# Verification and Validation of a Database Management Course

#### Nasser Tadayon, Connie Nyman

Department of Computer Science and Information Systems, Southern Utah University, Cedar City, UT, USA

Abstract - The concept of verification and validation (V&V) is one of the most essential part of any system to ensure that the products and processes conform to the requirements of the system. It would also ensure that the right problem is being solved in order to meet intended use and user needs. Within the required activities for verification and validation, the components of a system are checked to ensure that it satisfies the standards and conventions. In educational field, there are products, services, which as whole constitute a system that continuously goes through verification and validation at all levels by experts in the field. At each level of educational system, there are committees and processes that assess and evaluate (verify and validate) the outcome of the system. The V&V concept is used for checking a course as a component of a program within the higher educational system. The students go through different assessment process to ensure that they meet the requirement of the course and fulfills its intended purpose.

This paper investigate and explore the verification and validation within educational system as well as how it is established in a specific course, meeting the university level requirements. The paper also contains analysis of specific outcome through V&V process for the course. The course surveyed is a Database Management class offered through department of Computer Science and Information Systems at Southern Utah University.

**Keywords:** verification, Validation, Assessment, Project, Higher Education

# Introduction

A system in general is comprised of interdependent entities, processes, and data stores which interact with each other through dataflow. The educational system in United States is a complex system that has many components like the higher education with sub-components like programs offered within an institute. Although the educational system in US are mainly controlled by the states, at federal level, the department of education has an important role in encouraging education at the higher level. The role of federal government is mainly to provide financial assistance to students and states or funding specific programs that are essential through grant and loans or subsidies.

The department of education has indicated their mission is "to promote student achievement and preparation for global competitiveness by fostering educational excellence and ensuring equal access" [5]. It engages in four major types of activities:

- 1. Establishes policies related to federal education funding, administers distribution of funds and monitors their use.
- 2. Collects data and oversees research on America's schools.
- 3. Identifies major issues in education and focuses national attention on them.
- 4. Enforces federal laws prohibiting discrimination in programs that receive federal funds.

The states on the other hand, through the state office of education, monitor and fund public educational system at all level by identifying the skills and competencies requirements. At each level, the educational system goes through the process of verification and validation and is compared against other existing systems based on the quality and quantity.

# Verification and validation

Verification and Validation are defined as "independent procedures that are used together for checking that a product, service, or system meets requirements and specifications and that it fulfills its intended purpose" [1]. There has been many research and publications in the process of verification and validation within variety of systems in simulation or medical [3] but not much within the educational system. There seem to be many departments and committees within the educational system which through annual assessment, re-evaluate and identify the goals and objectives of the educational system at federal and state level based on existing data and the future demand.

In general, there are critical components and standards for a quality management system such as ISO 9000 [4] that are widely used to verify and validate a system. The words "verification" and "validation" are sometimes preceded with "Independent" (or IV&V), indicating that the verification and validation is to be performed by a disinterested third party.

It is sometimes said that validation can be expressed by the query "*Are you building the right thing*?" and verification by "*Are you building it right*?". In practice, the usage of these terms varies. Sometimes they are even used interchangeably.

The PMBOK (Project Management Body of Knowledge) guide, a standard adopted by IEEE, defines these terms as follows [2]:

- "Verification: The evaluation of whether or not a product, service, or system complies with a regulation, requirement, specification, or imposed condition. It is often an internal process. Contrast with validation."
- "Validation: The assurance that a product, service, or system meets the needs of the customer and other identified stakeholders. It often involves acceptance and suitability with external customers. Contrast with verification."

In order to understand the verification process used at the state level for a higher educational system, we must first define the requirement, the process, and the product. Although the requirement of obtaining a higher educational degree is mostly defined by the degree program but there are specific skills that must be met by all graduates of a higher educational institute. These skills are mostly outlined at some state universities or colleges as the general graduation requirement.

# **Essential Learning Outcome**

The general graduate requirement at higher educational institutes are identified as specific Essential Learning Outcomes (ELOs). Southern Utah University has adapted ELOs using the template provided by the Association of American Colleges and Universities (AACU) [6]. These ELOs are assessed to verify and validate the programs offered by the institute.

These competencies are embedded within the curriculum of all the degree programs. In general,

there are accreditation entities for specific program like business or computer science which clearly define the minimal required competencies for graduates within those programs. On the other hand, the product of the higher educational system are indeed the graduate students of the degree programs. The process is well defined within each institution and their programs which are clearly outlined through their catalog. The question of verification of a degree program within a higher educational institute relates to providing evidence that the product conform to the requirements. The validation would correspond to correctness, completeness, consistency, and accuracy of the degree requirement as well as satisfying standards, practices, and conventions during the process.

Although the database management course does not cover all ELOs for an undergraduate program, it emphasizes on some of them. A summary of some of the Essential Learning Outcomes (ELOs) at Southern Utah University related to the database management course are as follows:

#### INTELLECTUAL AND PRACTICAL SKILLS

#### 2. Inquiry & Analysis

**Inquiry:** Does the program of study/course require students to systematically explore issues, objects or works through the collection and analysis of evidence that results in informed conclusions or judgments?

