HOW ALIGNED IS THE COMPETENCY-BASED TRAINING MODEL WITH THE LEAN PHILOSOPHY?

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ABSTRACT

The Competency-Based Training (CBT) system departs from the traditional mode of training by focusing post-secondary training on defining, teaching, and assessing competencies industry requires. Therefore unlike the conventional system whereby the unit of progression is time and teacher-centered, in a CBT system the unit of progression is mastery of specific knowledge or skills, and is learner-centered. Comparably, the lean philosophy is proposing a departure from the traditional mode of construction to a more customer centered approach to construction.

This paper seeks to compare the tenets of CBT with those of Lean Construction to establish an alignment. The study was inspired by a growing concern for the adoption of lean methods to teach Lean Construction. Data for the study was mainly obtained from a case application of the CBT model in a B-Tech (Building Technology) programme in a polytechnic in Ghana. The data from the case study was checked against the principles of lean thinking to establish the extent to which the CBT model of training compares with the tenets of Lean Construction. Attention to customer needs, transparency, involvement and continuous improvement where some of the areas where CBT compares with lean.

KEYWORDS

Competency-based training, lean thinking, teaching lean construction, curriculum development

INTRODUCTION

Educators of Lean Construction (LC) are moving away from the traditional mode of delivering courses which is primarily centered on the teachers, lectures and examinations, to more student-centered and interactive methods of training to promote critical thinking and discussion between trainers and students (Tsao et al., 2013). This move by the lean educators apart from ensuring an effective and efficient way of imparting knowledge of LC, is also a demonstration of their commitment to "practice what they preach" by adopting training tools that identify with the philosophy of LC. LC is a customer-centered production based project delivery

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system which seeks to minimize waste and maximize value at the same time respecting stakeholders throughout the project delivery process with a pursuit of continuous improvement (Forbes and Ahmed 2011; Koskela et al., 2002). Beyond a focus on just the training tools, Tsao et al. (2013) observed the application of lean principles in the development of LC courses in universities in the USA, Brazil and Lebanon.

The Competency-Based Training (CBT) system also departs from the conventional mode of time- and teacher-centered teaching to a student-centered training with a focus on defining, teaching, and assessing competencies that are required by industry and employers (Jones et al., 2002). CBT is being promoted in the teaching of courses across various disciplines such as engineering and the medical sciences and could be adopted by the LC community for training in lean concepts.

This paper presents a study on the case application of CBT in a Bachelor of Technology (B-Tech) in Building Technology programme at the Sunyani Polytechnic in Ghana. Even though the teaching of LC was not a core objective of the programme, the study tried to align some of the practices (from the stage of curriculum development to the implementation of the programme) with the concept of lean thinking. It is envisaged that with the growing popularity of the CBT system in educational institutions, especially in Ghana, CBT could be adopted as an inherently lean tool for diffusing the knowledge of LC in countries like Ghana.

COMPETENCY-BASED TRAINING (CBT)

‘‘Competency’’ as a term is often used to generally refer to almost anything that might directly or indirectly impact job performance within a particular work environment (Fischer & Maritz, 1994). According to Sullivan (1995) and Blakemore (2008), competency is a skill performed to a specific standard under a particular condition. Competency can also be described as a set of behavior patterns that is required of a person in a position in order for the person to perform the position’s tasks and functions with the required proficiency so as to remain valuable to the organization and eventually valuable to the customer (Boam and Sparrow, 1992; Kemp, 1998).

CBT may therefore be said to be a form of training that is focused on building a skill to be performed to a specific standard under a particular condition. VEETAC (1992) views CBT as a style of training geared towards the attainment and demonstration of skills to meet industry-specified standards instead of focusing on an individual’s achievement relative to that of others in a group. Whereas in the traditional training system unit of progression is time and teacher-centered, in a CBT system unit of progression is mastery of a specific knowledge and skill (Sullivan, 1995). CBT is a student-centered and a self-directed approach to teaching and learning (Sullivan 1995; Afeti et al., 2003; Al-Qaisi, 2004). Students under the CBT training enjoy some flexibility since they are expected to develop their individual talents, interests, and skills leading to employment in various sectors of the economy (UNESCO/ILO, 2002).

