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A Quantitative Approach to Evaluate the Application of the Extended Situational Teaching Model in Engineering Education

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Abstract: The extended situational teaching model is a variation of situational teaching, which itself has roots in situational leadership. Application of situational leadership in education requires the teacher to lead students through various stages of the learning process. This paper presents the relationship between performance measures of extended situational teaching and common pedagogical tools in engineering classrooms. These relationships outlined the response of students at different preparation levels to the application of various course components, including classroom activities and out-of-classroom assignments, in respect to task and relationship behaviors. The results of a quantitative survey are presented to support the existence of such a relationship and to demonstrate the effectiveness of the extended situational teaching model. The survey covered 476 engineering students enrolled in nine different courses over a four-year period within the civil engineering program. The statistical analysis of the survey responses proceeded in two stages. The first stage of the analysis evaluates whether the survey tool can resolve meaningful differences between the categories of the situational teaching model, and provides aggregate recommendations for each category. In the second stage of the analysis, the specific instantiation of these categories is broken down according to academic standing (grade point average) and academic level, offering support for an extended situational teaching model. Conclusions discuss the statistical characteristics of the results and correlations between selected pedagogical tools and performance measures.

Keywords: higher engineering education; extended situational teaching; quantitative approach; situational leadership; statistical analysis

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1. Introduction

Situational leadership is a well-recognized model in organizational management. The theory of situational leadership is based on the leadership style theory by Reddin (1967), which was further developed by Hersey and Blanchard (1969) [1,2]. This theory has been frequently revised and refined to meet specific applications in management, supervision, education, and other areas. The concept of situational leadership instructs leaders to match their leadership style to the development levels of followers in a two-dimensional model. The development levels of followers are measured by their maturity and their need for guidance and support. The leader selects the leadership style which will provide for a combination of task and relationship behaviors. Figure 1 shows a schematic view of the relationship between leadership behaviors and development levels of followers in a two-by-two matrix [3–5]. This figure manifests four zones of T1, T2, T3, and T4, each introducing specific characteristics of leadership, tagged as Guide, Coach, Support, and Delegate, which define the leader-follower connection in respect to task and relationship.

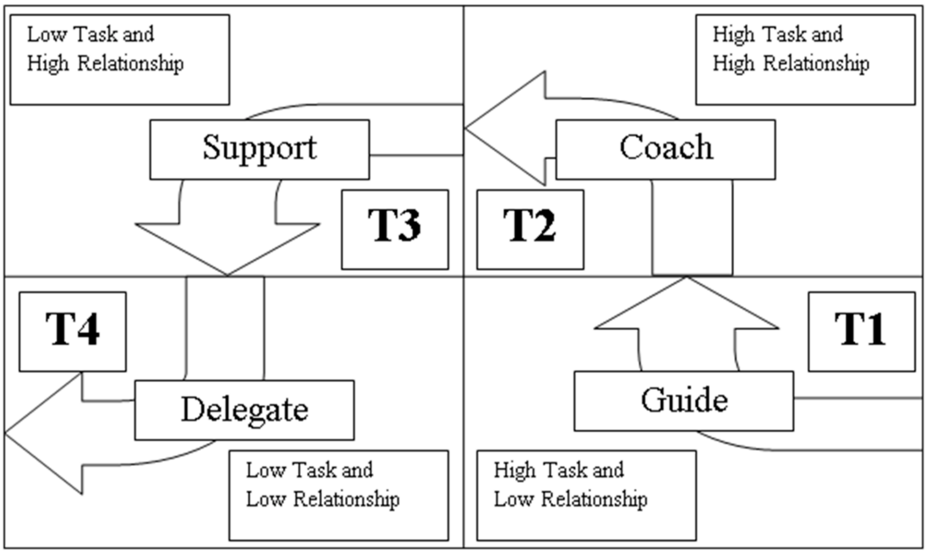


Figure 1. Situational leadership, after Hersey et al. (1982) [4].

Task or directive behavior, known in this paper simply as guidance, is often perceived as a job-related maturity dimension. This dimension reflects the ability or willingness of the follower to perform. The corresponding leadership style involves providing more guidance with a focus on task behaviors. These behaviors typically include work structure, organization, schedule, and resource allocation. On the other hand, relationship or supportive behavior is interpreted as a psychological aspect of the maturity dimension. This aspect relates to the confidence of the follower to perform. The matching leadership style involves providing more support with a focus on relationship behavior. This behavior is often characterized by the emotional state of the performer, the development of mutual respect and trust, and the improvement of communication and other soft skills. As a person matures in certain performance categories, the directive and supportive behaviors advance through four zones of the leadership style. This cycle will require the leader to adopt appropriate styles for each zone or situation [4–6].

Many researchers have studied the validity, applicability, and measurability of situational leadership styles in various applications, including education [7]. Hersey, Angelini, and Carakushansky (1982) conducted two training courses for small groups of managers. A total of 60 people divided into four groups were exposed to variations of situational leadership styles. The authors reported that changes in leadership style have a positive impact on the outcomes of training [4]. In a qualitative report, Grow (1991) expanded the idea of implementing situational leadership theory in classrooms and discussed how teachers can promote self-learning among students [8]. In a similar approach, Cramer (1994) emphasized using student assessments as a tool to select the appropriate teaching style and engage students in collaborative classroom environments [9]. Meyer (2002) confirmed the applicability of situational leadership in a clinical training environment [10]. In a quantitative approach, Vecchio, Bullis, and Brazil (2006) questioned 860 participants in field training about attributes of followers and styles of leaders [11]. These authors did not observe any strong correlations between the data and concluded that applicability of the theory to the observed field training might be limited. Tehrani (2011) suggested an extended version of situational teaching using limited data [12]. Further, McComb and Tehrani (2014) and Tehrani et al. (2014) used the concept of situational teaching in research methodology and STEM (science, technology, engineering, and mathematics) education for teachers, respectively [13,14]. A similar work by Feister et al. (2014) focused on project teams in a multidisciplinary project [15]. Qasrawi (2018) also discussed such an application for teaching a specific subject, concrete technology, in the field of civil engineering [16]. Blackburn, Bluestein, and Tehrani (2016) and Tehrani, McComb, and Papavasiliou (2017) examined this concept in research and service learning opportunities. These studies focused on qualitative aspects of situational teaching only [17,18]. Regardless, the application of situational leadership in engineering education is well manifested in recent research [19,20].

