Chapter 7.9

On the Role of Learning Theories in Furthering Software Engineering Education

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ABSTRACT

Learning theories describe how people learn. There is a large body of work concerning learning theories on which to draw, a valuable resource of which the domain of software engineering educational research has thus far not taken full advantage. In this chapter, we explore what role learning theories could play in software engineering education. We propose that learning theories can move the field of software engineering education forward by helping us to categorize, design, evaluate, and communicate about software engineering educational approaches. We demonstrate this by: (1) surveying a set of relevant learning theories, (2) presenting a categorization of common software engineering educational approaches in terms of learning theories, and (3) using one such approach (SimSE) as a case study to explore how learning theories can be used to improve existing approaches, design new approaches, and structure and guide the evaluation of an approach.

INTRODUCTION

Learning theories are attempts to describe and understand the various ways in which people learn. They are an important resource for educational research, as they can both guide us in creating new educational approaches, and help us analyze and improve existing approaches.

In this chapter, we propose that learning theories, which have thus far been explicitly leveraged in software engineering education in only a minimal way, can actually play quite a significant role in this domain. Specifically, we believe that learning theories can serve to move the field of

software engineering education forward by helping us to categorize, design, evaluate, and communicate about software engineering educational approaches. Categorizing approaches in terms of learning theories can help us to understand the approaches in relation to each other, understand how they fit together, and point out areas of untapped potential. New approaches can be designed to leverage certain theories whose potential is unfulfilled or known to be especially valuable in our domain. Learning theories can be used to evaluate approaches by helping structure experiments to look for the presence of these and other theories in the processes of learners. And, we can use our newfound knowledge to communicate in a common language—that of learning theories—about different approaches and our experience with them.

This chapter details this vision of principally using learning theories in the domain of software engineering education. We first briefly present a set of well-known (mainly constructivist) learning theories that are especially applicable. We then introduce a categorization of the major software engineering educational approaches to date in terms of the learning theories that they appear to have been designed around. Following this, we discuss the role learning theories can play in analyzing and improving the design of a software engineering educational approach (and designing new approaches), and focus on the analysis of one such approach (SimSE) as a case study. We then discuss how software engineering educational approaches can be evaluated in terms of learning theories, again using SimSE as a case study. We conclude with a summary in the final section.

BACKGROUND: LEARNING THEORIES

To provide some background for our discussion on the role of learning theories in software engineering education, in this section we will briefly introduce the set of learning theories that we surveyed for the purposes of our analysis. We do not include here an exhaustive list of all learning theories with significant detail. Instead, the purpose of this section is to simply introduce some of the ones we have seen software engineering educational approaches centered around most frequently, and provide pointers to where more information about each one can be found. In addition, we will also briefly touch on implications and typical or possible applications of each theory for software engineering education.

We chose the particular set of learning theories discussed here because of two criteria: relevancy to software engineering and orthogonality among the factors defining the theory. In other words, these theories are the ones we have seen to be most clearly and/or frequently embodied in the software engineering educational approaches that we surveyed. Furthermore, there exists a great deal of overlap among learning theories, and there are several learning theories that encompass a number of others. In these cases, we either group theories that have the same basic idea, and omit those that simply combine a number of theories.

We acknowledge that these theories fall mainly into the constructivist paradigm (rather than the behaviorist or cognitive categories), however, given that constructivism is the most recently-developed paradigm, and software engineering is a relatively new discipline, this is not surprising (it has been argued elsewhere, in fact, that the evolution of computer science education in the past decade or so has been significantly influenced by constructivism (Kolikant, 2001)). While it is certainly true that most delivery methods generally contain a mix of various theories that fall into each of the three camps (constructivist, behaviorist, and cognitive), because the constructivist aspects are the most focused on, we have chosen to scope this survey and analysis to focus primarily on these theories. Surely similar surveys and analyses could be done with cognitive and behaviorist theories that would yield interesting results, however, such exercises are outside the scope of the one presented here.

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