In the CBT training process the focus of the training should be on the outcomes, and the outcomes measured against specific standards related to industry requirements (Smith and Keating, 1997). A number of characteristics have been identified by Foyster (1990), Delka (1990) and Norton (1987) as being associated

with CBT. These, among others, include: carefully selected competencies, training materials keyed to competencies, self-paced learning and a flexible training approach. A conceptual model, based on the various descriptions of CBT, can be shown in Figure 1 below.

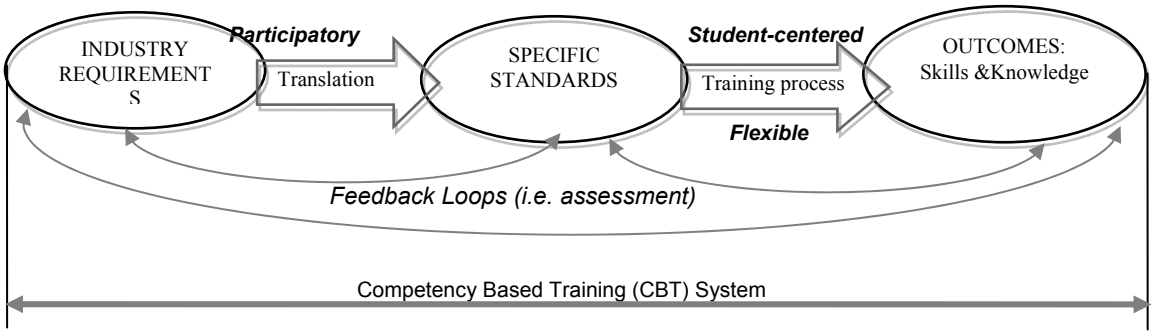

Figure 1: Conceptual Model of CBT

BENEFITS AND LIMITATIONS OF CBT

According to Sullivan (1995), the focus of the CBT on the success of the student is one of its principal advantages. Watson (1990) also observes that a great potential exist in CBT for the training industry. It appears CBT is particularly useful in situations where trainees have to attain a few specific and job-centered competencies (Watson, 1990). A number of specific benefits of CBT have been identified by Norton (1987). These include participants achieving required competencies for their jobs, stepping up of trainees' confidence, a more efficient and effective management of training time and more contact with individual or smaller group students.

In spite of the various benefits identified with CBT, its implementation is surrounding with a number of challenges. One challenge of CBT, as indentified by Sullivan (1995) is the fact that if initial follow-up assistance is not provided to trainers, they could slip back to the traditional style of training. Another challenge identified by Sullivan is that a CBT training tool is only as effective as the means of identifying the required competencies, and that when a wrong competency is developed, the training outcome will be ineffective. It has further been noted by Sullivan that a correct competency-based course can only be effective when the required CBT training approach and materials are employed.

THE LEAN PHILOSOPHY

The roots of the lean philosophy can be traced back to the Toyota Production System which is based on the two principles of continuous improvement and respect for people (Liker, 2004; Ohno, 1988; Womack and Jones, 2003). Kotelnikov (2007) describes lean as "doing more with less: less time, less inventory, less space, less labour, and less money". Kotelnikov (2007) goes on to describe lean manufacturing as shorthand for a commitment to eliminating waste, simplifying procedures and speeding up production.

The lean philosophy has been embraced in the construction industry under the umbrella of Lean Construction (LC). The description of LC has focused on delivering customer value while minimizing waste and maximizing value, with an

attention to ensuring continuous improvement, and upholding respect for people (Forbes and Ahmed 2011; Koskela et al., 2002; Santorella, 2011). The principles of LC, according to Tommelein (2002), include, among others, creating a reliable workflow, reducing waste, promoting transparency, pulling work and resources to meet specific needs, and reducing overall cycle-time. The implementation of LC as observed by Rybkowski et al. (2013) requires the adoption of hard skills (in the form of engineering flow processes, kanban, batching, just-in-time delivery and work-in-progress) as well as soft skills such as respect-for-the-individual and the cultural side of lean thinking (Liker, 2004; Santorella, 2011).

