

A Tool for IAS Curriculum Development, Management, and Accreditation

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Abstract – *In the area of computing, there are a plethora of curricular and training standards that attempt to define content for a computing curriculum. In addition, there are several accrediting bodies and standards. The task of building and maintaining a degree program aligned with one or more of these standards is a daunting one. Maintaining the appropriate documentation for managing such a process is time-consuming and space-intensive.*

In this paper, the authors will present a tool that was developed during a revision of an undergraduate information assurance and security degree. This tool was ultimately designed to 1) facilitate implementation of a given training standard into the curriculum, 2) provide for documentation to support program accreditation, 3) support change management within the program and accommodate changes in standards, and) do so at a reasonable cost in time and effort compared to an equivalent manual management process.

The authors will discuss how this tool can be used to manage the curriculum development and maintenance process. Specifically, the authors used this tool to create an IAS curriculum that incorporated training standards from NSA and ACM and adhered to accreditation and certification guidelines defined by NSA and ABET. While these standards were explicitly used, the tool is sufficiently flexible to adapt to other standards as well.

Index terms – Accreditation, Certification, Change Management, Curriculum Standards, Curriculum, Education, Information Assurance, Information Security, Outcomes Assessment, Security, Training Standards

I. INTRODUCTION

In fall 2002 the Information Technology (IT) faculty at the Pennsylvania College of Technology (PCT) perceived a demand for an Information Assurance and Security (IAS) program. Beginning in the spring of 2003, an IAS program was designed as an offshoot from an existing networking program. The program emphasized risk analysis and management of information security as a system. The program was developed throughout the summer and fall of 2003. It was reviewed by an advisory committee in spring 2004. The program was approved by

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the curriculum committee at PCT and began enrolling students in fall 2004.

The curriculum received two primary comments from the advisory committee: first, the program was a good target and graduates would be useful within their organization; second, since the Federal Government had provided criteria for training information security professionals, we should do a comparison with the NSA program and determine viability. On first review we had very little in common with the NSA criteria beyond NSTISSI 4011 [1]. At that time, none of the published NSA standards focused on risk analysis or risk management. It wasn't until November of 2005 that the CNSSI 4016 [1] standard defining the criteria for a risk management professional was published. Subsequent review beginning in January 2006 showed that the existing curriculum substantially met NSTISSI 4011 and CNSSI 4016. Given the feedback from the advisory committee, the faculty determined to align the curriculum fully with NSTISSI 4011 and CNSSI 4016.

During the same time period, several IT faculty members at PCT were participating in an effort to define IT curriculum and accreditation standards. This effort resulted in the creation of the Special Interest Group for Information Technology Education (SIGITE) within ACM [2]. The IT specific accreditation criteria [3], created by SIGITE, was adopted by ABET beginning in 2003. The IT curriculum document (IT2008) [4] was completed by SIGITE [5-10] and approved by the ACM education board in 2008. PCT faculty members served on both the accreditation and curriculum committees and two faculty members served on the curriculum writing committee.

As a result of faculty participation in the work of the SIGITE, the committee formed to review and revise the IAS program decided that the program should meet the ACM (IT curriculum draft) criteria and also meet the requirements for ABET accreditation, while maintaining alignment with the NSTISSI 4011 and CNSSI 4016 training standards. To do this would require a series of procedures and tools that would manage the mapping of NSA training standards to the new IAS program, the ACM IT curriculum to the program, and program outcomes to the ABET accreditation criteria.

The tool(s) should enable the user to map all the NSTISSI 4011 and CNSSI 4016 objectives to existing coursework so that a gap analysis could be performed to identify missing content. The tool(s) should be flexible enough to permit the same mapping for the ACM IT curriculum without losing the structure of the NSA mapping. The tool(s) must effectively support change management in order to maintain the curriculum. To support accreditation, the tool(s) should also facilitate internal outcomes assessment and the mapping of course and program outcomes to the ABET criteria. In this paper we describe a tool that satisfies these requirements.

II. IMPLEMENTING A CURRICULUM

In order to implement the NSA training standards into a degree program, it was necessary to consider several issues. First, the NSA standards are generally organized by program, function, area, subarea, and objective. NSTISSI 4011 is organized differently: faculty decided that a translation of the 4011 structure to the one described here would be less time consuming than creating a different tool. Second, the curriculum structure uses program, major, course, and outcomes. Third, each NSA objective must be mapped to at least one course outcome. The mapping must preserve both organizational structures in order to view the content from either perspective. The ability to move from one view to the other is necessary in order to complete a gap analysis effectively.

To perform such a gap analysis, it was necessary to be able to identify any NSA objective that was not mapped to some course outcome. However, the structure containing that objective must be maintained. Many objectives, taken out of context, are identical or virtually so. Without the structure to provide context, the intent of the objective is lost. This necessitated creating several reports or views to identify the unmapped content within its context.

