Is Five Enough? Modeling Learning Progression in Ill-Defined Domains at Tertiary Level

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Abstract. Insuring the progressive development of generic and discipline-specific high-level skills in a university degree is hard. This is partly because the skills are defined broadly, in terms of multiple curriculum frameworks which have different granularity and terms. Another key challenge is the definition of skill level progression, the very ill-defined notion of maturity. This paper describes the vision of CUSP, a system for modeling high-level skills via an overlay student model for long term progression of learning. We argue that the representation of maturity and knowledge should use 5 levels.

Keywords: Curriculum Mapping, Learning Progression, Graduate Attributes, Accreditation Competencies, Learner Model

1 Introduction

A typical university degree is 3-to-5 years long and is bound by multiple sets of curriculum frameworks. These typically include generic, transferable skills defined by the University or Faculty, discipline specific skills defined by vocational or accreditation bodies, and finer-grained learning objectives defined by curriculum bodies. A student completing a 3-to-5 year tertiary degree, with 24 to 60 core and elective subjects, should be able to track his or her progress against all of these skills.

It is widely agreed that generic skills, such communication or teamwork, are extremely important. These skills are ill-defined in several senses. Firstly, the role of increasing sophistication and higher levels of performance are a key part of their development. As a learner builds a particular skill, their knowledge increases. Additionally, as the learner gains new knowledge, they commonly consolidate their understanding of more basic concepts, developing greater maturity.

Such notions of progression and maturity are very ill-defined. One challenge is that flexible degrees must be designed so that students acquire maturity in generic skills via any of the allowed pathways. Another dimension is very pragmatic: skills are typically taught within the context of disciplines, such as physics, where the lecturer is expert in physics, but not communication skills as a discipline. So, in practice, even though there is a body of knowledge about the generic skill areas, those actually teaching may be unaware of it.

As we worked to model generic skills, we also noted that the notion of maturity is also important but ill-defined in other skill areas. For example, consider
the case of programming, a seemingly very well defined area, with many precise, fine-grained subgoals. Even for this, an important goal for a university degree, and a requirement for accreditation is for a growth in programming maturity. Students must do a sequence of programming subjects, each developing this ill-defined notion of maturity.

We now consider how to design long term learner model frameworks that can capture the progressive learning of high-level skills. A single degree will have skill sets derived from multiple internal and external curriculum frameworks. These skills come in varying granularities. Mapping each skill to each subject activity in which it is taught across a full degree is a very time consuming and intellectually challenging task. Also, modeling learning progression requires a representation of the skill level, which is not always explicitly defined in all curriculum frameworks. The sequencing and delivery of prescribed skills is thus often left to degree designers, who require aids to help with this monumental task.

2 Related Work

There have been numerous attempts to model competencies, generic skills and subjects, for example in standards such as IEEE LOM, IMS LIP, SCORM, HR-XML, IMS-RDCEO and EML (Educational Modeling Language\textsuperscript{1} [5]). In parallel, there has been considerable work on ontologies to model learnt skills (for example [1, 7]). We aim to go beyond just mapping competencies/skills to subjects in a single framework, as in Curriculum Central [3] which used 5 levels and UK-SpecIAL [2] which mapped subject multiple-choice questions to UK SPEC Standards for Professional Engineering accreditation attributes.

We draw on work to modeling learning progression and skill maturity in the context of computer programing, such as the use of the 5 maturity levels of the SOLO (Structure of the Observed Learning Outcome) taxonomy or its extension to 6 levels in the context of computer programing [6]. We have found no work that models learning progression of competencies/skills in terms of multiple curriculum frameworks across entire 3-to-5 year degrees with flexible pathways.

3 Approach

We have built CUSP (Course and Unit of Study Portal) which models entire degree programs in terms of core and elective subjects [4]. CUSP models skills in terms of 5 levels, and these are mapped against each subject’s learning outcomes and assessments. This enables CUSP to generate report matrices that span entire degrees and show which skills are taught in which subject and at which level. Multiple competency/skill frameworks are supported via a pragmatic approach that allows mapping equivalent attributes from different frameworks to each

\textsuperscript{1}Educational modeling Language, http://www.learningnetworks.org/?q=EML
other. This has proven to be a workable and scalable solution. However, frameworks of vastly differing granularities are difficult to map against each other. This can lead to translational inconsistencies in the learning-outcome, primary-skill, secondary-skill mappings.

Our next phase will be to introduce subject instance level mappings between skills from different frameworks, thus solving the granularity translation issues. We will then move towards creation of individual learner models that can be easily presented in a visualization, such as that shown in Figure 1. Here, a student can see their learner model in terms of skills from one of two different frameworks. Each LM lists the skills vertically downwards, and the learning progression horizontally across. Learning progression is a combination of increasing knowledge at higher levels and strengthened maturity at lower levels. The LM will be supported by evidence collected from assessment task marks. The LM will be navigable such that students can see which skills were developed in which subjects and which assessment tasks.

![Fig. 1.](image-url) On the left: learner model representing knowledge and maturity of generic Faculty Graduate Attributes for a fictional student. On the right: the same student’s model of knowledge and maturity based on discipline-specific ACM Computer Science high-level topic areas.
4 Conclusions & Future Work

The ill-defined nature of the high-level skills that we need to model has driven us to find a learner model representation that can address the needs of the many stakeholders involved: University level faculty concerned with graduate attributes; Faculty and School level academics concerned with the design of curricula for each degree; academics responsible for the design of their own subject; students who need to select subjects and to understand how the learning objectives and activities in each subject contribute to a big picture development of important long term broad skills.

Our previous experience has indicated that five knowledge levels is manageable for the curriculum design and mapping processes, especially for accreditation. It is enough to show progression over the three to five years of a degree and to capture the broad notion of maturity within an ill-defined skill. The modeling approach and five levels also support a compact representation of the learner’s current progress, clearly highlighting areas of relative strength and weakness.

The core contribution of this work is an open learner model design that is intended to be simple and clear enough to support a range of processes. It should assist subject lecturers in making their subjects contribute to the development of broad skills. It should help degree designers ensure their courses satisfy accreditation and curriculum requirements. And finally, it should act as an invaluable tool for students in planning studies, selecting subjects, understanding how each part of a subject contributes to long term learning across the degree, as well as reflecting on their progress in building high-level skills.

References