Significance of the Research

This brief literature review reveals that typical case studies on the implementation of situational leadership theory are primarily qualitative research endeavors. There are few quantitative studies, and those that have been conducted often yielded contradictory conclusions. Further, the implementation of this theory in highly specialized environments, such as higher-education classrooms, is challenging. The same can be extended to the application of situation leadership in specific areas of engineering, or similar areas within STEM (science, technology, engineering, mathematics) education. The main purpose of the current work is to investigate the applicability of situational leadership theory to teaching practice in engineering classrooms and to measure its effectiveness using a quantitative approach.

The term 'extended situational teaching' refers to a specific definition for the purpose of this article. 'Situational teaching' in this article refers to the application of situational leadership concepts in teaching practice, where the teacher takes the role of a leader, and students follow the teacher in their journey through development stages of situational teaching. 'Extended situational teaching' aims to project the conventional cycle of situational leadership, and consequently teaching leadership to a multi-cycle pattern of development cycles that covers the broader journey of followers, or students in this case.

2. Theoretical Framework

2.1. Models of Situational Teaching

2.1.1. Description of the Situational Teaching Model

Several pedagogical philosophies already begin to apply situational leadership to education. Constructivism, for example, identifies different background characteristics and bases of knowledge that students bring to the classroom, and calls on teachers to assess this background information and adjust instruction accordingly [21]. Among the various methods of instruction that instructors draw upon in engineering classrooms, the most common tend to be lecture, presentation, problem-solving, and discussion. Assignments such as homework, projects, and field studies are used for an additional practice of skills and application of knowledge. Learning opportunities can also be provided by quizzes and exams. As will be shown, different methods of instruction are more effective for different development levels. Aligning instructional methods with the development levels of students will yield a positive correlation to the assessed student learning outcome.

The four teaching styles in the situational teaching model are described below. These styles are adopted from original situational leadership styles [5,7] and applied into classroom teaching [4,12]. The interaction and relationship between these styles will be discussed later.

T1 style. The situational teaching model describes the first level of instruction as the 'guidance' of students towards a certain outcome. In the situational leadership theory, the guidance stage is also called 'telling' or 'directing.' This level is used to introduce students to a field or topic which is generally unfamiliar to them. The beginning of a course or program of study usually falls under this category. Introductory engineering courses, such as Introduction to Civil Engineering, are examples of guidance in an engineering program. Emphasis at this level is on high task and low relationship behaviors. The objective of educators is to provide students with the ability and motivation to perform a task. Methods used to engage students and familiarize them with contents include lecture, discussion, case studies, and reading assignments. The flow of information is one-way from the instructor to the students.

T2 style. This level of instruction builds on the previous one by providing a more supportive version of guidance termed 'coaching.' The situational leadership theory also refers to this as 'selling.' Here, the focus is on high task and high relationship behaviors.

Students are already motivated and proficient in the field of study. The objective of the instructor, then, is to help students develop agency, or the ability to make individual decisions in a given context. This requires learning more technical skills and knowledge, as well as increasing the self-efficacy of students. Educators must teach specific contents and build confidence within students. Methods that are used to accomplish this objective include guided practice, problem-solving examples, and homework assignments. The flow of information is still mostly one-way; students demonstrate their knowledge of theory and concepts but provide minimal feedback about their practical skills in the subject.

T3 style. After developing confidence in an area, students move on to the 'support' level of instruction. Emphasis shifts to low-task and high-relationship behaviors. Educators should use active listening, soft skills, as well as various channels of communication to build significant relationships with students. The objective of the educator is to encourage participation and inquiry from students. Methods of instruction used at this level may include discussion, questioning, projects, and quizzes. These methods should expand the creativity and critical thinking of students. Topics for discussion in engineering courses could include constructability, sustainability, and ethics. These are proper examples for this style, as information flows both ways between the instructor and the students.

T4 style. The final level of instruction is 'delegation,' which involves both low-task and low-relationship behavior. Students at this level of development have already built confidence and mastery in a subject. The objective of the educator, then, is to give students an opportunity to take full responsibility for a task within the subject. Students are thus able to test their technical skills and emotional self-efficacy, without the leadership of an instructor. Methods of instruction at this level are largely concerned with assessment of the student's individual competence. Exams and term projects, despite their different format and characteristics, are common tools employed at the end of a unit, course, or program of study to evaluate the overall success achieved by a student. Here, information flows mostly one-way, as students demonstrate their knowledge and skills to an instructor for assessment.

For the most effective results, the teacher's level of instruction must be matched to the student's level of development, both of which are described in the situational teaching model. Failure to select the appropriate level of instruction may result in a mismatch between teaching style and development level, which could disrupt learning and emotional growth. Table 1 presents a sample relationship matrix between teaching styles and teaching activities.

Table 1. A sample matrix of teaching styles and activities, after Hersey et al. (1982) and Tehrani (2011) [4,12].