RESEARCH METHOD

The study, which sort to establish the extent to which the tenets of CBT identify with the lean thinking philosophy, primarily centered on a case study and desktop literature review relating to the concepts of lean thinking and CBT. A case study is a research tool meant to establish an in-depth and concentrated knowledge about a situation or question by considering the real physical and social context of the case (Christiaans et al. 2004; Robson, 2002; Meredith, 1998; Yin, 1994). The case study employed here was the application of CBT in the implementation of a B-Tech (Building Technology) programme at the Sunyani Polytechnic in Ghana. The data collection tools employed in the case study included interviews, review of documents like reports and assessment records, as well as observation of learning and assessment sessions. Those who were interviewed included staff of the polytechnic and graduates of the programme. The involvement of the authors in the implementation of the programme, through curriculum development and delivery of courses, also formed the basis for data on the case study. A comparative analysis was undertaken using the findings from the literature review and the case study to establish the congruence of CBT with the lean philosophy.

FINDINGS FROM CASE STUDY

The Sunyani Polytechnic introduced the B-Tech in Building Technology programme in 2007 to contribute to an improvement in the construction industry in Ghana by training practically-oriented management level manpower to feed the construction industry. Even though the focus of this study is on the B-Tech (Building Technology) programme at the Sunyani Polytechnic, the implementation of the programme was done together with a similar programme at the Cape Coast Polytechnic under the auspices of the NPT/Gha/047 project of the Netherlands government and her Ghanaian counterpart, through a collaborative venture with the Kwame Nkrumah University of Science and Technology (KNUST) in Ghana, and the Technical University of Eindhoven (TU/e) in the Netherlands.

The implementation of the B-Tech (Building Technology) programme at the Sunyani Polytechnic employed an adapted version of CBT to fit the educational and socio-economic peculiarities of the Ghanaian context. There was therefore some level of departure, as is the case in other countries, from a strict form of CBT implementation (Kpamma et al., 2013; Van Egmond and Erkelens, 2005, 2006; Wouw and Hoorn, 2006 in Van Egmond and Erkelens, 2006). This notwithstanding, the case under consideration highlights several elements of CBT implementation as presented below.

CURRICULUM DEVELOPMENT

The curriculum development phase of the B-Tech (Building Technology) programme at the Sunyani Polytechnic was one of the stages where the tenets of CBT were vigorously applied. The whole process basically started with a preliminary survey of the various sectors of the construction industry in Ghana to map out competencies expected of graduates of the programme. This was followed by the development of a draft curriculum which was then submitted to various stakeholders for their inputs. The stakeholders did not just study the curriculum to make private contributions, but were invited to a series of meetings, workshops and seminars where a more participatory and transparent approach to the discussion of the curriculum was undertaken (Figure 2).

