Novel Approach for Teaching Engineering Courses at a University Level

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Abstract: Managing and teaching a university course is more multifaceted than many may believe. Limited published data were found in the literature on the subject of education and management of university courses that suggest rules and even equations to aid junior instructors in developing course management plans. Approaches providing numerical equations can assist in weighing-up adequate time for college instructors to complete a variety tasks related to course management. This paper reveals helpful data on how to establish an effective course management plan by including vital mathematical methods to accurately calculate what could be considered “reasonable time permitted” for major tasks or exams. The proposed paper may be unique since it will present three different equations to assess a reasonable period for such tasks. The equations provided were based on class observation and on student academic performance as well as on the instructor’s ability and experience in assessing the degree of difficulties of a given assignment. These suggested equations will be validated using an experimental designed time monitoring study developed by the authors to evaluate the time taken by engineering students to write a major assignment. The equations will include a multiplier called “time factors” and will be set as a function of the complication level of an assignment. These suggested factors will have numerical values. In addition, it will systematically discuss the relationships between time management planning designed for teaching a course and its effects on risk, and quality planning for the same course. This paper was prepared to fill a gap in the literature regarding the application of equations to university course management plans.

Key-Words: - Education, Equations, Time Management, Quality Management, Risk Management

1 Introduction
In general, before the start of each semester, the majority of instructors are expected to be done with their course material preparation. However, they may not include supportive management plans for each of their courses. These plans can be enhanced by integrating a combination of time management, quality management, and risk management modalities. This paper will demonstrate training on qualitative research method plan with an emphasis on teaching an individual college course and its consequences on other mentioned aspects of course management planning.

2 Time Management Planning
Good instructors should have a profound knowledge of their discipline with teaching skills that include knowledge of the optimal ways to employ their time to accomplish teaching goals and maintain equilibrium between obligations, desires and objectives. Many papers published on the topic of time management and teaching present the practice of course charts to incorporate time-based information. Fung [2] introduced a mechanism to monitor the progress of students in terms of the time they spend on topics to avoid prolonged and unnecessary web browsing and thereby affecting the progress of the student's entire study plan (2001). The study introduced the use of management techniques into the context of study planning. A course advisory system was proposed to monitor the
study progress of a student including instructor alerts if necessary. Mecan [4] proposed and tested a process model of time management by analyzing data obtained from a variety of employees who completed several scales and supervisors who provided performance ratings. The examination of the path coefficients in the model suggested that engaging in some time management behaviors may have had beneficial effects by lessening tensions and raising job satisfaction.

Macan and Shahani [5] relate time management with academic performance through the stress levels of college students. The authors of the paper recommend identifying the in-scope and out-of-scope factors for a delivered course. Second, they recommend finding the easiest available reference book that preferably contained solved examples. Third, collecting regulations and policies developed by the institution. Fourth, obtaining recent university published manuals to know how to post lecture notes, tutorials and assignments. Finally, developing the course outlines where such data may be collected and broken down into organized smaller components. Their study concluded that participants who obtained higher scores on the time management behaviors component had higher academic performance levels and lower stress levels. They showed that stress levels were minor when students felt in control of their time. The role of time management in effective planning and setting of clear goals was shown to be interrelated with an increase in performance.

3 Mathematical Time Equations

Instructors face real challenges when they try to assess the time they should allow for students to do a major assignment or exam. Three equations for determining time to complete an exam question were examined. The first of these equations was derived from the three point estimate (PERT) [3]. The second equation was based on twenty five expert professors’ opinion that taught engineering courses for over 30 years. The third equation was calibrated by the authors of this paper based on observing student academic performance during the last 5 years of teaching and contains time safety factors. An experimental time checking study was used to validate the third equation. In this study, the authors developed a total of 9 short exams. Each exam was designed to be one single question. Three of the total 9 short exams were designed to be similar to the tutorials (easy question). The other three were similar to the assignments given to students (medium questions) while the last three questions were designed to be relatively not straight forward ones. These questions were given to engineering students enrolled in introduction to statics and in mechanics of materials courses. Tables 1, 2 and 3 lists the time taken by course instructor to solve the three types of short exam questions (easy, medium and hard) compared to the time taken by students to solve them. Based on the given data presented in the tables, it is clear that the coefficients suggested by the authors in equation number 3 agree well with those given in the Tables.

\[ T = \begin{cases} 0.03 (2.5 H_1 + 3.5 H_2) + \\ 0.11 (2 M_1 + 4 M_2) + 0.17 P \end{cases} \]  \( (1) \)

Where:

- \( T \): assignment time estimation
- \( H_1 \): input time by outstanding student
- \( H_2 \): input time by excellent student
- \( M_1 \): input time by good student
- \( M_2 \): input time by satisfactory student
- \( P \): input time by marginal student

\[ T = 2.5 T_{\text{inst}} \]  \( (2) \)

Where:

- \( T_{\text{inst}} \): time taken by instructor to solve exam question

\[ T = 1.2 T_e + 1.5 T_m + 2 T_d \]  \( (3) \)

Where:

- \( T_e \): time spent by instructor to solve easy question
- \( T_m \): time spent by instructor to solve medium question
- \( T_d \): time spent by instructor to solve difficult question
Table 1: Time Taken by Engineering Students to Solve Tutorial questions in Statics and mechanics of Materials Courses

<table>
<thead>
<tr>
<th># of Students</th>
<th>Time Taken By Student (min)</th>
<th>Pass or Fail</th>
<th>Time Diff. In %</th>
<th># of Students</th>
<th>Time Taken By Student (min)</th>
<th>Pass or Fail</th>
<th>Time Diff. In %</th>
<th># of Students</th>
<th>Time Taken By Student (min)</th>
<th>Pass or Fail</th>
<th>Time Diff. In %</th>
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<tbody>
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<td>4</td>
<td>37</td>
<td>P</td>
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<td>40</td>
<td>P</td>
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<td>14</td>
<td>41</td>
<td>P</td>
<td>-10.9</td>
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<td>39</td>
<td>P</td>
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<td>42</td>
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<td>P</td>
<td>-4.4</td>
<td>6</td>
<td>41</td>
<td>P</td>
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<td>43</td>
<td>P</td>
<td>-6.5</td>
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<tr>
<td>4</td>
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<td>P</td>
<td>-2.2</td>
<td>2</td>
<td>43</td>
<td>P</td>
<td>-6.5</td>
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<td>45</td>
<td>P</td>
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<tr>
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<td>46</td>
<td>P</td>
<td>0</td>
<td>2</td>
<td>45</td>
<td>P</td>
<td>-2.2</td>
<td>4</td>
<td>46</td>
<td>P</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 2: Time Taken by Engineering Students to Solve Assignment Questions in Statics and in Mechanics of Materials Courses

<table>
<thead>
<tr>
<th># of Students</th>
<th>Time Taken By Student (min)</th>
<th>Pass or Fail</th>
<th>Time Diff. In %</th>
<th># of Students</th>
<th>Time Taken By Student (min)</th>
<th>Pass or Fail</th>
<th>Time Diff. In %</th>
<th># of Students</th>
<th>Time Taken By Student (min)</th>
<th>Pass or Fail</th>
<th>Time Diff. In %</th>
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</thead>
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<td>P</td>
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<td>12</td>
<td>52</td>
<td>P</td>
<td>-3.7</td>
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<td>P</td>
<td>-1.9</td>
<td>3</td>
<td>54</td>
<td>P</td>
<td>0</td>
<td>3</td>
<td>55</td>
<td>P</td>
<td>1.8</td>
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<tr>
<td>4</td>
<td>55</td>
<td>P</td>
<td>1.9</td>
<td>1</td>
<td>56</td>
<td>P</td>
<td>3.7</td>
<td>3</td>
<td>57</td>
<td>P</td>
<td>5.5</td>
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Table 3: Time Taken by Engineering Students to Solve Smart Questions in Statics and Mechanics of Materials Courses (First time seen questions)

<table>
<thead>
<tr>
<th># of Students</th>
<th>Time Taken By Student (min)</th>
<th>Pass or Fail</th>
<th>Time Diff. in %</th>
<th># of Students</th>
<th>Time Taken By Student (min)</th>
<th>Pass or Fail</th>
<th>Time Diff. in %</th>
<th># of Students</th>
<th>Time Taken By Student (min)</th>
<th>Pass or Fail</th>
<th>Time Diff. in %</th>
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<tbody>
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<td>52</td>
<td>P</td>
<td>-13.3</td>
</tr>
<tr>
<td>10</td>
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<td>P</td>
<td>-6.7</td>
<td>10</td>
<td>53</td>
<td>P</td>
<td>-11.7</td>
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<td>55</td>
<td>P</td>
<td>-8.3</td>
</tr>
<tr>
<td>9</td>
<td>59</td>
<td>P</td>
<td>-1.7</td>
<td>8</td>
<td>57</td>
<td>P</td>
<td>-5</td>
<td>12</td>
<td>57</td>
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<td>-5</td>
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<tr>
<td>4</td>
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<td>P</td>
<td>0</td>
<td>3</td>
<td>61</td>
<td>P</td>
<td>1.7</td>
<td>5</td>
<td>60</td>
<td>P</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>F*</td>
<td>0</td>
<td>1</td>
<td>61</td>
<td>F*</td>
<td>1.6</td>
<td>1</td>
<td>61</td>
<td>F*</td>
<td>1.6</td>
</tr>
</tbody>
</table>

P: means pass, F: means Fail
*students frequently missing classes.

The authors of the article suggest using one of these three equations in the course planning process.

4 Quality Management Planning

Preparing a quality management plan for a college course is extremely helpful because it forces the instructor to understand more precisely what course material need to be covered and what students need to learn. Quality management plans often put the instructor in a position to ask questions related to quantifiable aspects of students actual learning. It makes instructors keenly aware of the benefits of consistently revising teaching materials and in particular taking into account the time schedule set for the course. Meng et al. [6], who analyzed the characteristics of curriculum and the latest developments in quality management and reliability, found that reforming teaching methods greatly improved content innovation and teaching practices and evaluation methods. The authors expanded the heuristic teaching mode with the integration of statistics, quality control, and reliability. The heuristic teaching mode also promoted students' innovative practice ability and practical talents in quality management.