Style	**T1 Guiding**	**T2 Coaching**	**T3 Supporting**	**T4 Delegating**
Sample Classroom Activities	Introductory Lectures	Problem-Solving	Discussions	Assessments
Sample Assignments and Exams	Engaging Case Studies	Homework Problems	Comprehensive Projects	Exams

2.1.2. Better Matching of Style to Student with an Extended Model

Admittedly, a single group of students may span numerous levels of development, and each level of development may suggest the implementation of a different teaching style. This is indeed a challenge for instructors attempting to precisely match their teaching style to the individual needs of each student. In this case, it is useful to employ near-match tools that combine different methods of instruction. For example, lectures from the T1 style could be supplemented with problem-solving sessions or homework assignments from T2. Discussions from the T3 style could be used to assess term projects from T4. This near-match strategy relies on the assumption that the teaching styles used will be close enough matches to most students' development levels. The strategy also suggests that educators need not adapt their levels of instruction precisely to each student's level of development. Educators should instead use progressively more-advanced levels of instruction in order to encourage the intellectual and emotional progress of students beyond their current development levels and comfort zones. Utilizing the T2 style connects with students who are already at this high-task and high-relationship level, and prepares them to enter the T3 style later, but it also encourages students who are still in the T1 level of development to advance out of this category and into T2. Finding the near-match teaching style for students and using a variety of methods from the four different styles ensures that instruction is appropriate to most students, even if they are all at different levels within the model. Table 2 shows the matches, near-matches, and mismatches for each teaching style.

Table 2. Interactions and relationships between teaching styles, after Grow (1991) [8].

Style	Match	Close Match	Mismatch
T1	T1	T2 (and T4 from previous cycle)	T3 (and T4 from current cycle)
T2	T2	T1 and T3	T4
T3	T3	T2 and T4	T1
T4	T4	T3 and (T1 from next cycle)	T2 (and T1 from current cycle)

In this model, the teacher–student relationship corresponds directly with the leader–follower relationship of the situational leadership model. In a typical stratification of leaders and followers, the followers receive training and guidance from the same leaders throughout the stages of situational leadership. In a work environment, for example, employees are trained and advised by supervisors until they become experienced enough to do the work by themselves. Education affords a more extended version of that timeline. Engineering students advance through the stages of the situational teaching model over the entire span of their undergraduate education, under different instructors and in different classes. At the same time, engineering students could advance through all of the situational teaching stages in just one class, under a single instructor. Some examples of the different scales of situational teaching experienced by engineering students are listed in Table 3.

Table 3. Sample scaling of situational teaching at the course, program, and academic career levels.

Scale	T1 Guiding	T2 Coaching	T3 Supporting	T4 Delegating
Course (Structural Design)	Axial Loads	Buckling	Design	Application
Program (Bachelor in Structural Engineering)	Introduction to Engineering	Solid Mechanics	Structural Design	Senior Project
Academic career (Structural Engineering)	College or Lower Division	Undergraduate Upper Division	Graduate Studies	Ph.D. and Post-doctoral studies

Table 3 identifies three example scales to show the recursive application of situational teaching: a course in structural design, a bachelor's program in structural engineering, and scholarship in structural engineering. Within a structural design course, an instructor first delivers information about axial load calculations using a guiding (T1) teaching style; next, the instructor coaches (T2) students through a more detailed study of buckling effects in axially loaded members; next, the instructor supports (T3) students as they apply buckling concepts to the design of columns; finally, the instructor delegates (T4) authority as students apply these concepts in practice and other courses. At the scale of a bachelors program, instructors primarily teach early courses (like Introduction to Engineering) in a T1 style; gateway courses such as Solid Mechanics may be taught using a primarily T2 style, characterized by high-task and high-relationship behaviors; design-type courses are usually taught using a T3 style, characterized by high-relationship and lower-task relevance; finally, capstone courses are taught using a T4 style in which students are expected to demonstrate competence and mastery to instructors. A similar pattern can be traced through a more longitudinal career in structural engineering scholarship.

This variation in the situational teaching timeline necessitates an extended model to account for the different scales in its application. Since the education process is continuous, the extended situational teaching model must also be continuous. Thus, the model can be made to represent a single cycle within a more complex and continuous spiral of cycles in a student's on-going education. Each completed cycle of the situational teaching path must build upon the previous, preparatory cycle, and it must prepare students for the next, more-advanced cycle afterwards. This extended situational teaching model is illustrated in Figure 2, in which students follow a spiral path through each teaching style in each cycle of the model. In this figure, the first, second, and third consecutive cycles are labelled Tn, Tn′, and Tn″, respectively, where n indicates the referenced number of the style.

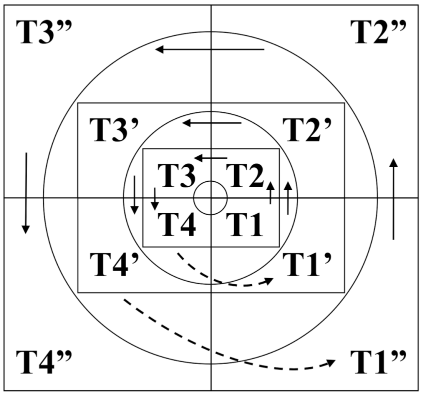


Figure 2. Extended situational teaching, after Tehrani (2011) [12].