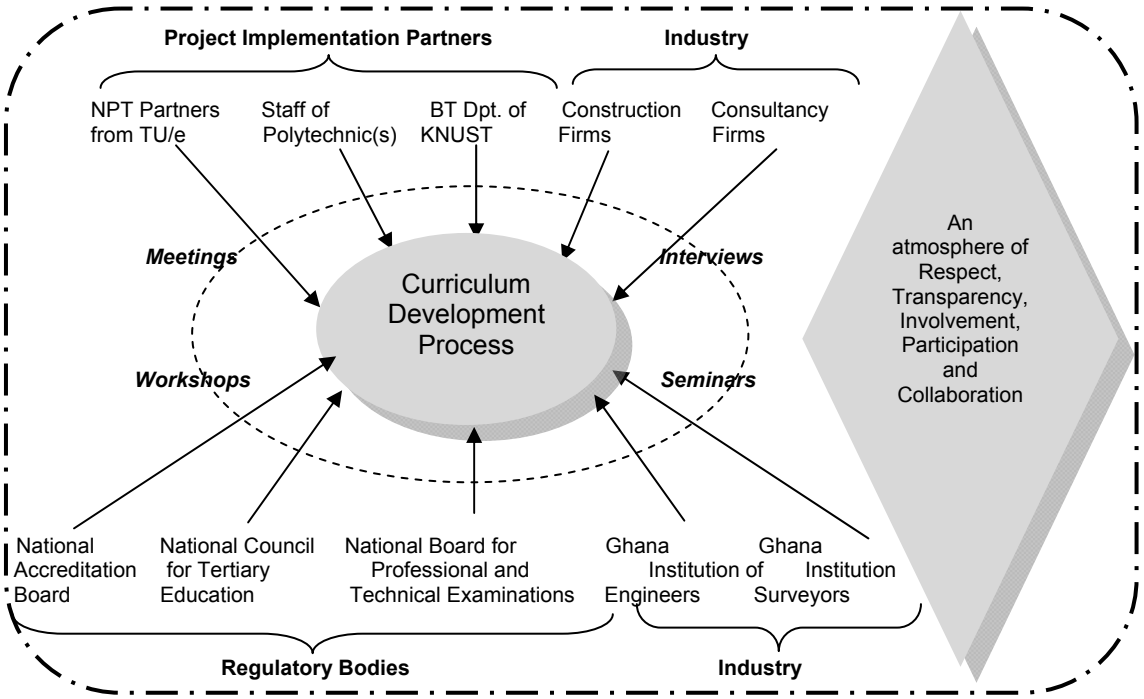

Figure 2: CBT Curriculum Development Framework Adopted for the B-Tech (Building Technology) Programme at Sunyani Polytechnic

The CBT curriculum development framework that was adopted in the implementation of the B-Tech in Building Technology programme at the Sunyani Polytechnic, share a number of attributes with the lean thinking philosophy. The culture of respect for people, transparency, involvement, participation and collaboration, that characterized the curriculum development process as shown in Figure 2, are in line with the teachings of lean thinking. Rybkowski et al. (2013) in their graphical definition of Lean Construction emphasize the need for promoting the "culture of respect" while ensuring a spirit of integration and collaboration among such project stakeholders as the owner, architect, engineer and contractor.

The curriculum development phase of CBT could be likened to the project definition and design phases of construction projects for the purposes of this study. Just as the design phase of construction projects has a tremendous effect on the process and product of construction (Chua and Tyagi, 2001; Undurraga, 1996; Koskela, 1992), the curriculum development phase also impacts the process and products of a training system. Identifiable with the collaborative atmosphere in Figure 2, Ballard (2003, 2000) in his description of the Lean Project Delivery System (LPDS^{TM}) indicated the need for collaboration as well as aligning customer needs with decisions at the project definition and design phases of the LPDS^{TM}. The strong participation of industry (who is the user of the products of the B-Tech programme) in the curriculum development stage is comparable with user/client involvement in the design process in lean project delivery system (Andrade et al., 2012; Caixeta et al., 2013).

TRAINING PROCESS

The target group for the B-Tech in Building Technology programme at the Sunyani Polytechnic included Higher National Diploma (HND) graduates in Building Technology as well as related courses, like Civil Engineering and Estate Management, with not less than two years relevant post-qualification experience. The duration of the programme, according to the curriculum, was 18-month, comprising three semesters.

The training process in the first semester generally adopted an adapted version of CBT in which case there was a blend of the traditional system of training and aspects of CBT. Various CBT tools were mixed with the traditional tools in the teaching, learning and assessment activities in the first semester. One of the CBT tools that was employed was Problem-Based Learning (PBL) in which case learning was more student-centered and occurred in small groups with teachers being facilitators or guides (Barrows, 2006). Peer teaching, group discussions and assignments were employed in a number of teaching and learning situations. Despite the fact that end of semester examination was a major component in the mode of assessment of some courses in the first semester, quizzes, presentations, demonstrations and course work were also employed in the assessment of courses such as Civil Engineering Design I, Building Drawing, Computer Applications, Project Planning and Control, Laboratory/Workshop Practice and so on.

