LEARNING HOW TO LEARN LEAN CONSTRUCTION CONCEPTS AND PRINCIPLES

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ABSTRACT

This paper discusses some theoretical issues concerning an ongoing research project which aims to develop directions for learning Lean Construction concepts and principles. Among the reasons for carrying out this study is the need to introduce such concepts and principles into construction practice, in order to foster the development of a Lean Construction theory.

The concept of learning is discussed and an overview of some theories on the learning process is presented, focusing on adult education and organizational learning. Some approaches to improve learning processes on Lean Construction concepts and principles are presented: a tool to expose and negotiate meanings, concepts from organizational learning, and experimentation with action and reflection on action.

KEY WORDS

Concepts, lean construction, learning, organizational learning.

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INTRODUCTION

Approaching construction processes through Lean Production theory is still a complex matter. The adaptation of concepts and principles from manufacturing to construction is not straightforward: the meaning of concepts, principles and approaches used to explain and improve manufacturing processes must be well understood in order to transfer them to the construction environment. Furthermore, old thinking patterns must be abandoned in order to apply such concepts in the construction environment. Those patterns include the belief that construction industry is too particular to have any similarity with manufacturing as well as the focus on solutions exclusively drawn from new technologies and financial support when time and economic constraints are involved.

This paper is concerned with communication of Lean Construction concepts and principles in order to allow the practice of this new approach by construction site managers. It emphasises the learning process as a fundamental aspect to change thinking patterns and managerial paradigm.

Learning is a very broad concept. Pedler et al. (1991) say it is rather problematic. Psychologists, educationalists, philosophers, and business managers among many other specialists have been studying the learning process from different points of view. The complexity of this subject comes from its nature. Learning is mainly a matter of the acquisition of **meanings** through a social-historical relation with the world (Vygotsky 1993).

Dealing with adult learners is specially complex. Most of the teaching techniques and methods being used, either on undergraduate courses or professional training programmes, are based on general education theory, developed mainly from studies of children's learning process (pedagogical models). Only in the Twenties, were adults focused as learners distinguishable from children (Knowles 1984) and the term ***andragogy*** started to be used for designating the field of study concerned with adult education.

Knowles (1984) points out the main differences between the pedagogical and the andragogical models used in education. From one hand, pedagogical models usually credit the teacher with the responsibility for the learning process: what, when and how must be learned. The psychological definition of adult is "*one who has arrived at a self-concept of being responsible for one's own life , of being self-directing*" (Knowles 1984). Therefore, adult learners tend to be self-directing, in spite of being rather conditioned to a passive behavior during training or learning activities due to their past experiences with traditional teaching methods. Consequently, the motivation to learn is not up to the teacher or instructor, but to the learner himself/ herself. Furthermore, the accumulated experience by an adult plays an important role in the learning process. On the one hand, according to Knowles (1984), adult learners are themselves the richest resources for one another, because they make use of their own experience to learn. However, experience may introduce barriers to the learning process, due to prejudices, defensiveness, mental models, and preconceptions about the reality built up over a lifetime.

In the Sixties the knowledge available on adult education launched the use of the learning process as an important element to changing processes within organizations (Pedler et al. 1991). Pedler et al. (1991) credit to Argyris and Schön's work, the dissemination of learning as a competitive weapon of high performance companies. However, organizational learning

presents a complex set of variables in addition to those related to the individual learning process. The links between individual and collective learning, the cultural aspect, and the management of the organizational learning process are some of the issues that have been studied. The goal is to develop a Learning Organization, defined by Pedler et al. (1991) as "*an organization that facilitates the learning of all its members and continuously transforms itself*". A more challenging definition is proposed by Garvin (1993): "*an organization skilled at creating, acquiring, and transferring knowledge, and at modifying its behavior to reflect new knowledge and insights*".

Based on this background, the Building Research Group (NORIE) of the Federal University of Rio Grande do Sul started a research project which proposes some directions for the learning process involved in the application of Lean Construction concepts and principles by the construction industry. The aim of this study is to improve construction managers' competencies, encouraging them to apply such concepts and principles.

Three main approaches have been identified for developing the study. The first one is concerned with the use of a tool to represent and negotiate the meanings of the concepts and their interrelationships. Such a tool would help to deal with some of the existing barriers in the learning process, due to differences in individual knowledge and experiences. The second approach deals with collective[4] and organizational learning[5], which should be addressed because Lean Construction theory is systemic, requiring changes in management approaches. Organisational learning means the development of collective competencies, which cannot be achieved only by individual learning but needs a process of collaborative inquiry and shared visions (Senge 1990). Finally, the third approach involves the experimentation of some Lean Construction concepts and principles in practice, since adult learners learn better when acting and reflecting upon their experience (Schön 1982).

