
AC 2011-2146: USING TOP METHOD TO ENHANCE THE CONSTRUCTION ENGINEERING STUDENT LEARNING

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Abstract

This paper discusses a pedagogical method of TOP and its implementation in the classroom to provide construction engineering students an opportunity to develop communication skills in order to better prepare them for future employment in the construction industry. While this discussion is based on the feedback from construction professionals, detailed course works are presented to illustrate the idea in order to make it suitable to other typical construction engineering classes. In this paper, communication practices, needs, and methodologies are written in detail as well as the implementation in a course from both instructor and student perspectives. The impact of learning and teaching is also discussed. The discussion and course practice results showed that these are effective methods to enhance student learning in the area of construction engineering.

Introduction

In the construction industry, professionals require new hires to have solid fundamentals of engineering knowledge along with limited professional skills, and strong oral and written communication capabilities developed when they were in school. Construction engineering students, therefore, need an opportunity in the classroom to develop these skills and to find ways to keep their motivation toward their construction engineering career. However, students often comment that they don't have many chances to obtain these skills in the classroom. How can this gap be covered? This paper addresses a TOP method – “TOP” is an acronym for Teamwork (T), Oral Interaction (O) and Professional (P) - based on the needs from the construction industry, to address the gap between academic knowledge and professional experience.

Communication in Construction

Industry professionals as documented in the literature suggest that communication is the key to the success of construction projects. Better communication allows for projects to be completed within budget with reduced amount of rework.¹ The primary function of communication is to transfer information.² Quality communication has to include successful transmission and accurate understanding of the message. Many factors can affect the transmission and understanding, including information, interpretation, and feedback. In the context of construction engineering, communication occurs not only among project team members, but also among all parties involved in the project including the public.

The communication initializer provides the ideas, needs, instructions, and information; some of these may have multiple purposes that are being communicated. For example in a scheduled disruption caused by road construction was provided to all parties involved in the project as well as to the public.² This serves as the specific purpose of communicating schedule information and

also as the general purpose of communicating to those who will be affected by the disruption. In this communication process, relationships are also developed accordingly.

According to Mubarak,³ good communication should have the following features:

- Clarity – The message provider and listener or reader must make sure the information or instruction is understood exactly as what is meant.
- Simplicity – A construction engineer should use simple language as much as possible in their daily communication but the documents must contain exact description.
- Accuracy – As a construction engineer, professional communication means the information is accurate, objective, and always updated.
- Preciseness and relevance to the subject – Having so much information regarding construction drawings, specifications, and field operation can make communication complicated and confusing among any parties that can mislead the project.
- Legibility – If the communication form is written, it must be with good readability. It shouldn't leave any room for guessing.
- Proper support tools – When providing construction instruction, sometimes “a picture is worth more than a thousand words.” Pictures, tables, charts, and videos should be used wherever possible. A follow-up should occur to check how much information is correctly understood.
- Good organization – Construction information should always be organized due to its teamwork nature. A certain format should be followed, especially for a large-scale project.
- Industry standards – It is very important for construction professionals to use common languages for communication. However, it has to follow certain industry standards to avoid confusion.

However, previous research^{4, 5, 6} showed that usually engineering students often don't develop high level communication skills before they graduate. This was further analyzed by Mieke Schuurman, et al.⁷ Moreover, “Unfortunately, a large number of undergraduate engineering programs are not sufficiently providing students the skills necessary to succeed in the workplace of the future.”⁴ This is most likely because “with the building of the analytic emphasis over the decades, the undergraduate engineering educational experience became increasingly fragmented into what appeared to the student as independent parts.”⁵ However, it has been recognized that a direct relationship exists “between the amount of technical communication instruction and career advancement.”⁶ This is especially true for construction engineering students based on the feedbacks that authors of this paper have documented from construction companies who attended recent engineering job fairs.

Statement of Needs

Based on the above discussion, the construction industry is involved in intensive communication. Therefore, having good communication skills is a basic requirement for construction professionals. Construction Engineering programs primarily prepare students for employment in the construction industry. This industry requires intensive communication skills at the

professional level within the realm of the team environment. Employers are emphatic that students must develop strong oral and written communication skills along with a body of knowledge of the construction/engineering disciplines. An opportunity must be provided to develop communication skills in order to better prepare the students for future employment. A significant gap exists between the industry's requirements and the students' capabilities in both communication and teamwork skills.