One cycle of this extended model can be demonstrated by the components of a single course. In typical courses, the situational teaching model begins with lectures (T1) that prepare students for guided practice (T2), which gives way to guided design (T3), which finally leads to individual applications of course contents (T4). Each course, then, serves as a single cycle of the model and prepares students for further courses that represent further cycles in the program of study. Prerequisite and introductory classes spark students' interest and prepare them for more technical and proactive upper-division courses. A larger scale of this model divides the entire education of a student into connected cycles of learning. On this scale, an undergraduate education serves as the preparatory cycle for students entering the workforce or moving on to graduate school. Regardless of scale, the cycles are continuous, and every cycle includes the four teaching styles: guidance (T1), coaching (T2), support (T3), and delegation (T4).

2.2. Research Questions

This paper aims to address the quality of the relationship between situational teaching styles and common pedagogical tools (both lecture components and assignments) in an engineering classroom, as framed in the extended situational teaching model. The results of this paper are expected to quantitatively describe the effectiveness of applied pedagogical tools throughout various development stages of students in the classroom.

3. Methodology

To assess the practical application of this situational teaching model, a study was designed to survey a total of 476 students from nine graduate and undergraduate civil engineering courses at California State University in Fresno. Surveys were done at the end of the semester. Measures were taken to make sure records are unique and independent to avoid duplication of responses.

3.1. Description of Survey

This study consisted of a questionnaire with two sections: lecture components and class assignments. The methods of instruction that fall under each section are outlined in Table 4. In the questionnaire, participants identified the most helpful and the least helpful methods of instruction for each section based on the 12 learning outcomes given in

Table 5. Each group represents a single style, as described in Table 1. A sample question may have asked students to identify the most helpful and least helpful lecture component (e.g., theory and concepts, problem-solving, class discussion, practical implementations, or others) to satisfy the ninth outcome of sharing ideas. The study also asked participants to provide general academic information and additional comments relevant to the survey. The purpose of these questions is to make sure that the sample is well distributed in respect to independent variables such as academic background, preparation for the course, progress in the course, and so on.

Table 4. Class components and assignments selected for analysis in the survey.

Lecture Components	Assignments
Teaching Theory and Concepts; Incorporation Problem-Solving Approach; Facilitating Class Discussions; Discussing Practical Implementations; and Others.	Required Readings; Homework Assignments; Quizzes; Exams; Class Projects; and Others

Table 5. Student learning outcomes selected for analysis in the survey.

Category	Outcome
1	Gain interest Provide specific information Direct and guide
2	Gain knowledge Explain decision-making process Persuade learning
3	Gain confidence Encourage performing Share ideas
4	Perform independently Fulfil objectives Take responsibility

3.2. Survey Respondents

Key information describing the characteristics of the respondent pool are provided in Table 6. A majority of students were seniors in the undergraduate engineering program. For most students, the current course fulfilled requirements for their major program. These results suggest a continued interest in the engineering field and prior completion of several engineering courses. The GPA distribution indicates that selected students came from a wide range of academic backgrounds.

Table 6. Summary of survey pool characteristics.

Year in School (College/University)	Number	Percentage
Sophomore (2nd year)	4	1%
Junior (3rd year)	42	9%
Senior (4th year)	399	84%
Graduate (Master or post-baccalaureate)	25	5%
Other	6	1%
Major Core (Required)	350	74%
Major Elective (Optional)	92	19%
Minor (Supplemental second discipline)	4	1%
Other	30	6%
2.0–2.49	34	7%
2.5–2.99	144	30%

Table 6. *Cont.*

Year in School (College/University)	Number	Percentage
3.0–3.49	173	36%
3.5+	101	21%
Other (unknown or not reported)	24	5%
Very Low	9	2%
Low	32	7%
Average	266	56%
High	139	29%
Very High	26	5%
Other	4	1%
Very Low	15	3%
Low	46	10%
Average	150	32%
High	196	41%
Very High	67	14%
Other	2	0%
CE 110: Computer Applications [1]	22	5%
CE 133: Design of Steel Structures [2]	190	40%
CE 136: Design of Wood structures [2]	90	19%
CE 137: Seismic Analysis of Buildings [2]	41	9%
CE 180: Senior Project [3]	69	14%
CE 185: Civil Engineering Practice [4]	38	8%
CE 191: Civil Engineering Entrepreneurship [4]	13	3%
CE 233: Advanced Design of Steel Structures [5]	6	1%
CE 291: Stability of Structures [5]	7	1%

[1] Lower-division core (first two years); [2] upper-division technical area course (last two years); [3] capstone (culminating project); [4] engineering practice (general); [5] graduate courses (master).

A list of the surveyed courses is also provided in Table 6. This paper's first author in the affiliated institute served as the instructor for all courses. Distributing the survey to courses taught by just one instructor ensured that teaching style was consistent across the courses, and that results were not affected by the use of different instructional methods. The courses still represent a range of academic levels, and the nature of courses, such as capstone project or engineering practice, is relatively broad.

Additional general academic information provided by survey participants is also displayed in Table 6. Based on background knowledge from prerequisites and individual interest in the subject, students stated that they were prepared for the current course. Most students claimed to have average or high preparedness. This suggests that students were already within the second stage of the situational teaching model, T2, which calls for high-task and high-relationship behavior.

Subsequent analysis will address differences in the alignment of assignments and lecture components to the situational teaching model as a function of academic level and cumulative GPA at the time of the survey (academic performance). Both variables are treated as categorical data, with levels as provided in Table 6.

4. Analysis

Analysis of the survey responses is carried out in two stages. The first stage of the analysis evaluates whether the survey tool can resolve meaningful differences between the categories of the situational teaching model, and provides aggregate recommendations for each category. In the second stage of the analysis, the specific instantiation of these categories is broken down according to academic standing (grade point average) and academic level, offering support for an extended situational teaching model.

