The 6th International Conference on Construction Engineering and Project Management (ICCEPM 2015)
Oct. 11 (Sun) ~ 14 (Wed) 2015 • Paradise Hotel Busan • Busan, Korea
www.iccepm2015.org

Modeling Laborers' Learning Processes in Construction: Focusing on Group Learning

Bogyeong Lee[1]; Hyun-Soo Lee[2]; Moonseo Park[3]

Abstract: Construction industry still requires a lot of laborers to perform a project despite of advance in technologies, and improving labor productivity is an important strategy for successful project management. Since repetitive construction works exhibits learning effect, understanding laborers' learning phenomenon therefore allows managers to have improved labor productivity. In this context, previous research efforts quantified individual laborer's learning effect, though numerous construction works are performed in group. In other words, previous research about labor learning assumed that sum of individual's productivity is same as group productivity. Also, managers in construction sites need understanding about group learning behavior for dealing with labor performance problem. To address these issues, the authors investigate what variables affect laborers' group level learning process and develop conceptual model as a basic tool of productivity estimation regarding group learning. Based on the result of this research, it is possible to understand forming mechanism of learning within the group level. Further, this research may contribute to maximizing laborers' productivity in construction sites.

Keywords: Group Learning, Labor Productivity, Computer Simulation Modeling

I. INTRODUCTION

Construction industry still requires various laborers to perform a project employing 11.1 million laborers in US [1] despite of advance in technologies. Therefore, improving labor productivity is a key strategy for successful project management in construction [2]. To forecast and improve labor productivity in construction, learning curve theory has been applied to labor-intensive tasks (e.g., concreting, re-bar fixing, masonry etc.). Learning curve theory is based on the ability to learn from past experience and it is a basic principle of human nature [3]. Especially, construction tasks are generally repetitive and they fits with learning curve effect, which is a phenomenon that a laborer becomes more productive doing a task when he or she performs the task repetitively [4].

Though previous studies effort to investigate and apply the learning curve effect to construction tasks, the studies mainly focus on 'individual level' of learning. This can cause misunderstanding about learning effect that labor productivity always improves because of laborers' learning. In fact, numerous construction works consist of group (crew) works and rarely done by an individual in isolation [4]. In other words, 'group level' learning should be further investigated to find out how laborers' learning is reflected in productivity improvement. Also, few studies have been modeled group learning process for practical use in construction, and only deal with its manifestation results. Without investigating the group learning process, managers may miss the managerial points, which can improve the laborers' learning and productivity.

In this context, the objectives of this research is to investigate the group learning effect, and analyze its development and manifestation process in construction. Also, this research develops a computer simulation model as a tool of productivity estimation regarding group learning. To achieve these objectives, this paper defines a concept of group learning in construction and model its concept for practical use in further research. The authors expect that the end results of this paper help to understand a dominant but invisible phenomenon through visible tools, and suggest managerial implications to construction site managers.

II. PRELIMINARY STUDY

A. Work Group Learning Theory

Group learning in work group has been mainly studied in social science. According to theory, a group learns naturally by itself within their environment [5] [6] [7] [8]. In other words, when a group is formed to perform tasks, the group naturally learns as a living system [6]. Group learning is a dynamic process in which learning processes, the conditions that support them, and group behaviors change as the group learns [5] [8] [9]. However, the results of group learning can be manifested in various ways (i.e., group learning can improve or deteriorate the situation). In detail, group learning can sometimes lead to unexpected outcomes such as forming dysfunctional habits or interaction that are counterproductive [5]. Figure 1 describes the possible various results. Thus, investigating

[1] Ph.D. Student, Dept. of Architecture and Architectural Engineering, Seoul National Univ., Gwanak-ro 1, Gwanak-gu, Seoul, Korea., itwillfly22@gmail.com
[2] Prof., Dept. of Architecture and Architectural Engineering, Seoul National Univ., Gwanak-ro 1, Gwanak-gu, Seoul, Korea., hyunslee@snu.ac.kr (*Corresponding Author)
[3] Prof., Dept. of Architecture and Architectural Engineering, Seoul National Univ., Gwanak-ro 1, Gwanak-gu, Seoul, Korea., mspark@snu.ac.kr

group learning process can help managers to reinforce only the positive effect of learning.

