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Application of Axiomatic Design for Project-Based Learning Methodology

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Abstract

Project-Based Learning is a method based on constructivist finding, its application is centred on project development as the learning tool catalysing knowledge discovery. Project-Based learning have been traditionally designed and implemented on a know-how and trial-and-error basis, but tasks and decisions taken during the design phases of the training modules have a substantial effect on its quality and outcomes. Axiomatic Design can contribute to improve the outcomes opportunities and the process efficiency by identifying where complexity exists within the requirements and design activities that underpin the model. In this study, the Axiomatic Design method is applied to link learning outcomes of Lean Six Sigma training with all the teaching processes and the availability of resources. As a conclusion some improvement suggestions are made to optimize the learning and teaching methodology in order to maximize the learner outcomes.

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Keywords: Axiomatic Design; Project-Based Learning; Lean Six Sigma; Training; Education

1. Introduction

Project-Based Learning is a constructivist pedagogy where learners use theoretical and technical knowledge to find solutions for practical problems. It is a learner-centered methodology involving a dynamic classroom approach in which learners acquire a deeper knowledge through an active exploration of real-world challenges and problems. Project-Based Learning changes the teachers' role from instructor to facilitator in order to develop the learners' technical proficiency as well as critical thinking, team collaboration and a set of attributes necessary to maximize problem solving. Project-Based learning (PBL) is a method of based on the constructivist finding allowing learners to gain a deeper understanding of the topics when they actively construct their understanding and competencies by working with and using ideas. In Project-Based learning, learners engage in real, meaningful problems similarly to what scientists, mathematicians, writers, and historians do when working through the research paradigm. Project-Based learning date back over a hundred years and can be attributed to the work of educator and philosopher John Dewey [1]. A Project-Based classroom allows learners to investigate questions, propose hypotheses and explanations, discuss their ideas, challenge the ideas of others, and try out new ideas. Learning environments that are Project-Based have five key features:

1. Start with a driving question and a problem to be solved.
2. Learners explore the driving question by participating in authentic inquiring processes of problem solving meaningful

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in the discipline. As learners explore the driving question they earn and apply functional and problem solving competences.

3. Learners and facilitators proceed through the class with collaborative activities to find solutions to the driving question(s). This mirrors the social complexity and enhance the 21st century skills in addition to the functional skills required by the disciple itself [2].

4. While engaged in the inquiry process, learners use abilities and technologies that help them participate in activities normally beyond their ability.

5. Learners create a set of tangible project/products that address the driving question. These are shared and represent the class's learning.

With particular regards to Continuous Improvement (CI) and Lean Six Sigma (LSS) [3], the most important value of such programs deployment is the development of competencies among the people, leading to both a deep knowledge of processes and a stimulus towards Operational Excellence as well as a motivation a sense of belonging to the organization [4] Competence is the combination of:

- *Knowledge* – the understanding about a specific subject, gained through education, training and experience;
- *Skill* – the ability to put a knowledge into practice, acquired through experience and practice;
- *Behaviour* – the "translation" of knowledge and skill into daily activities, that is the way of reacting to particular situations, obtained through experience.

Lean Six Sigma agents in particular need to be able to combine statistical and optimization tools knowledge with critical thinking, problem solving and people management skills which represents the functional characteristics to implement such type of CI. Key competencies can be resumed by the Competency Chart illustrated in Figure 1 where are reported the characteristics of the ideal Lean Six Sigma agent profile, indicating the initial, the required levels as well as the ones reached at the completion of the Project-Based Learning training module. By identifying the competency gaps it is possible to plan specific training programs by prioritizing competencies needed.

The most effective method to deploy LSS culture among a company is the *Learn-Do-Apply* approach, in which training sessions allow for Project-Based Learning in order to facilitate competencies acquisition, through the practical application of methodology and tools. Questions are the initial step of any class or design project, they represent the problem definition phase. Knowledge resides in the questions that can be asked and the answers that can be provided as indeed Aristotle suggests "the kinds of questions we ask are as many as the kinds of things which we know" [5].

LSS trainings start with questioning the participants with issues to address with LSS methodology, while through out the training process they are assisted in enhance and improve

Fig. 1. *Competency Chart* indicating progress of the competencies levels of a LSS agent

their performance through continuous feedbacks on how to apply a specific knowledge. Trainers support the learners though out the Design-Measure-Analyse-Improve-Control (DMAIC) roadmap by facilitating the proper tools knowledge acquisition and the respective application of them to the DMAIC methodology, working out any statistical issue [6] raised during the project execution [7]. To optimize the proposed methodology and to affect the training product quality and productivity, this study adopts systematic design model rather than the traditional ones based on know-how and trial-and-error. The systematic phases to develop a solution to increase efficiency of the training are facing the mental inertia and avoiding to show the possible solutions to be implemented. Axiomatic Design (AD) is used as the tool to design the LSS training model, while the Project-Based Learning (PBL) perspective training is used as the theme for the decomposition, starting from an overall perspective to then focus on training design [8]. Axiomatic Design indeed provides a framework in which the design process can be managed [9,10] and particularly, it provides criteria for distinguishing bad designs from good ones [8]. The systematic bi-dimensional decomposition used in Axiomatic Design facilitates the inclusion of all the relevant variables and scenarios, as well as contexts and situations. The first dimension of the decomposition into functional, physical, and process domains provides a clear categorization of Functional Requirements (FRs), Design Parameters (DPs), and Process Variables (PVs). These represent the domain where the concepts "WHAT we want to achieve" and "HOW we want to achieve it" lie (Figure 2).

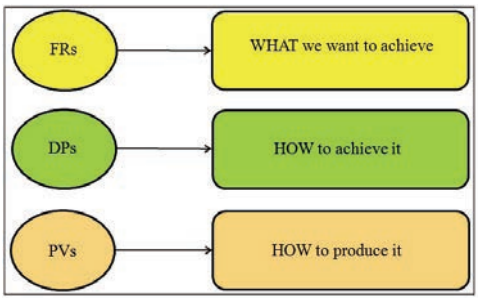

Fig. 2. Explanation of the Different Variables Related to the Domains