4.1. Comparison between Model Categories

Questions in the survey asked students to identify the most (or least) helpful assignment (or lecture component) for achieving each of the outcomes listed in Table 5. In this first stage of analysis, responses were summed according to the corresponding situational teaching category. This provided a frequency distribution for the most and least helpful assignments and lecture components for each situational teaching model category (T1–T4).

The preferences for assignments and lecture components in different situational teaching categories were then compared. This comparison was accomplished by applying Pearson's Chi-square test of independence to the preferences for successive categories (e.g., T1 compared to T2, and T2 compared to T3). The null hypothesis in this test is that the two observed frequencies are independent. The size of the difference between group preferences is reported using Cramer's V effect size, φc. Prior to comparison, the data were assessed to ensure that all assumptions for a valid Chi-square test were met. Specifically, we tested those assumptions outlined by McHugh (2013) [22]. No assumptions were violated. Demonstrating and interpreting the differences between situational teaching categories in this way provides a means of checking whether the survey tool was capable of resolving differences between the categories.

4.2. Comparison of Model Categories across Groups

The first stage of analysis summed responses across all students. However, this stage sought to test the influence of several variables on the responses to the survey. These variables included academic standing (grade point average, or GPA, as measured on a four-point scale) and academic level. Although these variables are ordinal or continuous in nature, they were treated categorically in the survey, thereby resolving distinct student groups and facilitating consistent analysis. This treatment provided a situational teaching signature for each group of academic level and academic standing, describing the preference for assignments and lecture components across different situational teaching categories.

Differences between these situational teaching signatures were again quantified using Pearson's chi-square test of independence between adjacent categories and the size of the differences was reported using Cramer's V effect size, φc. Prior to comparison, the data were assessed to ensure that all assumptions for a valid Chi-square test were met [22]. The only assumption violated was that related to sample size (i.e., that the expected values for each cell in the table should be adequately large), which was only violated in academic level comparisons against the sophomore category. For that reason, comparisons against the sophomore category are not discussed in the subsequent sections.

Showing that the situational teaching signature varies with changes in academic standing would provide support for an extended situational teaching model by demonstrating that different assignment and lecture components are effective for different academic levels. Showing a general absence of differences with respect to academic standing would provide additional support for our methodology by demonstrating that a situational teaching signature is not dependent on academic standing.

5. Results Discussion

5.1. Comparison between Model Categories

The results of the questionnaire for class assignments are amassed respectively in Table 7 for the most helpful assignment and Table 8 for the least helpful assignment. These tables display the percentage of responses for the most helpful and the least helpful assignments, as listed in Table 4, with respect to learning outcomes, as listed in Table 5. The learning outcomes are grouped and sorted linearly from the top to the bottom of the tables based on their relation to the situational teaching model categories of T1, T2, T3, and T4. There are significant differences between the most helpful assignments for T1 and T2 ($\chi^2_4 = 16.0$, $p = 0.003$; φc = 0.08), T2 and T3 ($\chi^2_4 = 133.1$, $p < 0.001$; φc = 0.22), and T3 and T4 ($\chi^2_4 = 101.4$, $p < 0.001$; φc = 0.21). There are also significant differences between the least helpful assignments for T2 and T3 ($\chi^2_4 = 73.3$, $p < 0.001$; φc = 0.16), and T3 and T4

(χ^2_4 = 149.2, $p < 0.001$; φc = 0.25), but not between T1 and T2. These differences and trends are discussed in greater detail below.

Table 7. Average percentage of responses for the most helpful assignments (excluding blank, void, and other responses).

Response/Assignment	Required Readings	Homework	Quizzes	Exams	Class Projects
T1. Gain interest, provide specific information, direct and guide	27	36	6	4	16
T2. Gain knowledge, explain decision-making process, persuade learning	22	37	7	7	17
T3. Gain confidence, encourage performing, share ideas	10	33	15	9	24
T4. Perform independently, fulfil objectives, take responsibility	7	34	7	21	22

Table 8. Average percentage of responses for the least helpful assignments (excluding blank, void, and other responses).

Response/Assignment	Required Readings	Homework	Quizzes	Exams	Class Projects
T1. Gain interest, provide specific information, direct and guide	17	5	27	29	14
T2. Gain knowledge, explain decision-making process, persuade learning	19	6	28	25	12
T3. Gain confidence, encourage performing, share ideas	22	7	18	35	8
T4. Perform independently, fulfil objectives, take responsibility	35	6	24	14	9

Table 7 shows that homework assignments were identified as the most helpful tool for achieving all of the desired learning outcomes by almost one-third of students. Homework assignments are one of the instructional methods in the T2 style. Since most of the survey participants fall under the T2 development level, it follows that T2 instructional methods, such as homework assignments, would be appropriate tools for this group of students. Conversely, exams (midterm exams, since the surveys were conducted before the final exam) were identified as the least helpful tool for achieving desired learning outcomes by almost one-quarter of students. Exams are an instructional method for assessing students during the final T4 stage of the situational teaching model. Thus, they would be a mismatch for students who are still in the T2 level of development, such as those who participated in the survey. The percentage of students who identified exams as the most helpful tool for the outcome of taking responsibility for learning increased gradually from T1 to T4 styles, showing that this T4 instructional method becomes more appropriate as students advance through the stages of development. Similarly, the percentage of students who identified reading assignments as the most helpful learning tool decreased from T1 to T4 styles, showing that this T1 instructional method becomes less appropriate as students move through the stages of development. Percentage results for quizzes as the most helpful tools are like those for exams. These results, however, may be complicated by the different potential perceptions of quizzes. Some quizzes were distributed as in-class assignments, which would more likely be perceived as exams (T4), and others were take-home assignments, which would more likely be seen as homework (T2). A high percentage of students identified class projects as the most helpful tools for achieving desired learning outcomes. In the beginning of a course, these projects are similar to homework assignments, which are appropriate for T2 development levels. Towards the end of a course, class projects become comprehensive term projects, which are more appropriate for T4 development levels.

