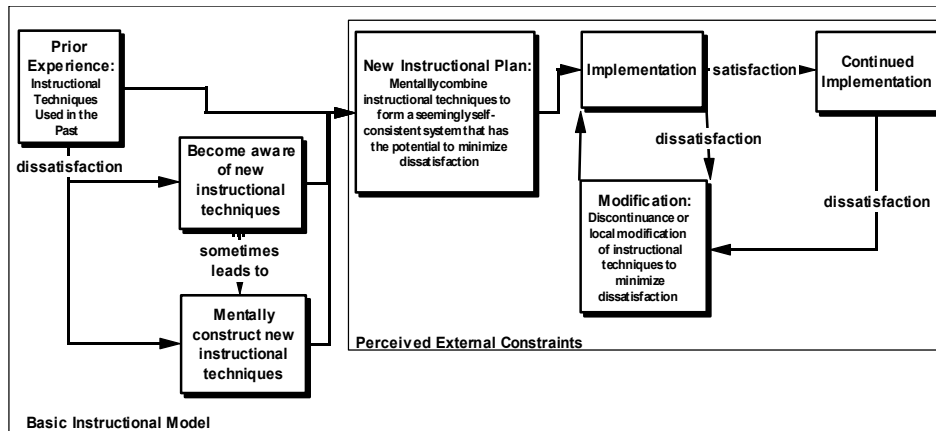
initiative to learn about new instructional techniques. He was also participating in a national program to improve introductory physics teaching. As part of this program he had the support of a teacher-in-residence – an experienced high school physics teacher who frequently attended the class and discussed instructional strategies with Dr. Holt. In addition to the support afforded by the national program, there was also a degree of accountability since Dr. Holt knew that he would have to report on his experiences.

## **Data Sources**

One of the characteristics of case study research is the reliance on multiple sources or evidence. [1] In this study, three principle sources of evidence were used: (1) Weekly interviews with the course instructor (15 interviews ranging from 20-60 minutes each); (2) Daily classroom observations (62 of the 67 class days were observed); (3) materials distributed to students (syllabus, exams, HW). Because the goals of the study were to understand the process of instructional change, the focus of data collection was on three dimensions of teaching practice: instructional materials, instructional strategies, and beliefs about instruction. [2]

## **Data Analysis**

The interviews were audio recorded and transcribed. A matrix display was used to organize the data by topic and by time. [3] The rows of the matrix contained topics. These topics included the various instructional strategies that were discussed (e.g., use of white board group



**Figure 1: A schematic representation of Dr. Holt's change process.**

work) as well as other topics that came up in the interviews (e.g., general level of instructor satisfaction with the course, instructor concerns). The columns of the matrix represented time. There were two columns for each week. One contained plans for the week (discussed before the week) and the other contained reflections on the week (discussed after the week). The column containing reflections on the week also contained notes about actual practices from the class observations and student materials. This arrangement of data facilitated the identification of changes in ideas or practices with respect to time as well as discrepancies between practices, goals, and reflections.

A model was developed to describe Dr. Holt's change process. Using Roger's model of adoption of innovations [4] as a starting point, this model was iteratively developed by following Dr. Holt's statements about and use of each of the instructional techniques throughout the semester. The process was considered complete when the model accurately described the implementation of each of the instructional techniques.

### Characteristics of Dr. Holt's change process

A schematic of Dr. Holt's change process is shown in Figure 1 and described below.

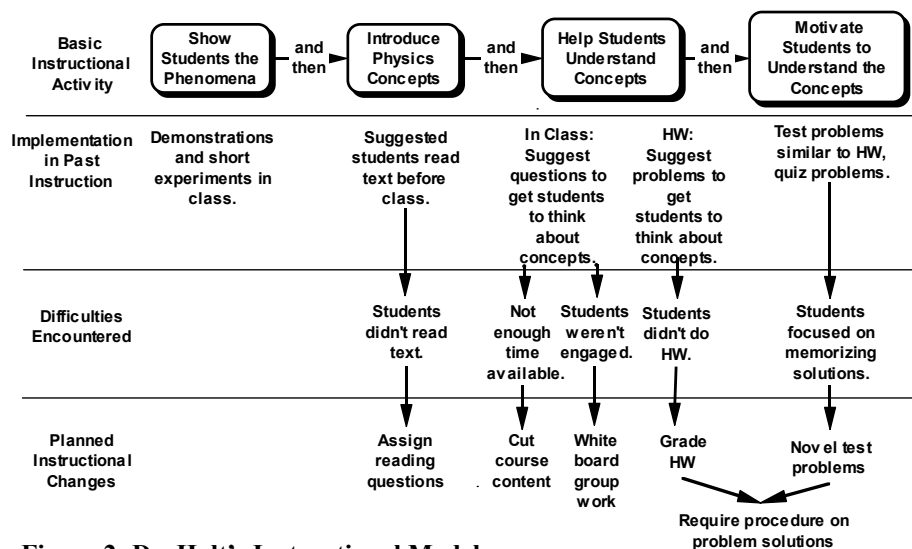
*Dr. Holt had a coherent basic instructional model that constrained/guided the change process.* This model is shown in Figure 2 and was inferred from statements made during the interviews. It was presented to Dr. Holt towards the end of the semester and immediately recognized as accurate. According to the model there are four basic

instructional activities that need to occur in a particular order. First, students are shown a new physical phenomenon. Second, the physics concepts are introduced. Dr. Holt believes that this can be done in class, but that it can also be done by having students read the textbook, leaving class time for other things.

