Architecting the CDIO Educational Framework Pursuant to Constructive Alignment Principles

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ABSTRACT

On the one hand, no one international model for quality assurance evaluation of higher education has emerged. On the other hand, as a reference model rather than a prescription, the CDIO initiative proposes a mature integrated framework for creation or continuous improvement of engineering programs. However, institutions developing and managing educational programs have to juggle the expectation of various accreditation and evaluation bodies, which may create consistency and interoperability problems. A need exists to unambiguously specify relations among quality assurance concepts to enable more transparent and comparable descriptions of quality frameworks for educational programs. Following constructive alignment principles, this article creates structural models using some of the CDIO Standards. In doing so it lays the foundations of an architectural meta-model for describing complex educational systems, which will contribute to consistency and interoperability among quality frameworks.

Keywords: CDIO, Constructive Alignment, Curriculum, Design, Education, Educational Frameworks, Engineering, Models, Quality Assurance, System Thinking

INTRODUCTION

The ongoing process of program transformation impacts an institution’s operating modes, its quality and its future performance. The management of educational transformation is thus of strategic importance to universities, schools and programs. During the last decade, various models of quality management have emerged in the form of quality assurance (QA) criteria and standards that can help program leaders to evaluate and improve their various educational systems including curricula, workforce, workspaces, support services, and administrative processes. However, these complex QA frameworks are not always clearly described. As a result, the increasing complexity of their concerns, criteria, and standards requires new and different types of expertise on behalf of program designers and managers.
It is very difficult for educational organizations and their managers to ensure interoperability among existing QA programs and frameworks since no global unified model for higher education QA has yet emerged. Therefore, it is essential to identify the common core concepts of the various QA frameworks to facilitate the process of program design and transformation. A system modeling approach is an obvious choice for meeting such a challenge since it makes it possible to meaningfully, unambiguously, and accurately specify concepts, relations, and viewpoints among stakeholders.

An educational program rests on three main pillars: 1) an intended or declared curriculum, 2) a enacted or taught curriculum, and 3) a validated or learned curriculum that share a set of common core concepts in the form of learning outcomes (Harden, 2001). The main objective of this article is to provide a framework for describing the concepts associated with these three pillars. This article identifies key concepts for modeling these pillars of educational programs following constructive alignment principles (Biggs, 1996). It is hoped that this effort will result in the unambiguous description of the relationships among these several concepts.

This article is structured as follows. As background, some existing notions of educational modeling are quickly surveyed. Next, three conceptual and structural models, that correspond to the aforementioned educational program pillars and that support constructive alignment, are proposed in the form of three diagrams as graphical representations that focus on nearly all of the CDIO Standards (CDIO, 2010). In this section it is argued that the CDIO Standards can be regarded as resources, properties or constraints in such models. Relations between concepts of these models are then derived. The following section examines the benefits of educational system modeling for various stakeholders, and presents the requirements for constructing viewpoints that represent their concerns. This section then reviews some quality management models in education so as to pave the way for future work on architecting educational systems. The last two sections respectively provide some future directions and conclude this article.

**BACKGROUND: TOWARDS MODELING EDUCATIONAL FRAMEWORKS**

Analyzing an educational program from conceptual and structural perspectives reveals semantic relations among the three pillars of an educational program: the intended or declared, the enacted or taught, and the validated or learned curricula (Harden, 2001). These three pillars share a set of common core concepts, principally in the form of learning outcomes. By analyzing the CDIO Standards from such perspectives it is possible to clarify and structure, at an abstract level, the currently complex CDIO Standards. In a more general sense, as the size and complexity of educational systems increase, it is a major challenge to unambiguously describe common concepts among the various stakeholders involved in program design or transformation. In such a context, modeling approaches allow one to represent, visualize, and document the artefacts of a system in terms of these different points of view. Models permit one to unambiguously and consistently describe concepts and their relationships (Muller et al., 2010). In addition, by minimizing ambiguities and introducing a certain degree of formality, modelling approaches enhance better understanding, coherency, alignment, analysis and (re)usability of common concepts, principles and recommendations related to program design or transformation.

**Managing Flexibility and Interoperability in Educational Frameworks**

The twelve CDIO Standards offer many keys for reforming and/or continuously improving engineering programs for preparing the next generation of engineers (Crawley et al., 2007). Representing much more than a simple syllabus that organizes learning outcomes, the CDIO Standards form a multidimensional
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