Student responses regarding the most and least helpful lecture components for achieving learning outcomes are amassed in Tables 9 and 10, respectively. These tables also include learning outcomes grouped and sorted linearly by their relation to the situational teaching model categories T1, T2, T3, and T4. There were significant differences between the most helpful lecture components for T2 and T3 ($\chi^2_3 = 133.6$, $p < 0.001$; $\varphi c = 0.22$), and T3, and T4 ($\chi^2_3 = 189.3$, $p < 0.001$; $\varphi c = 0.28$), but not between T1 and T2. Likewise, there were significant differences between the least helpful lecture components for T2 and T3 ($\chi^2_3 = 32.5$, $p < 0.001$; $\varphi c = 0.11$), and T3 and T4 ($\chi^2_3 = 85.2$, $p < 0.001$; $\varphi c = 0.19$), but not between T1 and T2. These differences and trends are discussed in greater detail below.

Table 9. Average percentage of responses for the most helpful lecture components (excluding blank, void, and other responses).

Response/Component	Theory and Concepts	Problem Solving	Class Discussions	Practical Implementations
T1. Gain interest, provide specific information, direct and guide	15	33	23	23
T2. Gain knowledge, explain decision-making process, persuade learning	18	31	22	23
T3. Gain confidence, encourage performing, share ideas	5	32	34	22
T4. Perform independently, fulfil objectives, take responsibility	7	47	9	28

Table 10. Average percentage of responses for the least helpful lecture components (excluding blank, void, and other responses).

Response/Assignment	Theory and Concepts	Problem Solving	Class Discussions	Practical Implementations
T1. Gain interest, provide specific information, direct and guide	37	16	20	16
T2. Gain knowledge, explain decision-making process, persuade learning	36	15	21	15
T3. Gain confidence, encourage performing, share ideas	45	16	16	12
T4. Perform independently, fulfil objectives, take responsibility	39	10	31	9

Problem-solving sessions were identified as the most helpful tool by almost one-third of students. This was an expected result, since problem-solving sessions are a T2 instructional method that would have been appropriate for the majority of T2 students in the surveyed sample. The expected trend from T1 to T4 styles evidenced in the results from the class assignments survey above did not seem to carry over to the results from the lecture components survey. The number of responses that identified class discussions as the least and most helpful tool were about equal across teaching styles. There were obvious preferences shown for instructional tools, which satisfies the T3 outcome of gaining confidence and the T4 outcome of fulfilling objectives. However, results were equally divided between class discussions and practical implementations for the learning tool, which satisfies the T1 outcome of gaining interest and the T2 outcome of persuading learning. This distribution of student preferences suggests the importance of using multiple instructional methods and channels of communication in the classroom to satisfy the development levels of all students. The percentage of students preferring practical implementations for gaining interest was over 20%. The objective of gaining interest falls under the T1 'guidance' style, whereas the instructional method of practical implementation falls under the T4 'delegating' style. In the typical situational teaching model, the T1 and T4 styles are expected to be a mismatch. In the extended model, however, the T4 stage prepares students for the T1 stage of the subsequent cycle. Thus, practical implementations might serve as learning tools that lead to increased student interest in further topics to be explored later in the class or in subsequent classes. As expected, the percentage of students who identified theoretical and conceptual components (part of the T1 style) as the most helpful learning tool decreased from T1 to T4; likewise, the percentage of students who identified these components as the least helpful learning tool increased from T1 to T4.

In general, little difference was observed between the preferences of outcomes corresponding to the T1 and T2 situational teaching categories, while large differences were almost always observed between T2 and T3, and T3 and T4. This may indicate that refinement of the outcomes used in the survey tool are necessary to resolve differences between lower categories of the situational teaching model, specifically those categorized by a high relevance of task-related behaviors.

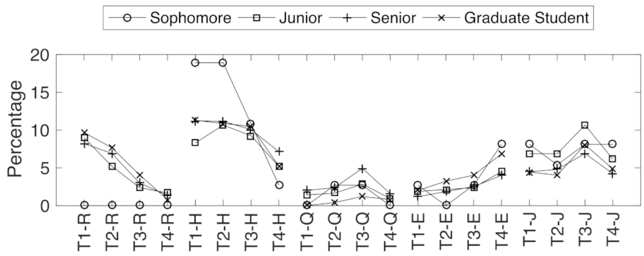
5.2. Comparison of Model Categories across Groups

The previous section demonstrated that the survey tools were largely capable of resolving differences between the different categories of the situational teaching model. This section examines the situational teaching signatures associated with different academic levels and academic standings. First, the variation in model categories across students at different academic levels is examined. Figure 3 compares the situational teaching signatures of sophomores, juniors, seniors, and graduate students in four subplots corresponding to the most helpful assignment, least helpful assignment, most helpful lecture component, and least helpful lecture component, respectively. Figure 3 shows results for the sophomore survey respondents, but this group was not used for comparisons because of the small sample size (n = 4) and violation of assumptions central to the Chi-square test.