The gap analysis identified several knowledge areas that were missing or covered at an incorrect level of mastery for NSA certification. To address the deficiencies, new outcomes were developed in appropriate courses or new course content was developed. When mastery levels were incorrectly applied within a course, the level of coverage within those knowledge areas was adjusted to meet the NSA objectives by changing course outcomes to meet the expected level of mastery.

Once all the content was mapped, it was also necessary to be able to see the course and curriculum content. In some cases, the definition and organization of a course was constructed from outcomes created in the mapping. Moreover, organizing the structure of the curriculum (ordering of courses, prerequisite structure, levels of

mastery, etc.) was greatly facilitated by being able to view the mapping from the course/curriculum view.

Finally, for the purposes of documentation for NSA certification, each outcome mapping needed to be able to identify the learning task the student performed to demonstrate appropriate mastery of the outcome. This same association of the outcomes to the learning tasks also facilitates maintaining an internal outcomes assessment program necessary for pursuing ABET accreditation.

III. MULTIPLE SETS OF CRITERIA

In IT2008, the information technology curriculum is organized by knowledge areas, units, topics, and outcomes. It is clear that there is a natural mapping of this structure to the NSA training structure (knowledge area = function, units = area, subunits = topics, objectives = outcomes). Therefore, the content of IT2008 can be mapped into a degree program while maintaining the contextual structure using the same methodologies described above.

In addition to mapping IT2008 content into a curriculum, it is also necessary to map the curricular content to the program outcomes and objectives. This is required by ABET in order to demonstrate that the curriculum accomplishes its objectives as well as the objectives that define an IT program. This mapping of course outcomes to programmatic outcomes and objectives is simply another structure similar to the ones already discussed. The IT department at PCT currently uses a different mechanism for this, but the tool described here could be used just as effectively.

While IT2008 and the ABET IT criteria have been explicitly considered by the IT department at PCT, similar comments would apply to other curricular standards and other accreditation standards. The authors believe that the tool described here can be readily adapted to accommodate other standards.

IV. THE TOOL

Built as an extension of a paper system, Microsoft Access 2003 was used for the initial build of the tool. Access was chosen because it was easily available but the tool could be implemented in any available database software. Since the initial version, the tool has been ported to Access 2007 and is expected to port to Access 2010 as our school moves to that version on Microsoft Office. The intent of using a database was initially to mimic the paper process so that it was easier to repeat the process over multiple certification needs.

The first implementation of the tool focused on managing the CNSSI 4016 outcomes. Tables were created to

identify the credential (program), function, area, sub-area, and outcome (see Figure 1). The credential was included in a “program” table because different certifications would eventually be entered into the database. At the function level, a table was created to include the function by linking it to the program. Each area is listed in the area table linked back to its appropriate function while the subarea is linked back to area and the objectives are linked back to subarea. At each level the tables daisy-chain, permitting a query to move up or down the structure. Each table included a name and description for reporting purposes. In the case of the objective table, most of the credentials from the NSA identified mastery level of entry, intermediate, or advanced.

advantage provided by the database was the ability to not only select a single class outcome and see all of the accompanying objectives, but also to look at a single function from a certification and see all of the classes the related objective permeated. The flexibility provided by the database led to the discovery of various objectives that were determined to be improperly assigned and resulted in changes during the classification process. As additional certifications were considered by faculty, existing objectives were reviewed and compared to objectives already assigned to the outcome. This permitted the faculty to determine that an appropriate class outcome was being selected as additional objectives were added to each class outcomes.

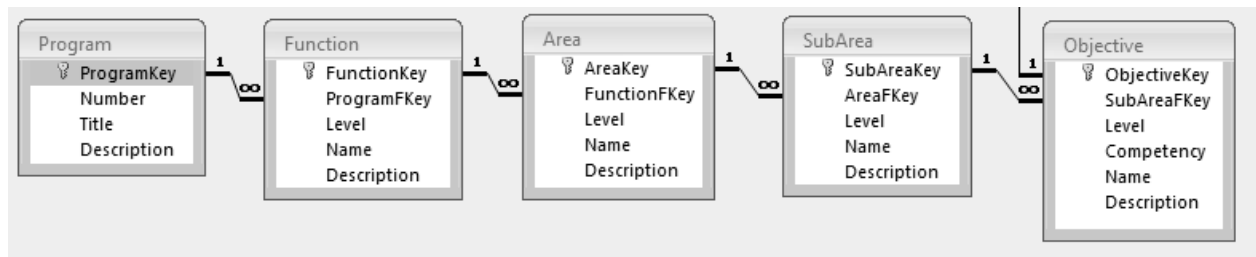


Figure 1: Table structure of NSA training standards

The second phase of the development took the class information required by PCT and built tables to represent that information (see Figure 2). This set of data also represented information for an outline under the outcomes of the class description. The purpose was to permit assignment of additional outcome details to help professors cover appropriate content that can easily be missed during the execution of the class, or to acclimate an individual new to the class to the intended content. The faculty involved in the development of this process felt that this part of the tool was a necessity to maintain adherence to the guidelines when certification was granted.