Methodology

Within recent years, skills related to teamwork and communication training had been addressed in the classroom, but the adaption of the TOP strategy may take this approach to a higher level. To address the issues of communication, teamwork, and professional perspectives, the TOP strategy was applied to a senior-level construction class. The purpose of this application was to allow students to gain communication and teamwork skills in a professional manner, and to learn these skills more thoroughly within an applied environment.

The scope of the work consisted of the following components:

- Two-way exposure to construction professionals: professionals came to students and students went to professionals.
- Continuous oral communication training.
- Contractor office simulation focusing on teamwork.

Course Details – Instructors

The TOP method was applied to the Construction Scheduling and Project Control course. In order to understand the suitability of TOP for this course, the course description is provided below:

Construction Scheduling and Project Control “*provides a discussion on the theories, principles, and techniques of construction planning and scheduling with an emphasis on time management, costs, and resources through the preparation and analysis of network schedules.*”

The objectives of student learning for this course include: (1) understanding and describing the process of construction project planning, scheduling and control, and ethical issues involved in the construction scheduling process, (2) developing a Gantt chart for a construction project, (3) manually creating and calculating a project schedule using network scheduling techniques for a construction project using critical path method (CPM), (4) updating schedules and monitoring the progress of work, and (5) performing the project schedule calculation and analysis using computer software.

First, focus group meetings with several construction professionals were held to gather and review details of the industry requirements for new hires, especially a scheduler and a plan was developed to apply these requirements to the classroom using the TOP method.

Second, the TOP strategy was implemented into the course preparation, using:

- Two-way exposure to construction professionals – the instructor planned frequent visits by construction professionals to the classroom and student were required to interview professionals.
- Continuous oral communication training – the instructor planned to require students to practice their oral communications in several ways, including: site visit/interview report, formal oral presentations, instant observations, and required in-class discussion for almost every class periods. The goal of the preparation was to have every student speak at least twice per week for the entire semester.
- Contractor office simulation focusing on teamwork - the course was modified from a traditional classroom setting to a “contractor’s office” by rearranging the tables and dividing students into groups. Students acted as engineers during class time – but always within the “construction team” environment.

Third, in order to provide students both scheduling theory and practice in a way that students can learn conveniently, the projects used in class were actual commercial projects but with some assumptions to address drawing deficiency and to simplify the students’ work. Companies, who were willing and were selected to support this project, were typical representatives of the construction industry. The instructor traveled to these companies, conducted interviews and meetings with related professionals, visited appropriate projects, and made agreements for providing current construction data and long-term collaboration. A typical meeting agenda consisted of the following:

- Meet and greet.
- Review of Construction Engineering program.
- Why is the program is seeking industry collaboration and what is the vision (i.e., why expend the effort and what is the exact nature of the revised program)?
- Industry observations on education and skills of graduates entering the industry.
- Brain storm ways the industry might provide involvement.
- Action items and follow-up schedule.
- Project site visit and project data.

These companies and their projects covered different types of construction – commercial, residential, transportation, and utility projects. Different perspectives of a project were also discussed – design, construction, engineering, and consulting.

Finally, the instructor was able to tie all these items together to fully implement the TOP method into the classroom. At the end of the semester, in order to assess and evaluate the implementation as related to the students’ learning, all students were surveyed on how well they met the course objectives.

Course Details – Students

Processes described on the instructor's perspective was of course implying on students' perspectives as well. The two items that deserve a detailed description are provided below.

Student interviews with professionals.

Interviews and hands-on tasks were used in class to help students understand the scope of the work and the responsibilities of a construction scheduler. This process allows students to recognize the knowledge, skills, and experience that a successful scheduler must have and to explore the scheduling software currently used in the construction industry. Students worked in a group and based on the student's experience and personal interest, each group interviewed a contractor either from the contractors described in the previous section or from their own contacts. Each group had obtained a set of project documents and scheduled the project accordingly to the instructor's requirements. A local contractor was preferred as it is more convenient to get the information, however, contractors, who are not local were acceptable. Typically, the students needed to gather three things from this interview:

- Scheduling practice including the people, process, skills, and the software that was used.
- An example project including the project's drawings and specifications, estimate, and the construction schedule – this was very important since students used this project for other assignments.
- Quality and safety plans for developing the schedule.

Before the interview, students developed a set of questions to collect this information.

The projects that students collected and used for the remainder of semester were in the area of commercial, residential, transportation, or utility construction. For a residential project, students were aware that they might not be able to get their formal scheduling documents but informal scheduling work was used. If the project was expansive, only sections of the project were needed.