Tackling any of these three elements (a framework to expose and negotiate meanings, organizational learning, and experimentation with action and reflection on action) requires a discussion on the learning process.

MEANING OF LEARNING

In order to present the diversity of approaches related to the concept of learning, Pedler (1997) identifies four different categories of learning, drawn from the literature:

- We can learn ***about things***, which means acquisition of ***knowledge***. Both the memorization and the '*knowing why*' are included in this category, which is concerned with knowing the theory and getting information;
- We can learn to ***do things***, or acquire new ***skills***, ***abilities*** and ***competencies***. This category includes mental and manual skills, social abilities with others and competence in complex situations. Pedler stresses that there are criticisms about

[4] Collective learning: results from shared perceptions, knowledge and mental models (Stata 1997)

[5] Organizational learning: The main process from which results managerial innovations (Stata 1997)

splitting knowledge (theory) from doing things (practice), mostly by researchers involved in action learning approaches;

- We can learn "***to become ourselves, to achieve our full potential in our lives***". It means ***personal development***, involving intellectual growth and skill acquisition. It is related to personal satisfaction, according to one's purpose in life and identity; and
- We can learn "***to achieve things together***", which Pedler calls ***collaborative enquiry***. It is suggested that learning is a result of interaction between people: people gather to do things together, either intellectual or manual activities, on behalf of the group.

From the first to the last aspect, the learning approach evolves from individual to collective, from passive to active, and from specific to holistic.

The literature on Leaning Organization always mentions **change** as a central concern of the learning process (Pedler et al. 1991, Weinstein 1995). For instance, Swieringa and Wierdsma (1995) regard learning as a *change of conduct.* Argyris and Schön (in Kim 1993) argue that learning means that new knowledge is *translated into different behaviors* which are replicable. Kolb (1997), in his experiential learning circle, also states that learning is a process in which the knowledge is created through the *transformation* of experience. Therefore, from the organizational learning point of view, learning cannot be passive (like memorization of concepts) and it is mainly holistic in spite of also requiring some individual development of skills, abilities or competencies. One of the most important concerns of the organizational learning is how to bridge individual with collective learning in order to achieve a stage of development in which the organization learns.

Individual learning is the subject of the theory on Education and there are two opposite philosophies about learning process: the Behaviorist and the Cognitivist/ Constructivist theories. From the point of view of the Behaviorist theorists, the learning process is a matter of responses to stimuli, from either the teacher or the teaching material. They do not consider the internal world of the learner and evaluate the learning results based on external and objective data: the right answer or behavior to the questions or demands. The Behaviorists believe that the active agent in the learning-teaching process is only the teacher: the student is a passive agent, who just responds to a stimulus controlled by the teacher or the system. The main Behaviorist theorists were Skinner and Gagné (Zuber-Skerritt 1991).

On the other hand, the Cognitivist/ Constructivist theory focuses on the human mind: its memory, cognitive structures, and the process of information storage and retrieval. Cognitive structures are the way knowledge is organized and stored in the human mind. Ausubel asserts that cognitive structures are hierarchically organized. He claims that the learning process occurs when new concepts can be subsumed to some existing concepts in the cognitive structure (Moreira 1997; Zuber-Skerritt 1991).

Ausubel's Meaningful Learning theory states that when a new concept links to an existing one, this new concept becomes meaningful to the learner, which means that s/he has learnt the new concept. This association of the new with the existing concepts in the cognitive structure is called not arbitrary because it happens consciously and only with those

concepts which are really relevant: Ausubel named them '*subsumer' concepts* (Moreira 1997).

It sounds somewhat redundant to talk about *meaningful learning*, since it seems to be impossible to learn without getting or understanding the meanings of what is being taught or studied. However, this term has been used to distinguish from the mechanical learning or memorization (Moreira 1984). In mechanical learning the new information is memorized, with little or no relationship with relevant concepts already known by the student. This process just keeps new information for a while in the memory and after some time it is forgotten. Ausubel views learning as a substantive process, not literal as in mechanical learning. Unfortunately, teaching practices are often developed without considering what the students already know, their experience, or their preferred learning style. The lack of concern about teaching strategies and learning evaluation leads to the trivialization of learning. It can also lead to an unconscious consideration of memorization as learning (Moreira 1984).