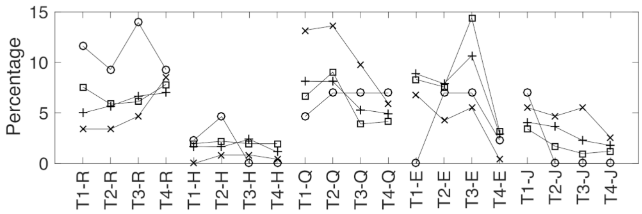
Figure 3a shows the situational teaching signatures for the most helpful assignment at different academic levels. There were significant differences between the situational teaching signatures of juniors and seniors ($\chi^2{}_{19}$ = 34.6, p = 0.016; φc = 0.09) and seniors and graduate students ($\chi^2{}_{19}$ = 31.3, p = 0.038; φc = 0.09). The most notable difference between juniors and seniors was that juniors generally saw projects as being more helpful than seniors did (across all situational teaching categories). Similarly, seniors saw exams as being more helpful than juniors did (across all situational teaching categories). In comparison to seniors, graduate students had a higher preference for exams (which increased substantially in T3 and T4), and a lower preference for quizzes. Figure 3b shows the situational teaching signatures for the least helpful assignment at different academic levels. There were significant differences between the situational teaching signatures of seniors and graduate students ($\chi^2{}_{19}$ = 64.12, p < 0.001; φc = 0.12), but not between juniors and seniors. The primary driver behind this difference was that graduate students dispreferred quizzes (especially for the T1 and T2 categories) and projects more than senior students did. Seniors tended to show more dispreference for homework and exams.

Figure 3c shows the situational teaching signatures for the most helpful lecture components at different academic levels. There were significant differences between the situational teaching signatures of juniors and seniors ($\chi^2{}_{15}$ = 31.2, p = 0.008; φc = 0.08) and seniors and graduate students ($\chi^2{}_{15}$ = 35.0, p = 0.002; φc = 0.09). The difference between juniors and seniors derived from the fact that seniors displayed a higher preference for problem-solving lectures (particularly the T3 and T4 outcomes) while juniors showed a higher preference for lectures based on practical considerations (with a higher preference the T1 and T2 outcomes). The difference between seniors and juniors seemed to be driven entirely by the fact that graduate students displayed a higher preference for problem-solving lectures (particularly the T3 and T4 outcomes).

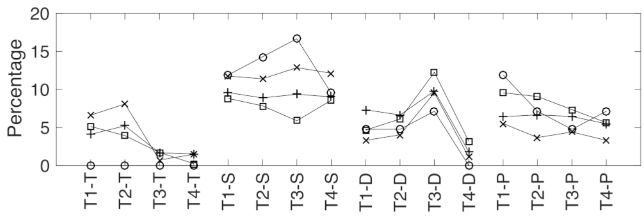
Figure 3d shows the situational teaching signatures for the least helpful lecture component at different academic levels. There were significant differences between the situational teaching signatures of seniors and graduate students ($\chi^2{}_{15}$ = 53.9, p < 0.001; φc = 0.11), but not between juniors and seniors. This difference was driven almost entirely by the fact that graduate students had a higher dispreference towards lectures on practical considerations, but this dispreference was highest for T1 and T2 outcomes. This may simply have been an indication that graduate students tend to be more interested in research and less in practical implementation. Yet, this still serves to vindicate the need for an extended situational teaching model to resolve such needs.



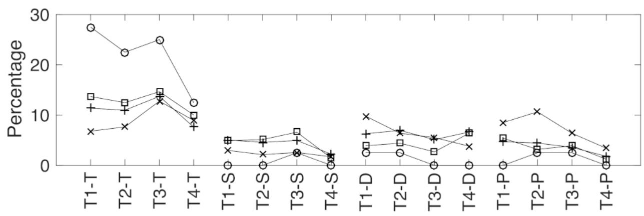
(**a**) Most helpful assignment



(**b**) Least helpful assignment



(**c**) Most helpful lecture component

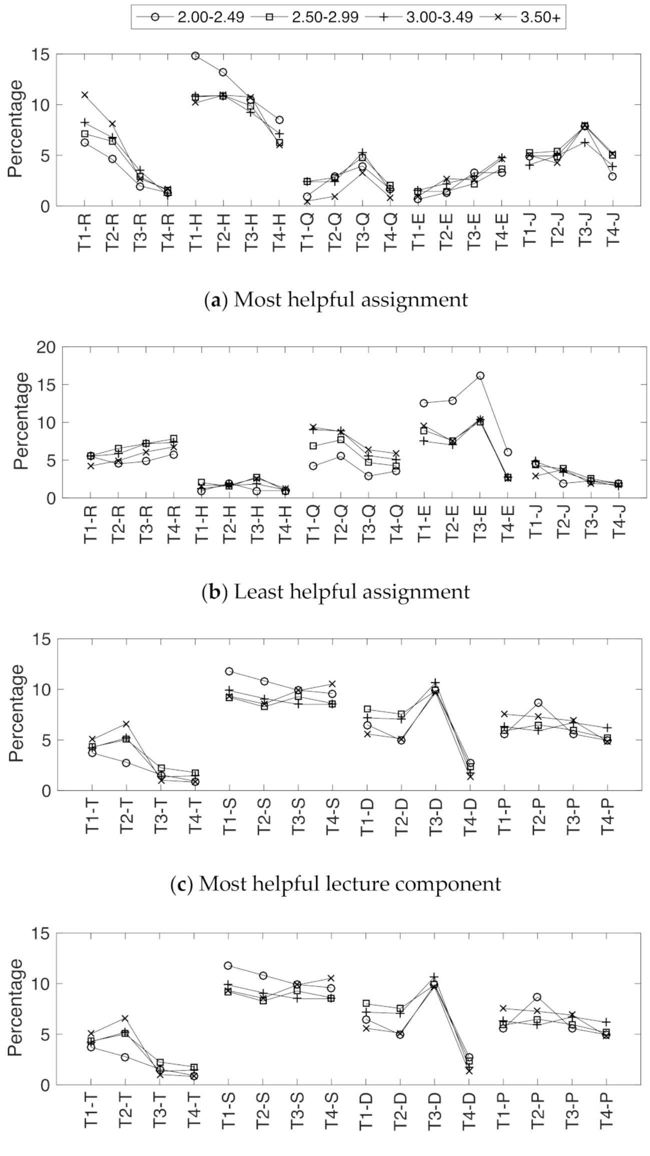


(**d**) Least helpful lecture component

Figure 3. Comparison of model category signatures for students at different academic levels. T1–T4 = situational teaching categories; R = readings; H = homework; Q = quizzes; E = exams; J = projects; T = theory; S = problem-solving; D = discussion; P = practical.