Third, questions are asked or problems assigned to help students develop an understanding of the concepts. Fourth, students are motivated to understand the concepts by being required to solve test problems. Dr. Holt believes that if the test problems are not novel then students focus on memorizing problem solutions rather than understanding the concepts. One aspect conspicuously absent from Dr. Holt's instructional model is any mechanism to help students use their knowledge of the physics concepts to solve problems. This reflects Dr. Holt's belief that all a student needs in order to solve problems is a good understanding of the physics concepts.

*Dr. Holt looked for or developed new instructional techniques to solve specific problems that kept him from fully implementing his instructional model in the past.* Dr. Holt identified dissatisfaction with many of the instructional techniques that he had used in the past (see Figure 2). For each area of dissatisfaction, Dr. Holt was typically aware of several possible solutions. He became aware of some of these through external sources and developed some himself. When learning about techniques from external sources he tended to stop gathering information after developing an awareness that the technique existed (awareness knowledge), rather than moving on to develop knowledge about using the technique (how-to knowledge) or knowledge about why the technique works (principles knowledge). [4]

*Dr. Holt developed a new instructional plan before the course started.* In constructing his plan, he mentally combined instructional techniques that



**Figure 2: Dr. Holt's Instructional Model.**

he had used before with new instructional techniques to form a seemingly self-consistent system that was consistent with his basic instructional model. The plan included an instructional cycle where one lecture would be used showing students the phenomena. That evening, students would be introduced to the basic physics concepts related to that phenomenon by reading the text. He planned to encourage students to read the text by requiring them to submit a question about the reading via email before the next lecture. During the next lecture, various activities would be used to get the students to think about the concepts. Many of the instructional strategies used in his instructional plan are shown in Figure 2.

*After initial implementation of his new instructional plan, Dr. Holt made local modifications.* Dr. Holt either discontinued or modified aspects of his new instructional plan that he was not satisfied with. For example he almost immediately revised the instructional cycle that he had planned. Instead of having rigid categories of showing the phenomena, introducing concepts, and helping students understand concepts, he found it was preferable to integrate these activities. Some aspects of his instructional plan were initially perceived to be satisfactory, but were later modified due to dissatisfaction. For example, the use of novel exam questions was slowly phased out during the second half of the semester in response to poor student performance.

## Impediments to change

An impediment to the change process is a factor that prevents an instructor from reaching the desired improvement in student learning that initiated the change process. Four factors were identified that were consistent with the change process for each individual instructional technique. They were modified slightly based on comments by Dr. Holt.

*Factor A: Dr. Holt's basic instructional model constrained his instructional choices.* His basic instructional model was implicit, unquestioned, and did not appear to change throughout the semester. Dr. Holt did not consider possible instructional techniques or look for possible explanations that fell outside of his basic instructional model. Most of his model was compatible with the results of educational research and helped to effectively guide the change process. Other parts limited the change process. For example, as mentioned earlier, Dr. Holt believed that students would be able to solve problems if they understood the concepts. Thus, he placed a lot of emphasis on conceptual understanding and relatively little on the modeling or teaching of problem-solving skills. This lack of instructional emphasis on problem solving may have been one of the factors limiting students' abilities to solve novel problems at the end of the course. Prior research has also shown that beliefs and values can constrain teachers' thinking. [5]

*Factor B: Dr. Holt did not seek to gain much knowledge about new instructional techniques.* As discussed earlier, Dr. Holt only obtained awareness knowledge about instructional techniques before attempting implementation. In some cases this lack of how-to or principles knowledge led to implementation difficulties. For example, his implementation of white board group work did not reflect the five essential components of cooperative grouping, [6] of which Dr. Holt was

unaware. As the course progressed he found that students were becoming progressively less engaged in the group activities. It is not clear whether it would have been possible for Dr. Holt to avert these difficulties by obtaining more knowledge before implementation. The principles knowledge may not have made sense without some relevant prior experience. It seems likely, however, that developing more how-to knowledge about managing small group work could have averted some of the difficulties.

*Factor C: Planning was overly optimistic.* Dr. Holt's initial plans for the course were very elaborate and did not anticipate possible problems such as the students not responding as expected or the course elements not fitting together as hoped. For example, his planned instructional sequence (showing students the phenomena one day, having them read about the relevant physics concepts that night, and then having them use the concepts the following day) was found to be constraining and very quickly discontinued. In addition, Dr. Holt did not anticipate the considerable time and energy that change requires. When sufficient time and energy were not available, Dr. Holt would revert to previous instructional practices of doing semi-interactive lectures where he would develop a topic by asking a series of questions to the class and having students call out answers.

*Factor D: The implementation of the new instructional plan was overridden by perceived external constraints.* A common concern expressed during the interviews was the need to cover a certain amount of material. This led Dr. Holt to revert to his previous instructional practices. For example, he believed that well-designed white board group work was very effective in helping students understand the physics concepts; however, it took a lot of time. Semi-interactive lectures were often chosen over white board group work in order to cover the necessary material.

## **Discussion**

This study confirms the findings of previous studies that a desire to change, although necessary, is not sufficient for change to be successful. [7] In

this study, Dr. Holt's ability to change was limited by an implicit instructional model, a lack of how-to and principles knowledge of instructional techniques, overly optimistic initial planning, and a desire to work within perceived external constraints. This study was limited to one semester. Others have suggested that it takes a teacher between 3 and 5 years to successfully change their instruction. [2, 8] Thus, this case study may represent the initial phase of a successful long-term change process. Dr. Holt indicates that he plans to use the results of this initial experience to continue to work towards his instructional goal of helping students develop a real understanding of physics concepts.

## **Acknowledgements**

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