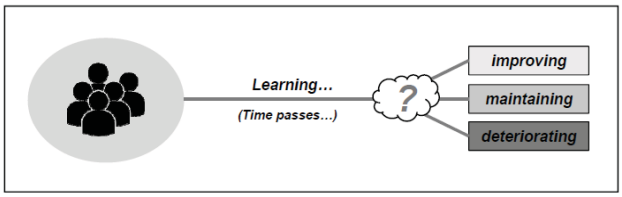

Figure 1. Various Results from Group Learning Process

B. Group Learning in Construction

Learning curve theory in construction is generally defined as 'an individual laborer's learning' from task repetition. According to the very definition of learning curve theory, managers should track a laborer every single day when they want to know the laborer's learning rate and its effect. However, getting an individual laborer's learning information is impossible and also useless for management. This is because 1) construction tasks in sites are generally performed by groups (e.g., steel work, masonry work, etc.) and 2) productivity improvement from learning can only be manifested within group level. As a result, previous research [2] [3] [4] generally assume that a group learning is identical with the sum of each individual's learning. However, this assumption can cause errors to forecast the labor productivity (Figure 2). For example, though managers hire a group of skilled laborers to improve the productivity, their productivity is not improved as expected. It can be an evidence that learning in construction occurs in group level. Therefore, learning development process in construction sites should be further investigated in group level.

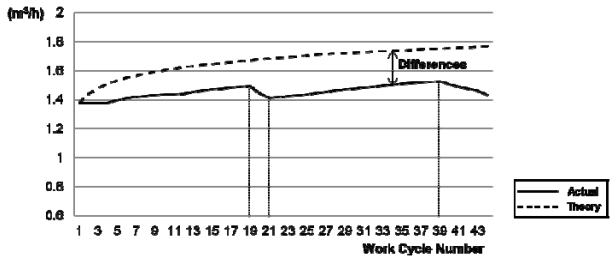

Figure 2. Productivity Curve: Actual vs Theory (adapted from [10])

Construction tasks performed by groups have common characteristics. The authors suggest typical four characteristics as follows (Figure 3).

1) Group-based tasks progress sequentially or collectively.

2) Other members' working behavior or performance can affect my task.

3) Productivity of a group is more meaningful than every individual's productivity.

4) Group members are frequently changed for various reasons (e.g., turnover or new hiring (including foreign laborers)).

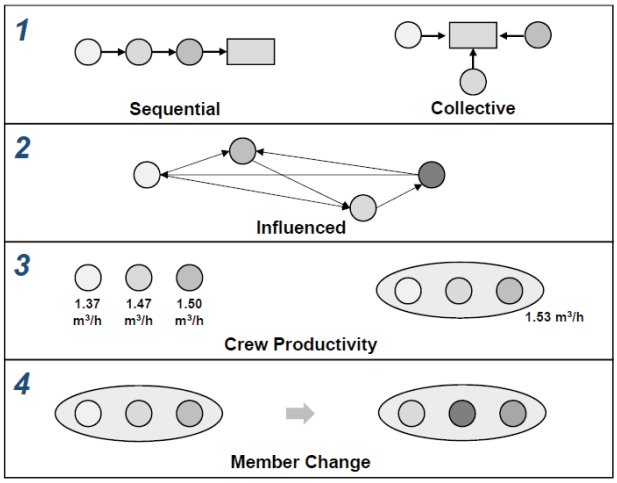

Figure 3. Group-based Tasks' Characteristics

The four characteristics can affect group learning development or manifestation process, and they will be applied as task rules in developing models.