A cognitive structure is dynamic and changes whenever a new concept is subsumed or an existing one is modified. This process can start in a teaching event or in the daily routine, since the meanings of the concepts are the result of a social and historical process which occurs between the subject and the environment: the process of sharing the meanings of words (Vygotsky 1993).

SHARING MEANINGS OF CONCEPTS: VYGOTSKY'S THEORY

A comprehensive awareness of individual learning is not enough to understand the meanings assigned by an individual to a specific word, neither to grasp how to transform individual learning in collective learning and change a managerial process or an organization. The literature on Organizational Learning mentions the process of sharing meanings and communication among the key points to a collaborative enquiry (Pedler et al. 1991).

Vygotsky is pointed out by the literature as the precursor of the field of psychology concerned with the role of signs in human activity. His theory gave birth to the knowledge on shared meanings. His ideas and experiments founded the basis for the understanding of the cognitive process (Wertsch 1985). His theory is very complex, but this paper will present only the aspects related to the development of concepts, in order to understand collective learning process.

The starting point of Vygotsky's framework for understanding the development of concepts in the human mind is that speech is a mediation system which allows the exchange of thoughts and experiences, and consequently, to establish communication and social interaction. This mediation system has words as the essential elements: words as signs standing for things and ideas, and communicating thoughts. Nevertheless, a deeper examination on the development of understanding and communication processes at childhood lead to the conclusion that in addition to signs, communication requires **meanings**. According to Vygotsky (1993) meaning is an attribute of signs or words which allows **generalization**.

The adults' capacity to generalize the meanings of words supports communication as well as the development of concepts. Novak and Gowin (1984) define concept as "*a regularity in events or objects designated by some label*". These authors call label what Vygotsky calls word: the instrument of language to communicate the perceived regularities. Vygotsky

carried out some experiments with children, adults and mentally ill adults in order to understand how concepts are formed in the human mind. One of the main conclusions he has drawn from these experiments was that by the age of 12 or so children's thoughts cannot operate with concepts. They use words to designate things and ideas based on **association** process using **complexes** instead of concepts (Vygotsky 1993).

Operating with complexes means that the relation between the words and the objects are concrete and real, neither abstract nor logic. It is an association process of the features perceived and the words. On the other hand, the need to solve problems encourage the development of concepts. A word is a sign used by the human mind to conduct the mental operations aiming to elaborate a concept and get the solution for the problems faced. It is a creative process, according to Vygotsky (1993).

The evolution from thinking with complexes to concepts is similar to the evolution of the speech. The meaning of a word can change over time, because usually a word is originated as a complex, due to its association with some objective feature. Then, the use of this word among a group of people results in a meaning that is shared by this group and the word becomes a concept. Still, the meaning can change because using a word is a sharing process. One of the examples given by Vygotsky is the word used to designate ink. A long time ago, every ink used for writing was black and the Russian word for ink refers to this color.

On the other hand, a word can assume one meaning but with different senses, depending on the context. Vygotsky calls sense as the sum of all the psychological events that a word arises in our consciousness, and the meaning is only one of the zones of the sense, the more stable and precise one. This is an important aspect to take into account concerning the process of sharing meanings because, according to Vygotsky, when one is consciously trying to understand something, s/he is more likely to be operating with the sense of the word instead of the meaning (Vygotsky 1993).

FIRST APPROACH: A TOOL TO THE NEGOTIATION OF MEANINGS

Vygotsky´s (1993) theory on speech and thought adds more elements to understand the Lillrank's (1995) framework for transfer of innovations between different environments (Figure 1).

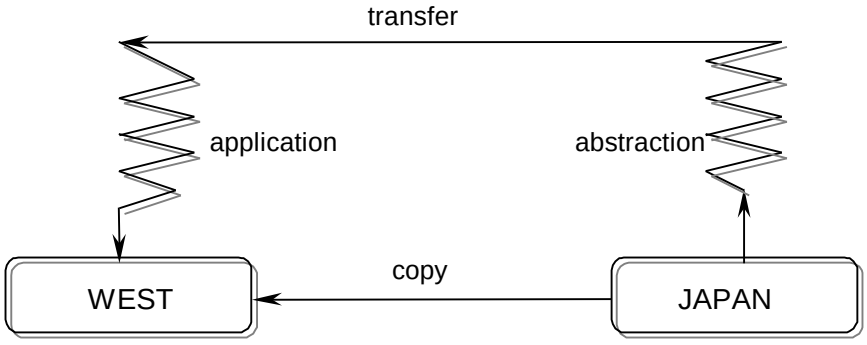

Figure 1: Transfer of Complex System Requires Abstraction and Application (Lillrank 1995)