Next, the variation in model categories across students with different GPAs was examined. Figure 4 compares the situational teaching signatures of students in GPA groupings of 2.00–2.49, 2.50–2.99, 3.00–3.49, and 3.5+ in four subplots corresponding to the most helpful assignment, least helpful assignment, most helpful lecture component, and least helpful lecture component, respectively.

The situational teaching signatures were largely similar across different academic standings, with only three significant differences being identified between adjacent academic standing groups. The first showed a difference in the most helpful assignment (see Figure 4a) between the 3.00–3.49 and 3.5+ groups (χ^2_{19} = 51.0, p < 0.001; φc = 0.14). This difference was driven by the fact that students in the 3.5+ group tended to see readings as more helpful during early categories of the situational teaching model (T1 and T2) and did not see quizzes as less helpful than students in the 3.00–3.49 group. The second difference was in terms of the least helpful assignment (see Figure 4b), and was exhibited between the 2.00–2.49 and 2.50–2.99 groups (χ^2_{19} = 48.3, p < 0.001; φc = 0.17). This seems to have primarily reflected the fact that poor students (2.00–2.49 GPA) preferred exams less than students with higher academic standing. The final difference occurred in terms of the least helpful lecture component (see Figure 4c) between the 3.00-3.49 and 3.5+ groups (χ^2_{15} = 28.2, p = 0.021; φc = 0.10). In earlier situational learning categories, discussion was considered less helpful by students in the 3.5+ group, and problem-solving lectures were preferred in later categories.



(**a**) Most helpful assignment

(**b**) Least helpful assignment

(**c**) Most helpful lecture component

(**d**) Least helpful lecture component

Figure 4. Comparison of model category signatures for students in different GPA bins. T1–T4 = situational teaching categories; R = readings; H = homework; Q = quizzes; E = exams; J = projects; T = theory; S = problem-solving; D = discussion; P = practical.

Together, the trends observed across different academic levels and different academic standings offer insight regarding the situational teaching model and provide support for the extended situational teaching model. Specifically, the differences observed for different academic standings indicates that the extended situational teaching model is a necessary extension of the more common situational teaching model, where the T4 preferences facilitate preparation for the T1′ zone. While the situational teaching model has utility, it is not fully capable of resolving the nuanced differences that might occur as students progress through their academic career (evidenced by differences between situational teaching categories for different academic levels). Further, the analysis shows that the situational teaching categories are largely invariant with respect to academic standing. This indicates that it is not necessary for instructors to cater the delivery of the course to address students with different standings.

6. Discussion and Conclusions

This paper presents an overview of different teaching styles outlined in the proposed situational teaching model, which is based on a well-established situational leadership model. The methodology suggests preferred methods of instruction for each teaching style based on responses from a representative population of engineering students. The model emphasizes that relationship as well as task behaviors must be employed in the classroom, and various instructional methods and channels of communication should be used to best respond to different development levels of students. In this way, the classroom shifts to a student-oriented outlook of finding the best near-match styles to fit diverse levels of emotional and academic readiness. In early stages, this flexibility in teaching style serves to guide students, gain their interest, allow participation and open communication, as well as to foster mastery in knowledge and skills. In later stages, students are encouraged to assume responsibility for their own performance without direct support and assistance from an instructor.

This model provides a framework that can be used to develop appropriate course materials, instructional methods, and evaluation criteria for students. Early homework and reading assignments should be tailored to engage and coach students in basic theories and skills relevant to the subject. More open discussions and comprehensive projects should serve to support students, build their confidence, and allow them to apply knowledge learned. These projects also serve as important opportunities for students to develop critical thinking and writing skills. Quizzes and exams enhance competence in using judgment and solving problems, especially under pressure. In addition, human skills and emotional intelligence can be promoted in the later stages through collaboration and presentations.

Adapting and sequencing teaching styles in this manner allows students to develop, master, and apply their skills with greater confidence and success. Engineering students learn to recognize and define problems and then extrapolate causes and solutions based on theoretical and conceptual backgrounds. As students advance through the stages of the situational teaching model, they learn skills needed for subsequent stages and begin to take responsibility for their learning. Consistently applying this model in engineering courses will result in students who are thoroughly prepared and well-versed in the qualities of professional engineers. Hence, the outcomes of this paper are applicable to course and curriculum design, including delivery and assessment for diverse bodies of students with different maturity levels.

It should be noted that this works specifically focused on students in a single program (civil engineering) at only a single university. Thus, the results may not be widely generalizable to other universities or other engineering programs. However, the results of this paper do warrant further investigation on the application of extended situational teaching in engineering classrooms. The inclusion of classrooms across diverse engineering disciplines is the first step to recognize patterns in various fields. Further, quantitative surveys throughout academic levels will also help researchers to identify recursive applications for extended situational teaching in the mobilization of students from undergraduate to graduate levels. It would also be essential to measure the effectiveness of extended situational teaching in future direct and indirect assessments. Modification of the model would further facilitate broader analyses of parameters like the interactions between maturity of students and learning styles.

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