After the interview, each group developed a written report to describe:

1. The interview process and information obtained.
2. Project objectives, including:
 - A brief description of the project.
 - The method or type of construction.
 - The project start and completion dates.
 - Project milestones.
 - Total project costs.

Using the project obtained, students had to act the role of a construction professional by preparing a Work Breakdown Structure (WBS), making an activity list and determining the project “logic.” At this stage, the groups of students:

1. Developed a WBS including:
 - a. Identifying the major CSI divisions and code numbers.
 - b. Having no less than 50 activities in the schedule.
 - c. Calculating the duration for each activity by using the estimate information obtained.
 - d. Listing any assumptions.
2. Decided the logical relationships between activities and made a summary table including following items:
 - a. Relationships among activities - meaning the construction operations based on a constructability review.
 - b. WBS code numbers, durations, predecessors or successors, concurrent activities, responsible party, resources that included labor, equipment and materials.
 - c. Costs for each activity.

Each group then entered the data into Microsoft Project or Primavera P6 and printed the required outputs: cost reports, Gantt chart, calendar view and a PDM network. Each group conducted an analysis of their schedule.

Finally, each group wrote a final report, which included:

- A letter of transmittal.
- Standard format (title, table of contents, tables and figures, etc.).
- A project narrative (divided into sections or subheadings).
- Analysis summary or conclusions.
- Appendices.

Student Formal Presentation

Each student group made a final presentation of their projects. They were evaluated by instructors, students, and invited professionals based on the following criteria:

1. Organization — Is the presentation organized? Is the methodology and approach of the presentation well crafted? Is the subject relevant to construction? Is there a logical structure to the presentation?
2. Confidence/Enthusiasm/Interest — Is the presenter knowledgeable? Relaxed? Does the presenter have a good stage presence and do they seem positive? Is there frequent eye contact? Does the presenter look only at one person, or make eye contact with several people? Is their voice stable? Are they caught up in any distractions? Do they convey an interest for the subject?
3. Clarity — Is the material explained in a coherent fashion? Does the presenter use proper terminology? Is the presentation straight forward or confusing? Does the presenter do a

- reasonable job of making the material understandable?
4. Visual Aids — Are the visual aids understandable and are they appropriate? Does the presenter explain the visual aids? Is the presenter creative in their use of the visual aids? Are there not enough or too many visual aids (slides)? Are the visual aids visible long enough for the audience to read and understand them?
 5. Technical Content — Is the presentation accurate? Is the selection of the supporting references for the presentation appropriate? Is the overall presentation too broad or too narrow in its content?
 6. Personal Appearance / Timing — Does the presenter look professional? Was their appearance appropriate? Is the introduction, body, and closing summary the proper length with regard to time?
 7. Summary — Does the presenter review key points? Does the presenter end with a strong statement? Does it seem the presentation came to an end in a proper way? Does it close in a way that didn't leave the audience hanging?
 8. Answering Questions — Does the presenter answer questions directly? Do they try to give the best answer to the questions?

Impacts on Learning and Teaching

The Student Rating of Instruction (SROI, i.e., course assessment survey) indicated that the students were able to fully accomplish the objectives. More than 85% of students reported that they were 90% confident that after the semester that they were able to:

- Understand and describe the process of construction project planning, scheduling and control, and ethical issues involved in the construction scheduling process.
- Develop a Gantt chart for a construction project.
- Manually create and calculate a project schedule using network scheduling techniques for a construction project using CPM.
- Update schedules and monitor the progress of work.
- Perform the project schedule calculation and analysis using computer software.

They were also 70% confident related to explaining and performing resource leveling.

Conclusions

This paper reports the implementation of a TOP strategy to help student learning in terms of teamwork, professional skills, and communication capacity. Based on the results of student performances and responses, this method is effective. In general, by implementing the TOP method, students and the instructor were able to obtain the following:

- Created an innovative and positive learning environment – the exposure to

construction professionals allowed students to experience actual construction challenges. Students can develop fundamental skills needed for successful project implementation and delivery.

- High quality of learning – the TOP method intuitively increased student interest and comprehension which could ultimately lead to higher quality in the students' work.
- Faculty learning – the instructor has promoted their professional development and gained an opportunity to “reform” their teaching style that is suitable to a new generation of student learners.

In a summary, TOP help students develop skills of teamwork and communication in a professional manner. The instructor has also learned from this process and gained significant insight into the student mindset related to student perspectives. Industry professionals, who were also involved in this process, really liked this method and are willing to review other construction courses in the near future.

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