One of the courses in the first semester that largely addressed the concerns of CBT was a capstone course named “Integrated Project”. This course sought to give students the opportunity to simulate professional practice in the construction industry. Students, in this course, were given a live project and were expected to play the roles of consultants, contractors and clients to undertake pre-construction documentation of the project. Students were expected to undertake a practical application of most of the courses they learnt in the first semester in the integrated project. Critical professional competencies such as preparation of bill of quantities, tender documentation, contract documentation as well as technical and financial proposal writing were expected to be acquired in this course. PBL, peer teaching, group discussions and seminars were the main teaching methods, whereas presentation was the key method of assessment. This practice of adopting a simulated working environment, as is the case in the integrated project, is identifiable with the tenets of lean construction since process and product

simulation is an encouraged strategy in the lean project delivery system (Ballard, 2000).

The second semester involved a six month internship programme in which case students were posted to industry to experience a real industrial working environment. Teaching and learning, during this phase of the training process, was not only taken out of the classroom, but was also facilitated by supervisors in industry instead of lecturers. The role of lecturers during the internship was to undertake monitoring to ensure that students were at their various places of internship and to also provide further explanation to the supervisors on their role as supervisors during the internship. The participation of industry players in the training process, particularly during the internship phase of the training programme, was a further demonstration of the fact that CBT is identifiable with the lean principles of involvement, collaboration and transparency. Another demonstration of the congruence of this phase of the programme with the lean philosophy is the fact that there is a minimization of wasteful training practices since all activities by the interns, during this period, are generally related to the competencies required by industry.

The structure of the last phase of the training process which is in the third semester was comparable with that of the structure of the first semester. Even though the process generally followed the traditional lectures and end of semester examination pattern, various CBT tools were combined with the traditional tools in the teaching, learning and assessment activities. One of the CBT tools that were employed was PBL in which case learning was more student-centered and occurred in small groups with teachers being facilitators or guides. The project work was one of the courses where PBL was applied. Peer teaching, group discussions and assignments were also employed in a number of teaching and learning sessions. Despite the fact that end of semester examination was a major component in the mode of assessment of some courses in the first semester, quizzes, presentations, demonstrations and coursework were also employed in the assessment of courses such as Project Resource Management, Civil Engineering Design II, Professional Practice and Management, Project Cost Management and so on. The various CBT tools that were employed in this semester enhanced the student centered nature of the program which could be compared to the customer centered nature of lean.

DISCUSSION: WHERE CBT MEETS LEAN

The results of the case application of CBT at the Sunyani Polytechnic as well as information from literature on CBT and LC indicate that some practices ranging from the curriculum development stage to the training phase of CBT implementation are comparable with the tenets of LC. In making the comparison between CBT and LC, an attempt has been made to compare the elements and stages in the educational training process to the elements and stages in construction process. The cases of comparison that are worthy of note include the identification of: (1) the curriculum development phase with the design and documentation phase; (2) the training phase with the construction phase; (3) graduates as products with buildings and infrastructure, as well as (4) industry or employers with clients or end-users.

The manifestation of the convergence of CBT with LC is expressed in such lean tenets as involvement, collaboration, customer satisfaction, continuous improvement and transparency (Table 1).

Table 1: Convergence of CBT with Lean Construction

CBT	LC	Realm of Intersection Between CBT and LC
1. Involvement of stakeholders such as teachers (trainers) and industry **in** *curriculum development.*	Involvement of stakeholders such as Client/users and contractors in *design and documentation.*	***Involvement***
2. Collaboration among stakeholders such as trainers, trainees, industry/employers, regulatory bodies etc. in *curriculum development and training Process.*	Collaboration among project participants such as architects, engineers, contractors, suppliers, clients, users etc. in *design / documentation and construction.*	***Collaboration***
3. *Graduates/products* of CBT are expected to possess the specific competencies required by industry to meet the needs of employers.	*Products and services* of LC (e.g. buildings and designs) are expected to satisfy the needs of clients and users.	***Customer / Client Satisfaction***
4. Continuously adapting and improving *curriculum and training process* to meet the changing needs of industry.	Continuously improving *processes and products* to meet the needs of clients/users.	***Continuous Improvement***
5. An atmosphere of transparency and respect is ensured through the participation of stakeholders like employers in the *curriculum development and training.*	A participatory approach to decision making in the *design and construction process.*	***Transparency and Respect***
6. Various tools and strategies have been adopted and developed for *training* : PBL, internship, coursework, assignments, simulation, peer teaching etc.	Various tools and strategies have been adopted and developed for *design and construction*: Last Planner System, BIM, CBA, Standardization etc.	***Development and Adoption of Special Tools of Implementation***