C. Two Types of Group Learning

Group learning can be categorized into two types in detail, 1) individual's learning in the context of group (so-called group context learning) and 2) actual group learning. First, group context learning is defined as an individual laborer can learn by observing other members or group environment. Observing other group members or group environment is a result of group performance and this type of learning can influence each individual's performance. Herriott et al. [11] mentioned that how one actor can supplement learning from direct experience (i.e., individual skill learning) through diffusion of experience by copying others [12]. The contents of group context learning includes both productive and unproductive (i.e., other members' know-how, task-relevant experience or counterproductive habits etc.), which are generated from group learning process. In this research, individual laborer can learn from others by informal communication (e.g., observing or just working together).

Actual group learning is literally a result of learning among group members. In this process, information or knowledge that group members have is directly shared in the group and the result of this process is reflected to group environment. A group-level learning is developed by formal communication (e.g., directly transferring or sharing activities). Ingram and Simons [13] described that groups facilitate the transfer of experience among members through three specific mechanism: 1) by increasing the opportunity for transfer, 2) by increasing the motivation for transfer, and 3) by increasing the capability of organizations to successfully apply the experience of others. Through the above process, productive or counterproductive learning behaviors are generated and they can influence an individual laborer as a group culture or environment (group context learning).

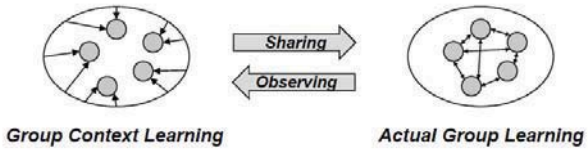

Figure 4. Two Types of Group Learning

III. Model Development

A. Modeling the Group Learning Processes

This research will construct a computer simulation model to estimate the group learning effect and its influence to productivity. In this paper, the authors suggest a model framework describing the group learning process, from development to manifestation.

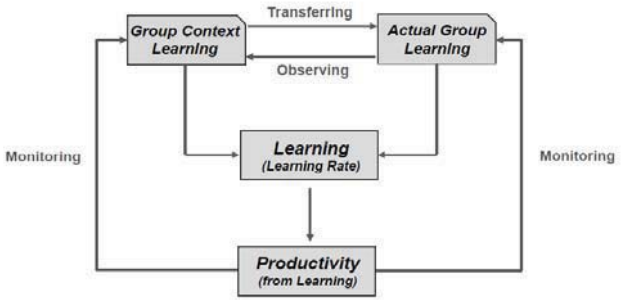

Figure 5. Conceptual Model of Group Learning Processes

The authors divide the group learning process model into 4 parts: 1) Observing, 2) Transferring, 3) Manifestation, and 4) Monitoring. In this case, observing and transferring part can be referred as development process. In this process, observing makes individual laborer learns group culture or environment. To increase observing, the laborers' number of observation and work days in the group should be increased. Transferring helps to build a group culture from group members. At this time, laborer's willingness to transfer his/her knowledge, adaptability to environment, and opportunity to transfer influence transferring activity. This two process occur repetitively and group learning is developed.

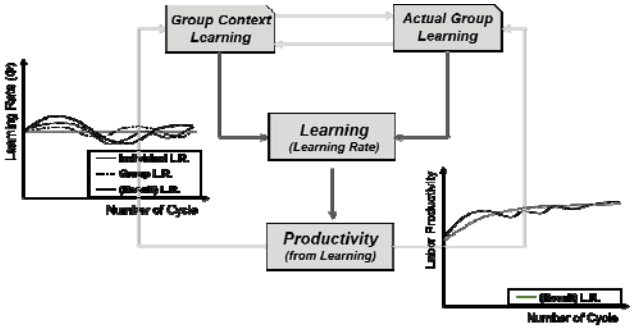

Figure 6. Group Learning Manifestation Process

Developed group learning is invisible and it can be perceived when manifested into labor productivity. In this manifestation process, group learning rate is determined according to the above variables' influences. Finally, monitoring activity is about group members' perception about group learning. It is assumed that learning occurs actively when group members clearly perceive their task goal and their group-level learning [8]. Thus, number of informing about group status and goals can help the group's monitoring activity.