**Analysis:** Does it also require students to break complex topics or issues into parts to gain a better understanding of them?

**3. Critical Thinking** - Does the program of study/course require students to comprehensively explore issues, ideas, artifacts, and events before accepting or formulating an opinion or conclusion?

**4. Creative Thinking** - Does the program of study/course require students to combine or synthesize existing ideas, images, or expertise in original ways, as well as think, react, and work in an imaginative way.

**5. Communication** - Does the program of study/course require students to develop and express ideas; in writing, by speaking, visually, kinesthetically, through design, or aurally?

**8. Teamwork** - Does the program of study/course require students to productively interact with others (in or out of class) to complete assignments, tasks or projects?

**9. Problem solving** - Does the program of study/course require students to design, evaluate and implement strategies to answer open-ended questions or achieve desired goals?

#### PERSONAL & SOCIAL RESPONSIBILITY

**13. Lifelong Learning** – Does the program of study/course require students to engage in purposeful learning activities, undertaken on an ongoing basis with the aim of improving knowledge, skills, and competence which is directed toward developing learning self-sufficiency?

# **Course evaluation**

Database Management is a required course for several programs. This course is being analyzed to identify V&V for some of the ELOs through the course project. Two external team projects were used during this course to provide students with real world experience. A member of department's IAB (Industrial Advisory Board) who is the cofounder of an application development company was one the customers for the project. The other customer was a graduated student who was working on developing an application with embedded database. The students were expected to gather relevant information needed for developing the database from the customers and design and develop a database to meet their requirements. The following list of ELOs related to the project were assessed for verification and validation:

- 2. Inquiry & Analysis
- 5. Communication
- 8. Teamwork

# Verification and validation of the Essential Learning Outcomes

The following is a brief list of some of the activities related to verification and validation of three ELOs mentioned above:

#### Inquiry & Analysis:

Validation (Are you building the right thing? external): The students were given a general description of the requirement and went through the process of fact findings. The customer gave a presentation and there were open Q&A sessions with the customer. A requirement specification document was developed by all teams. All requirement documents (SRS) were sent to the customer for possible changes before their final approval. Verification (Are you building it right? - internal): The SRS document was checked for the format correctness using the IEEE template.

#### Communication:

Validation (Are you building the right thing?external): The teams interviewed the customers and were encouraged to obtain additional information from the website and through direct contact with the customers (validate).

Verification (Are you building it right? -Internal): The teams were asked to develop requirement and design documents and present the implementation of the project with running several test cases to the customers (verify).

#### Teamwork:

Validation (Are you building the right thing?external): The teams had the option of changing roles as they would deem appropriate. They were also asked to find common meeting times during launch activity. The team had regular meeting off the class time and were asked to keep track of the meeting minutes (validate).

Verification (Are you building it right? -Internal): The teams were set based on the student's transcript, schedule, and preference. They were provided with a set of team roles and were suggested a specific role for each member (verify).

# **Data analysis**

In order to assess the team performance, everyone in the class including the team members and the customers were asked to rank the team based on their individual contributions and presentation. The overall average was calculated using formula: AVERAGE (all evaluation)\*30-200)/10. This would eliminate several high scores (noise in data) recorded by some students. There were 20 students who ranked 10 for all presentations. The ranking are separated by the self-evaluation (team members ranking themselves), customer evaluation, peer evaluation (other students ranking the teams), and overall ranking. The average of all ranking for each team based on the project is as follows:



Figure 1 Presentation Ranking for project 1



Figure 2 Contribution ranking for project 1



Figure 3 Presentation ranking for project 2



# Conclusion

There are several other ELOs that were verified and validated using the project in this course but only a few are shown in this paper. The data collected demonstrates the assessment mostly related to the 3 specified ELOs.

For the first project, the data indicates that all the teams had a higher self-evaluations for their contribution and their presentation than their peers. The customer had the lowest evaluations for both presentation and contribution on all teams.

For the second project, self-evaluation was the highest ranking in both presentation and contribution. However, the customer had the lowest presentation ranking for all teams except one. The contribution is mixed among customer and peer evaluations.

The data supports the fact that the teams worked relatively well together but the expectation of the customer was not fully met.

# **References:**

- Global Harmonization Task Force Quality Management Systems Process Validation Guidance (GHTF/SG3/N99-10:2004 (Edition 2) page 3
- [2] IEEE. "IEEE Guide--Adoption of the Project Management Institute (PMI®) Standard A Guide to the Project Management Body of Knowledge (PMBOK® Guide)--Fourth Edition". p. 452.
- [3] R. Sargent, "Verification and Validation of simulation models", journal of Simulation (2013) 7, 12–24. doi:10.1057/jos.2012.20; published online 7 Dec 2012
- [4] ISO website (http://www.iso.org/iso/home/standards/management-standards/iso\_9000.htm)
- [5] US Department of Education (http://www2.ed.gov/about/what-we-do.html)
- [6] Association of American Colleges and Universities Learning Outcomes Assessment (http://leap.aacu.org/toolkit/learning-outcomes-assessment)