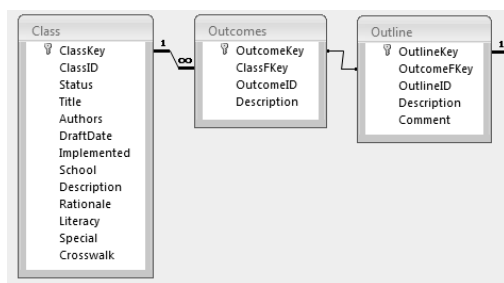


Figure 2: Class representation of information

The two data sets were then joined together with a single linking table. This table provided the mechanism to move between the class outcome and the certification objectives. This was originally emulated using paper strips, each containing a single objective. By placing each strip into a folder for the class and collecting them into related groups, course outcomes could be assigned. The

The IT faculty went on to incorporate NSTISSI 4011, CNSSI 4013, and NSTISSI 4015 into the database. Both 4013 and 4015 had a format similar to that found in CNSSI 4016; unfortunately NSTISSI 4011 was formatted differently. The difficulty faced by the faculty was in accommodating the different format, and consideration was given to creating a new table set that represented the data format of 4011 and a new linking table. In the end the faculty determined that it would be better to evaluate the 4011 objectives and to use the structure provided by the newer training standard documents.

In each case the amount of time spent entering the data into the database was similar to the time used to manipulate the information and to generate the paper slips used in the original process. While the time to enter the data was similar, once in the database format, manipulation and management of that data became much easier and showed a time savings over the faculty efforts managing the manual methodologies previously used.

The advantages of the database soon became clear when the faculty undertook a gap analysis of the coursework that corresponded to CNSSI 4016. When all of the linkages between existing classes and the 4016 outcomes were completed, what remained were unassigned objectives from the credential. To resolve this problem, a report was created that listed all of the credentials within 4016 that did not have an associated link to a class outcome. This report was the basis to determine what new classes were needed and provided a foundation for needed outcomes within those classes. During the same period of

time, the faculty needed to change one of the classes and modify the outcomes, so a report was created that listed each of the class outcomes followed by the assigned objectives. The objectives report permitted the faculty to make a quick determination about the affected outcomes because they were able to see all of the objectives involved in the change. The objective report has also been used to help faculty teach classes by reviewing the outcomes and the assigned objective to help guarantee that those topics are covered and the credential is being satisfied.

Another report was soon requested to list each of the certification and all associated classes that contained objectives. This report became instrumental in determining the classes required for each certification track and the consolidation of objectives that became outliers within the classes. Once the mapping had been completed, the faculty found a number of classes that had only a few assigned outcomes. Upon review it was determined that these outcomes belonged in those classes because of the content being covered. However, it also provided a reason to move outcomes to other classes or to find other certification objectives belonging within the realm of the class. This part of the process permitted the faculty to consolidate the objectives within an appropriate number of classes while also covering the class topics in a cohesive manner.

IT faculty began the process of applying for NSTISSI 4011 certification in 2007. The database played a critical role in this process as well. A report was created that printed each of the certification objectives and listed the class objective that supported the knowledge and was used as a checklist for completed items. The beginning of this part of the process prompted the addition of the outline level of the class structure, which will permit a description of the activity that supported the objective and the level at which the class will be covering that objective. While this report did not contain the detail of the class activity, it will be used during the data entry of the next certification application and for providing activities for each class. The faculty intends to extract the data submitted for our first certification and populate the outline area. This will help expedite renewal and the management of changes seen in either the course outcomes or the certification requirements. By having the information easily at hand, items that have not changed will be easily accepted, permitting the user to focus on any changes.

The lessons learned through the management of the certifications for NSTISSI 4011, NSTISSI 4015, CNSSI 4013, and CNSSI 4016 have permitted a flexible process of managing the information associations between the college's classes and the certifications. As the faculty members' attention turns to management of those certifications, we believe that the same principles will

also be applicable to the IT2008 criteria management and to ABET accreditation. By extending the database to represent the objectives in each of these areas, the time spent to organize the class outcomes and other objectives can be reused to provide proof of effort.

V. Conclusion and future work

As described above, a tool has been developed that facilitates implementation of curriculum and training standards into a degree program by enabling a mapping between the training standard objectives and the curricular outcomes. By mapping curricular outcomes to learning tasks, this same tool facilitates curricular accreditation and certification. Once the data has been recorded in the database, the tool can easily show how changes in either the training standards or the degree program affect each other and what content must be altered to realign the two. Finally, in the experience of the authors, the use of the tool requires less time than a similar paper process and provides greater flexibility and function for managing all stages of the process.

Currently the tool does not explicitly document the relationship between course outcomes and learning tasks, but this functionality is under development. A series of comment areas now provides a rudimentary form of tracking for this information.

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