One of the major levels where the intersection of CBT and LC is apparent is involvement. In the implementation of lean thinking, a participative approach to decision making is required and this can be achieved by involving various stakeholders. Involvement in LC implementation is particularly very useful at the preliminary stages like design for a clear definition of user/client requirements to avoid errors and rework. Likewise in CBT implementation involvement of stakeholders is important to allow for a correct definition of industry/ employee expectations and needs to avoid the need for retraining after graduates have been

employed. Involvement also enhances transparency which is also key in the lean philosophy.

Collaboration is another realm where CBT meets lean. In lean thinking collaboration ensures that team members of diverse interests and background work together effectively to achieve the common goal of waste minimization and value maximization during design and construction. A number of studies related to collaboration have recently been undertaken by the LC community (Howell, 2013; Sampio de Melo et al., 2013; McConaughy and Shirkey, 2013). The implementation of CBT also requires some collaboration particularly among major stakeholders such as the trainers, industry/employers and the trainees/students during the training and curriculum development process. The internship phase of CBT implementation, in the case of the B-Tech in Building Technology programme, was an instance where strong collaboration among trainers, students and industry was required for the internship programme to be successful.

CBT also overlaps with LC in the realm of customer/client satisfaction. Ensuring customer/client satisfaction is one of the core pillars of the lean philosophy. All the lean implementation tools that have been developed or adopted are geared towards speedily delivering value to the customer while eliminating waste. CBT also has as its philosophy, the need for trainers to aptly satisfy the needs of industry by turning out graduates with competencies that are required by industry. The pursuit of involvement and collaboration, as discussed above, are some of the steps towards ensuring customer satisfaction in LC and CBT.

Another practice that is common to LC and CBT is continuous improvement. Continuous improvement apart from leading to an improved satisfaction of the needs of customers, also leads to an appropriate response to changing demands of the operating environment. The implementation of CBT requires continuous contact with industry to determine their changing needs for students to be trained accordingly. The internship phase in the case study of CBT implementation at the Sunyani Polytechnic was one of the conduits of constant touch of trainers and trainees with industry to ascertain their changing requirements.

LC and CBT also intersect at the level of ensuring transparency. In LC implementation, an atmosphere of transparency is required to be created in the activities of participants. A participatory approach to decision making is one of the strategies of ensuring transparency in LC implementation. In the implementation of CBT, transparency was ensured through the participation of stakeholders like employers and professional bodies in curriculum development and training process. The internship phase of the case study was one of the moments where employers took an active part in the training and grading of students.

The development and adoption of special tools and strategies for effective implementation is associated with both LC and CBT. A number of tools and strategies have been developed or adopted for an effective implementation of LC. These, among others, include the Last Planner System (LPS), Standardization, Building Information Modeling (BIM), Integrated Project Delivery (IPD) and Choosing By Advantages (CBA). In the implementation of CBT a number of strategies and tools have also been developed or adopted. Some of these CBT implementation tools include PBL, simulation, internship, coursework and peer teaching.

CONCLUSION

The CBT model in theory and practice is student- and industry-centered with a focus on equipping trainees with specific competencies that aptly meet the needs of industry. The study of the case application of CBT revealed that several practices, spanning the curriculum development stage to the training stage, compare with the tenets of LC. Stakeholder involvement, collaboration, transparency, customer/client satisfaction, continuous improvement and respect for people are some of the principles of LC that characterize the implementation of CBT. CBT could therefore be described as an inherently lean training tool that could be adopted for teaching LC particularly in the diffusion of the knowledge of LC in countries like Ghana where level of familiarity of the concept of LC is still low.

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