Lillrank compares the transference of innovations from a diverse culture with the power transmission between two points: the longer the distance, the higher the voltage that the electric current should be switched at the origin. Similarly, the greater the cultural, historical and economic differences between two contexts (distance), the higher the level of abstraction required for the transfer of innovations in order to adapt and apply the concepts and principles to the new context. Lillrank (1995) stresses that the success of the transference depends on two processes: abstraction at the origin and application at the end to adapt the concepts. The copy of methods, processes, techniques and concepts from cultural diverse contexts are simpler but inefficient. More than that, it can lead to distortions.

In the light of Vygotsky's theory, this abstraction and transference deals essentially with words, meanings and senses. So, it is not enough to abstract the concepts from the Toyota Production System, adapt and apply them in the western construction process in order to transfer the innovation. It is also important to consider the signs to be used in this process, or the words which are used to communicate these new ideas. In other words, it is a matter of coherence between thought and speech.

The use of Concept Mapping is proposed in this study as a mechanism for negotiating the meanings of Lean Construction concepts. Figure 2 presents an example of a Conceptual Map. It is a learning tool intended to represent meaningful relationship between concepts (Novak and Gowin 1984). The concepts are related through propositions which link words, connecting the meanings of the concepts. The map presents the concepts organized in a hierarchical structure, from the more inclusive concepts (at the top) to the more specifics ones (at the bottom). This tool makes explicit the connections between concepts that an individual builds in his/her cognitive structure, either wrongly or rightly, and can be used for mediating the negotiation of meanings in a group. The use of the Concept Mapping for modeling the connections between Lean Construction concepts is being tested at NORIE, through the development of workshops.

However, this tool is concerned only with the content of the theory, in spite of helping in the communication and reflection on current concepts applied in construction management. Therefore, learning needs other approaches to deal with the dynamic process of experimentation, reflection, changes, and mainly with the collective learning process.

SECOND APPROACH: ORGANIZATIONAL LEARNING

As discussed in the first section, apart from the individual learning, changes in organisation processes require the development of collective competencies, since individual learning, although necessary, is not sufficient to assure changes in the organisational behaviour.

Swieringa and Wierdsma (1995) argue that learning in organisations occurs in one, two or three cycles. The first cycle takes place when the rules (implicit or explicit instructions that govern people towards desired attitudes) no longer lead to the desired results. In order to change these results the organisation starts to discuss those rules, i.e., how things are done. This process can result in changes in the collective behaviour. This is called **improvement**.

If changes in the rules are not sufficient, the organisation can conduct discussions towards its insights (perceptions, arguments, theories that form the way organisations are managed), i.e., questioning the way things are done. This is a deeper and systemic change that can affect not only individuals but also departments and sectors. It is called **renovation**.

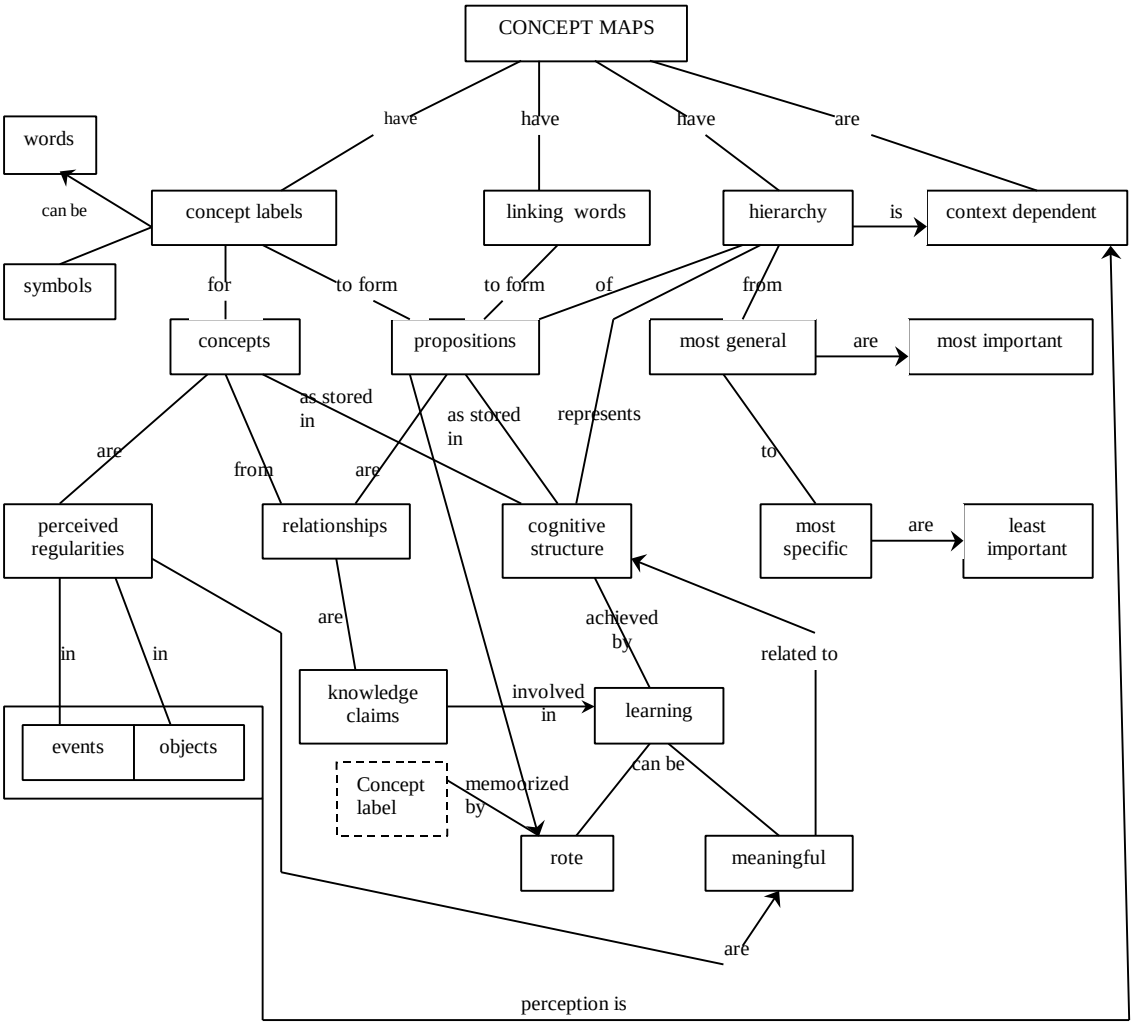

Figure 2: Concept Map Showing the Key Feature and Ideas that Underline Concept Maps (Novak and Gowin 1984)

The third cycle learning occurs when the basic organisation principles (visions that take the form of politics, strategies, and organisation culture) are discussed. Every organisation faces this kind of questioning a number of times along its life cycle. It is called **development**.

Argyris and Schön share these same ideas. Both authors assert that people hold maps in their heads about how to plan, implement and review actions. They also state that few people are aware that the maps they use to take actions are not the theories they explicitly espouse (Anderson 1997). Those authors suggest that there is a theory consistent with what people say (Espoused Theory) and a theory consistent with what people do (Theory in Use). Most often, people are unaware of their theories in use. People need to know more about their

theories in use, in order to make more efficient choices about the actions they take, and therefore to approximate both theories.

In their approach to learning, Argyris and Schön propose that theories in use are developed by governing variables (accepted values which determine people's strategies for action). These strategies will have consequences that may be intended or unintended. When the consequences (outcomes) of actions mismatch what is expected, there is a need for a change that can happen in two different ways. They are related to the concept of single and double loop learning.

In single loop learning, changes would happen on strategies of action only, not in governing variables. Double loop learning takes place when governing variables are examined and changed as well as strategies of action. This second type of learning is more effective since it brings to the surface some prejudices and characteristics of mental models that govern decision making and actions. The result is a consciousness about how decision making is structured.

On the whole, both approaches stress that learning is a process of change that leads to a more effective action. This process implies exposing and discussing individuals' and organisational values, insights and ideas that govern actions.

Organisational learning implies a process of collective learning that happens through dialogue and collaborative inquiry. Swieringa and Wierdsma (1995) state that the potential of individuals and groups to learning can be amplified through this interaction.

Undoubtedly, the implementation of Lean Construction theory and practice implies changes in organisations. It would require not only individual learning of new concepts and competencies, but also a change on the way things are done within organisations. This change would require questioning the rules and insights (Sweringa and Wierdsma 1995) that govern planning and action within construction. The ongoing research project regards learning organisations as an approach that could help the introduction of Lean Construction concepts in the common practices of the construction industry. First of all, the use of Lean Construction approach requires changes in managers' governing variables (focus on process instead of conversion only, value instead of costs, effectiveness instead of productivity, and so on). Secondly, because it also requires collective learning in order to make things happen.

The development of collective competencies within organisations still needs more investigation, specially on the link between individual and group learning. Most of the theories on organisational learning are based on reflecting and acting over organisational problems. In addition, organisational learning is a process full of conflicts that emerge from the difficulties of sharing a vision, the gap between individuals espoused theories and theories in use, the lack of confidence between partners, which generate what Argyris (1997) named defensive routines. Pedler (1997) argues that the Action Learning approach is concerned with all these matters.

THIRD APPROACH: ACTION LEARNING

Pedler (1997) presents three interpretations of Action Learning as an idea, rather than a method: as problem solving, as self-development, and as collaborative enquiry. These differences are due to the diversity of reported experiences about the application of Action Learning ideas in teamwork and organizations. Weinstein (1995) defines it as "*a process*

underpinned by a belief in individual potential: a way of learning from our actions, by taking the time to question and reflect on this in order to gain insights and consider how to act in the future".

Action Learning is carried out in small groups (sets), based on a process of questioning, acting and reflecting in actions and in past experience. However, a set is not a team, neither a counselling group, nor a problem-solving group, where tasks are well defined. Action Learning focuses on the individual, in spite of involving a group. Sets support the learning of each individual (Pedler 1996; McGill and Beaty 1995).

Action Learning approaches learning through regular meetings, with a set advisor, when set members discuss their problems and commit themselves to doing something towards the solution of these problems, and present the consequences of these actions in the following meeting. This process includes some key elements: problems, commitment, reports and discussion.

Problems are different from puzzles, in the Action Learning approach. A problem has no existing solution, and there might be different courses of action towards its solution. A puzzle is a difficulty to which a solution already exists (Revans 1997). Problems usually involve people.

Commitment with the set implies that there must be confidence among set members and also that they must volunteer to take part in a set. The climate in a set must allow sharing and comradeship: sharing experiences, and mainly what they do not know.

Each set member presents a report about the actions and consequences of these actions s/he had undertaken since the previous meeting. This process of telling what happened stimulates the reflection in action. The discussion about the outcomes of each set member must be guided by questions instead of advices, which is more likely to occur. A set meeting is an opportunity for sharing experiences, but the most important element in Action Learning towards learning is the improvement of a questioning insight.

The main elements of Action Learning have been applied in a group of five building company managing directors and one researcher, as part of the ongoing research project at NORIE. The purpose of this group is to improve the set members capacity to analyse their problems in the light of Lean Construction concepts and principles. This improvement implies in the development of questioning insights, learning how to deal with the theory in use and espoused theory, sharing meanings of concepts, and learning how to learn Lean Construction concepts and principles.

The participation of a researcher from NORIE in this group aims to bring challenging questions to the analysis of the problems, attempting to introduce Lean Construction concepts and principles. Nevertheless, this researcher is also committed to the group to present his own problems and share his deficiencies on knowledge with other members. It is expected that the conceptual maps can support this process. The purpose of the use of conceptual maps in this study is to find a simple and clear way to communicate Lean Construction concepts and principles during the discussions of problems in the group, as well as to identify possible barriers for understanding the meanings of these concepts.

FINAL COMMENTS

This paper is concerned with the need to disseminate and apply in the real world Lean Construction concepts and principles in order to contribute to the consolidation of a theory. It proposes learning as a key element of this process, but stresses that learning processes must be better understood in order to be effectively managed.

Three approaches are proposed to learn how to learn Lean Construction concepts and principles: a tool to expose and negotiate meanings, based on Meaningful Learning and Vygotsky's theories, experimentation with action and reflection on action, and organizational learning.

The application of these approaches started recently at NORIE as a first experiment to introduce alternative methods and elements to learn such a complex subject. Therefore, changes in the development of the study are likely to occur. The motivation for this experiment comes actually from the idea of Action Learning. The purpose of the ongoing study is to understand the barriers to learning Lean Construction concepts and principles through actions, reflection on actions, sharing meanings with professionals, and learning to deal with theories in use and espoused theories.

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