B. Expected Results of Modeling

The suggested model's final result is performance forecasting, which is from group learning. Group learning effect is determined with directions (positive or negative) and extent of learning rate, which is also determined with the influencing variables. As a result, it will reveal an invisible process with quantification model.

Another expected result of the model is the managerial implications to site managers. The information includes how the managers can control the laborers' group learning and how reinforce the positive effect of group learning. Also, it can help to respond the inflow of foreign laborers issue or laborer distribution problem, which are recently occurred.

IV. Conclusions

This research analyzes the group learning development and manifestation process in construction tasks. Also, it suggests a conceptual model of labor productivity from laborers' group learning effect with managerial implications.

In future research, the authors should develop a systematic model including quantified variables. At the same time, laborers' actual observing, transferring, and monitoring activities will be investigated with a survey and interview, to validate the model. However, the authors also presume that developed model cannot calculate the exact value of labor productivity and its result will be limited to forecast relative magnitude and trends.

The authors expect that this research will extend the previous research of 'learning in construction' to more practical level. It contributes to explaining an invisible phenomenon through visible model. Also, it would finally be helpful for maximizing laborers' productivity in construction sites.

Acknowledgement

This research was supported by a grant (15CTAP-B080352-02) from Infrastructure and Transportation Technology Promotion Program funded by Ministry of Land, Infrastructure and Transport of Korean government.

REFERENCES

[1] The Center for Construction Research and Training, (2013). *The Construction Chart Book: The U.S. Construction Industry and Its Workers*, 5th ed., Silver Spring, MD: CPWR.

[2] Oglesby, C. H., Parker, H. W., and Howell, G. A. (1989). *Productivity Improvement in Construction*, 1st ed., New York, NY: McGraw-Hill.

[3] Jarkas, A. M. (2010). "Critical Investigation into the Applicability of the Learning Curve Theory to Rebar Fixing Labor Productivity," *Journal of Construction Engineering and Management*, vol. 136, no. 12, pp.1279-1288.

[4] Adrian, J. J. (1995). *Construction Productivity: Measurement and Improvement*, 1st ed., Champaign, IL: Stipes Publishing.

[5] Sessa, V. I. and London, M. (2008). *Work Group Learning: Understanding, Improving & Assessing How Groups Learning in Organizations*, 1st ed., New York, NY: Lawrence Erlbaum Associates.

[6] Jaques, E. (2002). *The Life and Behavior of Living Organisms: A General Theory*, 1st ed., Westport, CT: Greenwood Publishing Group.

[7] Wilson, J. M., Goodman, P. S., and Cronin, M. A. (2007). "Group Learning," *Academy of Management Review*, vol.32, no.4, pp.1041-1059.

[8] Argote, L. (1993). "Group and Organizational Learning Curves: Individual, System and Environmental Components," *British Journal of Social Psychology*, vol. 21, no. 1, pp.31-51.

[9] Kasl, E., Marsick, V. J., and Dechant, K. (1997). "Team as Learners: A Research based Model of Team Learning," *Journal of Applied Behavioral Science*, vol. 33, pp. 227-246.

[10] Lee, B., Lee, H., Park, M., and Kim, H. (2015). "Influence Factors of Learning-Curve Effect in High-Rise Building Constructions," Journal of Construction Engineering and Management, vol. 141, no. 8, pp. 04015019-1-11.

[11] Herriot, S. R., Levinthal, D., and March, J. G. (1985). "Learning from Experience in Organizations," *The American Economic Review*, vol. 75, no. 2, pp. 298-302.

[12] Ryu, C., Kim, Y. J., Chaudhury, A., and Rao, H. R. (2005). "Knowledge Acquisition via Three Learning Processes in Enterprise Information Portals; learning-by-investment, learning-by-doing, and learning-from-others," *MIS Quarterly*, vol. 29, no.2, pp. 245-278.

[13] Ingram, P., and Simons, T. (2002). "The Transfer of Experience in Groups of Organizations: Implications for Performance and Competition," *Management Science*, vol. 48, no. 12, pp. 1517-1533.