Quixiang [9] presented a method for analyzing and prioritizing requirements from the perspective of employers. The authors took management courses as an example and used the quality factors development (QFD) methodology for identifying different teaching methods and evaluating their effectiveness in meeting employers' expectations. The results show that the most effective teaching methods are group work, case study, simulated teaching, internship and class discussion.

Akdere [7] explored the relationship between knowledge management and quality management. The paper discussed its applicability in human resource development for enhancing organizational capacity and capability in achieving performance excellence. The role of quality management in planning was shown to
be interrelated with innovation and improved teaching practices.

5 Risk Management Planning
Risk management planning for a course is an important tool to ensure that threats in most teaching situations are clearly addressed and strategies are in place to limit possible negative effects on the progress of a course. These threats may be treated as opportunities to create healthy class environments for students. Two examples from the authors’ experiences are related to teaching load and lack of student academic performance data. One risk in teaching may occur when instructors carry out a teaching load beyond four subjects in one semester due to departmental pressure. This may cause discomfort for the instructor as it will not provide him with the time and flexibility that may be needed later on to extend such things as lecture time due to a deficiency in the students’ knowledge that should have been addressed in prerequisite courses. Second, in the context of a college course, the absence of reliable data or records to assess students’ actual academic abilities may be considered a risk that will affect the course time schedule set by an instructor. Often, very useful glimpses of a student’s academic ability can be gleaned from assessments given at the outset of a course, however, it is altogether a different matter to have information before hand and to fashion instruction prior to a course. This situation can be viewed as a risk in that there is a lost opportunity to connect understanding and learning for both faculty and students prior to active instruction. Since these conditions are generally overlooked or ignored, understanding on student and faculty ends may be fraught with more assumptions than clarity. The level of academic cooperation, coordination, and follow-up needed to make an “academic follow up system” function would make such a prospect seem unfathomable for many academic institutions.

Sullivan [8] presented the detailed experience of a professor and students in using the Second Life multi-user virtual environment (MUVE). The paper highlighted the specific teaching and learning issues that arose as a result of using the technology. Through an examination of the data, the assumptions were identified by the authors based on personal interest and epistemological commitments, which led to problems in introducing the technology in the course. The problems that appeared were addressed through revising the syllabus to create scaffolds for student learning with the Second Life environment. The authors also addressed the implications of the study regarding the impact of student expectations and the trajectory of the use of a technology.

Dark [1] assessed student performance in an information security risk assessment, service learning course. The study presented a brief overview of the information security risk assessment course as background information and a review of relevant educational assessment theory with a focus on outcomes assessment. In his study he described an example of how performance assessment theory was applied to a service learning course. The role of risk management in planning was shown to be interrelated with a greater awareness of the complexity of the teaching situation.

6 Application
The purpose of this section is to give a detailed possible approach to the practical application of the aforementioned modalities to a college course. After the instructor breaks down the work to be done by students in the course the instructor will track the associated dependencies. From these dependencies, the instructor can draw a Gantt chart and initial deadlines for his course. As a consequence, a critical path will be calculated and used to find the exact contingency. This will enable the instructor to know with certainty the expected time needed to deliver his course. The earned value of the actual teaching hours (time effort) will be calculated and the planned value will be extracted from the developed schedule. The scheduled variance will then be estimated. The schedule variance is used as an indicator of whether or not the instructor is under or ahead of schedule. A schedule index is also calculated by dividing the earned value by the planned value as per instructor plans to see if it is greater, less or equal to one (1). If the value obtained is greater than one, this will indicate that the instructor is ahead and if it is less than one, indicates the instructor is behind schedule.
7 Outcomes
Applying the outlined procedure may yield useful data for instructors. Course activities and a time schedule will be estimated which will allow for a more complete schedule to be developed. The approach will yield dates, allow milestones to be set, and clarify resource allocation needs along with calculations of work periods needed to complete each identified activity. Identifying the critical path (the longest period to complete teaching the course) helps to calculate the variance by summing up all activity variances on the calculated critical path. This data can be obtained by using the three point time estimate method. This value will help instructors to assess exactly the contingency needed to deliver his course on time with no delay taking into account the unseen situations and will also leave him enough time to take care of the other management plans designed for the course as discussed earlier in the paper.

8 Limitations
The authors recognize two limitations of the approach. First, further analysis and elaborations of the modalities of time management, risk management, and quality management would continue to clarify their applicability to course management planning. Second, the relation of mathematical formulae to particular components of specific modalities could possibly yield diversified applications, particularly links to the integration of technology.

9 Conclusion
The authors of this paper posit that using the suggested components as a cohesive analytical tool and analyzing the basic steps along each milestone of a college course, namely, midterms, major assignments and finals may yield data that is useful for the management of a university course.

10 Acknowledgment
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References:


