ABSTRACT

Project Management lesson learned reports are a valuable industry tool needed to capture the essence of the skills and techniques to be repeated or avoided in the future. In the classroom, we used the SIMPROJECT simulation to engage students in real world situations and experiences to aid them in internalizing the concepts of managing time, cost, quality, and stakeholder communication in orchestrating a successful project. A qualitative analysis of student lesson learned reports suggests that students internalize important concepts and begin the process of integrating these concepts together to strengthen their critical thinking skills.

KEYWORDS: Project Management, Critical Thinking, SIMPROJECT, Lessons Learned, and Qualitative Analysis

INTRODUCTION

Successful project organizations often require lessons learned or postmortem evaluations of successful and less than successful projects to capture the essence of the attributes, skills and techniques to be repeated or avoided in the future. Often these organizational evaluations turn negative hindering the learning process and building a culture that avoids mention of negative experiences. This is not what we want. Project team members should be able to evaluate a full range of project experiences using positive principles as well as learning that anticipating a positive outcome leads to positive actions (Baaz et al. 2010). Lessons learned are part of a learning experience that seeks to avoid adverse results that occurred in the past in the hope that they can be avoided in the future. It is also hoped that the attributes, skills, and attributes of successful project teams can be codified and adopted by newly formed project teams (Greer 2008). Students learning project management or about project management for the first time are often overwhelmed by the complexity and laser focus project managers have on time, cost, quality, and stakeholder value. Students reflecting upon experiences in completing a SIMPROJECT simulation using a lesson learned format encourages a self-reflective review of individual performance, develops a culture of shared student experiences and could be useful in furthering student understanding of how project management really works.

Learning positive lessons from past projects and actually implementing the learning from these projects is commonly acknowledged as difficult to achieve (Fuller et al. 2011). This need not be so. The aviation industry has been able to adopt learning and adaptation support systems that transformed internal processes, established an organizational memory, and altered employee mindsets (Pourdehnad et al. 2012). In a similar manner, being able to alter project management student mindsets is an important part of any project management course. To what extent we actually alter student mindsets would be useful knowledge to project management instructors to confirm student understanding of key concepts, weak areas that need emphasis, and how well students are integrating course knowledge into their overall
understanding of how project management works. A lesson learned report from each student at the end of a SIMPROJECT simulation can be a valuable student learning exercise that encourages reflection and internalization of course knowledge. Likewise, a qualitative analysis from existing lesson learned reports would allow project management instructors to externally validate student learning and Assurance of Learning (AoL) objectives. Thus, this study sought to discover those project management concepts being retained by project management students and which were not to better access student learning in order to benefit future students and indirectly evaluate faculty instruction.

The next sections will discuss the importance of lessons learned, methodology, and the text analysis technique. Results will be presented, follow-on data collection discussed, and conclusions presented.

LITERATURE REVIEW

A lesson learned is the knowledge acquired from an innovation or an adverse experience that causes a worker or an organization to improve processes, activities, safety, efficiency, effectiveness, or quality. The Project Management Institute Body of Knowledge (PIMBOK) defines Lessons Learned as the “The learning gained from the process of performing the project. Lessons learned may be identified at any point. Also considered a project record, to be included in the lessons learned knowledge base.” More narrowly defined, “lessons learned are one set of important project outputs delivered at the end of the project quotation (Jugdev 2012).” Lessons learned seeks to identify recurring events and apply some metric that measures whether positive changes are being achieved. Ultimately, we would like lessons learned to be applied, shared and distributed across the organization. In this case, we would like to confirm that our students identify both innovative experiences and adverse experiences and apply what they learned to the next simulation or the next real world project they encounter.

Baaz et al., (2010) lists 19 organizational and personal barriers to collecting post-mortem evaluations that students might use to understand lessons learned. Of these barriers, no culture for inter-project learning, lack of time for reflection, blindness toward own work practices, situated knowledge, tacit knowledge, lack of awareness, and lack of procedure seem particularly important to students participating in a project management simulations and writing a lessons learned report. No culture for inter-project learning is about the importance of learning from each other. Lack of time for reflection suggests students will need time to elaborate and explain their experiences. Blindness toward own work practices advocates students needing to identify excellence and challenges as well as realizing they are doing a good job. Situated knowledge requires students to analyze cause and effect and gives them the opportunity to see the next step. Tacit knowledge proposes a process where students can elaborate on each lesson learned and the ability to group lessons learned together. Lack of awareness is about creating an assignment (i.e. the SIMPROJECT simulation discussed below) where students see the completion or ending of a project. And, lack of procedures is the necessity for students to appreciate the importance of using a structured way of identifying both challenges and excellences.

It is generally acknowledged that it is important to produce business students with strong writing skills but it can be difficult to implement assignments within technically focused courses (Bealing 2014). In this context, students can improve their writing skills in generating lessons learned reports in a natural way consistent with typical organizational expectations following the completion of a project. In general, lessons learned should be written in a short concise format,
have a context, and tell a story. No flowery language. The reader should feel there is something to know and something they should want to know. The writing style must not be overly theatrical, use unknown acronyms, or use a lot of technical jargon. The writing tone should be conversational and down-to-earth. The emphasis on explaining the cause-and-effect of what occurred and not poking holes in some methodology. In the end, we want a product that reflects the growth and evolution of the collective experiences of the individual student and that follows the flow of the course.

THE SIMPROJECT SIMULATION

Hands-on projects have been shown to be effective in producing project management students with employable skills (Pollard 2012). SIMPROJECT is a project management software simulation program (https://www.simprojectonline.com). Instructors may select any of three simulations: IT communication, New House Construction, or New Product Development. Each simulation comes with a unique Work Breakdown Structure (WBS), a specific budget, and a group of resources that must be assigned to specific tasks within the WBS. Students implement a project plan that predicts the timing and cost of projected milestones using MS Excel and MS Project templates. As the simulation progresses, students are given specific feedback about the effectiveness and efficiency of their decisions. Students also complete preliminary exercises that help them identify and predict effectiveness and efficiency of project resources.

Effectiveness within SIMPROJECT is the concept of assigning the correct resource to the correct task. A resource is an avatar with a specific job description and individual character attributes. Efficiency in SIMPROJECT is used to predict the individual performance of a resource (person) based on these individual characteristics. Efficiency is a measure of how well the assigned avatar is able to perform the assigned task within the simulation. Students must consider assigning different resources (i.e. different people with different job descriptions and individual capabilities) to different tasks and consider the implications of time and cost over the entire project as opposed to a linear assignment of resources by individual milestone. Students often struggle with task descriptions that can be vague or less than ideal reflecting the known knowns, known unknowns, and the unknown unknowns of the project management planning process.

Once a plan has been developed and submitted to the instructor, students enter their choices into the simulation. The simulation resides on a server. Students do not need to be in the classroom to use the simulation allowing it to be used in online classes as well. Students systematically make decisions for 12 decision periods. Each decision period is equal to a project milestone. Students compete against each other across four dimensions: time, cost, functionality (quality), and stakeholder value. Students can see how they perform in relation to other students and their own plan. The computer simulation calculates a number of idealized findings that compares the student input to the optimum result calculated by the simulation based on a derived optimum solution and with comparisons from other student results. Students can then compare their input with their results and see the impact of their decisions. This allows the student to modify their plan for future milestone decisions based on real-time information. The realism of the simulation helps students understand the importance of planning for the entire project rather than a hit or miss approach employed by many failed projects. It is in this context that students record both the positive and adverse experiences they encounter.
At the end of each simulation, students prepare a lessons learned document. Each lessons learned document should be no more than two pages, double spaced, and use a number 12 font. Students are asked to focus on those things they perceived as doing well and those things they would like to improve upon (adverse experiences). Students are instructed to reflect on the causes and effects of their decisions, the need for a structured approach to planning, and the need to reflect, learn from, and document their experiences as a project manager within the simulation. These documents are submitted electronically for evaluation, grading and data collection.

QDA MINER 4 AND WORDSTAT 6

This study used WordStat 6 to conduct a content analysis of graduate student lesson learned reports after completing a SIMPROJECT simulation. Inductive content analysis is based in grounded theory and has been used to understand e-mail discussion groups, Listservs, Air Quality Checklists (Hackbarth et al. 2009), and other archived textual information. WordStat is a text analysis module with QDA Miner4. WordStat 6 reads and understands text by analyzing the inter-relationship among words and phrases in the text. There is no pre-coding of text nor is it necessary for the analyst to pre-determine any categories in advance. WordStat allows categories to surface from the data by allowing the text form the lessons learned documents to formalize into meaningful conceptual groupings. The most fundamental outputs of the program are keyword co-occurrence matrixes and Dendograms (cluster analysis) which show the pattern of relationships between key words or phrases and further identifies clusters of key symbols (concepts) (Hackbarth et al. 2009).

Like other qualitative analysis software programs WordStat 6 can also provide a variety of global statistics. These statistics provided no meaningful insight into data from past studies and thus, for this study as well, we can be satisfied with a straightforward analysis presenting frequency tables and dendograms (Colfer et al. 2001). While the program is not particularly difficult to use, some thought, preparation, and bookkeeping skills are needed to make sense of the data. Table 1 summaries the process needed to create, correct, and organize a WordStat 6 text file (Hackbarth et al. 2009).

METHODS AND DATA COLLECTION

Eighty three unique lessons learned reports were collected from graduate students attending a core introductory graduate level project management course at a Regional Midwest University using SIMPROJECT as is a software tool to better understand project management methodologies. Once collected, these reports were organized and imported in WordStat 6. All reports were analyzed as a single collective document. The intent is to understand the collective results first and then recode the documents into meaningful classifications for a deeper understanding of student learning and for eventual submission to a peer reviewed journal inclusive of additional analyzed data.

Table 1 suggests an organized process to gather, organize, format, and then analyze the lessons learned qualitative data in the WordStat 6 program. While the program can automate many of these steps, it is important to understand how the data might altered intentionally or unintentionally, and what steps the author might take to better structure the raw data to improve the understanding and interpretation of results.
Several students took advantage of the open format to use bullet points instead of a more
detailed explanation. In addition, students tended to use imprecise wording and make
assumptions as to what he reader might or might not know. In the future, students will be given
a more structured format with additional expectations regarding grammar, complete sentences,
and the thoughtful integration of concepts reflecting critical thought of the project management
planning process and the workings of the simulation.

<table>
<thead>
<tr>
<th>Step One</th>
<th>Gather lessons learned data.</th>
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<tbody>
<tr>
<td>Step Two</td>
<td>Consolidate data into individual file or group files for later coding. Conduct initial analysis including word frequency, key word grouping, phrases, and relationships. Check for spelling errors.</td>
</tr>
<tr>
<td>Step Three</td>
<td>It is also important to consider lemmatization. This is the process of taking individual words and replacing them with another word form or with a sequence of words. This is a procedure by which all plurals are transformed into singular forms and past tense verbs are replaced with present tense verbs.</td>
</tr>
<tr>
<td>Step Four</td>
<td>Create an exclude file that eliminates unnecessary and redundant words. Words are systematically eliminated one at a time until a file remains that can be interpreted clearly. Most excluded words are direct or indirect articles, such as a, an, and, the, as well as conjunctions, and, or, or other common words. We also excluded vague or meaningless words within the context of the documents. Excluding words is an interactive process requiring words to be excluded in differing orders to assure a consistent result.</td>
</tr>
<tr>
<td>Step Five</td>
<td>Re-run data and update exclude files until a meaningful interpretation of the data emerges. Create Dendograms and 2D/3D multidimensional analysis diagrams.</td>
</tr>
</tbody>
</table>

RESULTS

Table 2 reflects key phrases from the documents. WordStat 6 selects repeated phrases based
frequency. One must also recognize that the lemmatization procedure (Table 1, Step 3) alters
words but not their overall meaning or relationships with other words. For instance, “lesson
learn” as opposed to “lessons learned” is used 143 times reflecting the instructors’ emphasis on
the importance of the assignment. It is telling that the most important phrases reflect key
learning points from the course. For instance, students were asked to focus on building a core
team, using MS Project to manage the time elements of the project, considering the critical path
of the entire project, and having an executable plan to measure their results against the
calculated results of the computer simulation. The phrase “Unallocated Resource” reflects a
common problem students have with the simulation in that students often do not assign a
resource to a task either because they are not effectively tracking resources or where they are
assigned; or they keep resources in reserve for assignment to a future task not understanding
that the unallocated resource is still collecting a salary and is not working. Thus, they find a
sizable chunk of money deleted from their budget, with no direct benefit to the project in that the
resource is not working on a task, for no other reason than they failed to assign a resource to a
job.

From an instructor point of view, typical areas of student difficulty emerge and reflect the
importance of the lessons learned assignment in having the student reflect on what could be
done better in future projects. Many students mention specific resources (avatars) like the
project manager, system analyst, and hardware manager. These specific resources come from the New Product Development simulation and reflect student confusion on how best to assign hard to fit resources. The Hardware Analyst can only be assigned to specific tasks without incurring time and cost penalties because they were assigned to a task they were unsuited for that resulted in the task taking far longer than it should along with the increased cost of a resource working a task longer. The system analyst can do the project manager job almost as well as the project manager but at a much lower cost. Students must learn to do multiple time/cost analyses to understand that tasks can be completed for much lower costs without significantly affecting the timeline. Alternatively, some tasks must be done by the project manager or the critical path is altered in a negative way even though the project manager works at a higher cost. The nature of the simulation makes it impossible to assign the ideal resource to every task. Students must often make sub-optimal choices resulting in a longer task time and a higher cost or vice versa. Students would often select a lower cost resource to reduce the cost of the overall project but then find the overall time of the entire project greatly lengthened. In general, this reflects the inability or lack of interest of some students in developing multiple plans that attempt to compare and contrast different avatar assignment possibilities.

As part of the planning process, students must develop a low cost plan, a shortest time plan, and a realistic plan prior to beginning the simulation. Ultimately, students discover that early good decisions make for a successful project. Whereas, lack of effective early planning results in poor early decisions that follow the student through the rest of the simulation. It was hoped that students would reflect upon “attention to detail” as an important concept as opposed to specific planning failures.

It was surprise to not see mention of MS Excel. Tracking the cost of assigned resources is an important part of planning for the simulation and controlling the simulation and seems to have been over-looked by the students. Students seem to focus on reducing project costs but not understanding the trade-off between time and project costs. The longer a project takes, the more it can cost. They try to optimally assign resources to reduce costs but fail to realize that there is an importance in getting projects done quickly and in fact, the simulation penalizes the participants for assigning resources in a way that does not balance time and cost. Further, the simulation also requires participants to consider the functionality (quality) of the finished project. The key words and phrases do not indicate if students had difficulty achieving the desired project objectives and were the project stakeholder’s satisfied with how the project was being managed.

### Table 2: Key Phrases

<table>
<thead>
<tr>
<th>KEY PHRASES</th>
<th>FREQ</th>
<th>KEY PHRASES</th>
<th>FREQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>LESSON LEARN</td>
<td>143</td>
<td>LOW COST PLAN</td>
<td>25</td>
</tr>
<tr>
<td>PROJECT MANAGER</td>
<td>114</td>
<td>EFFECTIVENESS AND EFFICIENCY</td>
<td>24</td>
</tr>
<tr>
<td>INFORMATION TECHNOLOGY</td>
<td>97</td>
<td>SYSTEM SOFTWARE ENGINEER</td>
<td>22</td>
</tr>
<tr>
<td>PROJECT MANAGEMENT</td>
<td>93</td>
<td>MANAGER ACTION</td>
<td>22</td>
</tr>
<tr>
<td>UNALLOCATED RESOURCE</td>
<td>87</td>
<td>EFFECTIVE RESOURCE</td>
<td>22</td>
</tr>
<tr>
<td>LOW COST</td>
<td>72</td>
<td>ENTIRE PROJECT</td>
<td>22</td>
</tr>
<tr>
<td>CORE TEAM</td>
<td>55</td>
<td>PERIOD TASK</td>
<td>22</td>
</tr>
<tr>
<td>CRITICAL PATH</td>
<td>54</td>
<td>EXPENSIVE RESOURCE</td>
<td>21</td>
</tr>
</tbody>
</table>
Figure 1 reflects a 2D map of key word phrases clustered by their proximity to each within the text. Group numbers were assigned to specific groupings and the underlying concept identified. These groupings should reflect the broader concepts being taught to the students and perhaps imply some sense of integration of the necessary skill sets need to effectively manage a project. They hopefully imply student take-a-ways that reflect the emphasis the instructor placed on particular concepts and the agreement by the student that this concept was important enough to be a take-a-away.

Group 1 might be called “real-world planning”. Students discovered that early and effective planning result in lower costs and shorter project times. It also includes the idea that the plan includes all tasks throughout the life of the project. Many students only plan the first few steps of a project figuring that once they see how it goes, they can make better decisions. What they find out is that they inadvertently made a trade-off by choosing a particular course of action that has adverse future effects that might have been avoided had they planned better. Or they find out that spending time up front to plan saves management time in the future. They end up spending time trying to figure solutions to problems that could have anticipated with a lot less work.

Group 2 reflects the importance of determining the critical path and assigning effective and efficient resources as part of a project plan. We might name Group 2 “early planning”. As students assign resources to tasks, they can use a Gantt chart to identify the critical path and see how the critical path changes as resources are added or reassigned. They can couple this with and MS Excel spreadsheet to monitor changes in project costs. Group 3 can be named “resource allocation”. Students seem to struggle with making trade-off decisions between high cost/highly effective resources that can greatly shorten task times on key tasks found on the critical path with it being unnecessary to assign high cost/highly effective resources on tasks not on the critical path.
Group 4 is named “core team”. It is well established that a core team is more effective in delivering a project on time, on cost, with the expected functionality. Teams that are disrupted or poorly conceived tend to deliver project failures more often. Students seem to have taken to heart the importance of a core team remaining on a project from start to finish. Group 5 is about “MS Project”. Students have an expectation of learning MS Project in a project management class. MS Project is also used to plan task times, manage the critical path through the Gantt chart, and track milestone completion. Students are expected to use both MS EXCEL and MS Project to plan and manage their SIMPROJECT simulation.

Figure 1: Clustered Key Phrases

Group 6 is named “just-in-time resources”. One of the rules in SIMPROJECT is that resources hired in one period cannot be used until the next period. Students fail to realize that hiring a resource in the real-world takes time. You cannot just go to a street corner and higher a system software engineer or a hardware analyst. Because of their failure to anticipate future resource requirements, they end up assigning the wrong resource to a task simply because no other resource is available. Thus, they incur additional time and cost penalties.

Group 7 is named “team member” and is closely associated with core team. The core team must be managed in how it is assigned to different tasks throughout the project simulation. You may have a core team, but the core team is often augmented with temporary resources for the accomplishment of specific project tasks. Effective early planning using the core team concept
simplifies the planning effort and makes it easier to anticipate the effects of different personnel assignment decisions on total project time and cost.

**DISCUSSION AND CONCLUSIONS**

It is clear that students are grasping the importance of early planning. The difficulty seems to be convincing the students that the time they spend planning saves time in the wrong run. Project management is about disciplined management and effective control of resources. There must be trade-offs in project planning. You cannot be low cost, shortest time, and deliver a highly functional product or service. You must give in somewhere. Shortening the project time requires better resources (people). Better people give you better functionality but better people also cost the project more money. You might be able to complete a project with good functionality with less able resources but at the expense of a longer project time. Students seem to grasp this concept intellectually but seem less willing to operationalize the concept using MS Project and MS Excel to determine the implied trade-offs.

It is expected that students would focus on time and cost and the impact of resource efficiency and effectiveness on their plans. From an instructor viewpoint, the lack of not mentioning Functionality and Stake Holder Value as key components of the planning process is cause for concern. Students are evaluated by SIMPROJECT Cost (30%), Time (30%), Functionality (20%), and Stake Holder Value (20%) to create a standardized measure to compare one student to another as they progress through the simulation. Students are aware of these measures and compete for the highest ranking but they often fail to plan or compensate for functionality and stake holder value. They fail to effectively utilize the available software tools to arrive at a balanced approach to decision making. They see cause and effect for immediate decisions but for many, SIMPROJECT is their first exposure to long-term decision making. It is like a Grand Master Chess player seeing twenty moves ahead with all of the variations and possible consequences. Exposing students to SIMPROJECT is like playing checkers and then moving on to chess. Or you have been playing chess with 4 pieces and now you have 8.

Advanced concepts like improving project quality and increased stakeholder value at the expense of project time and cost may be new ideas in an introductory project management course. It may be that until a student can grasp the more fundamental and basic concept of time and cost planning, instructors may delay introducing functionality and stakeholder value.

Future improvements in the study would develop a more comprehensive lessons learned format that would do a better job of guiding students toward key learning points. The current lessons learned format, other than length, was left to the students. They were required to have a minimum of three lessons learned they hoped to build upon in the next simulation and three concerns they wanted to work on. The open format sought to discover what key points students focused on as opposed to what the instructor was focused on.

More analysis is needed to resolve differences between those ideas found to be important to students as opposed to the instructor. For instance, the instructor spent class time emphasizing the impact of time and cost on the functionality aspects of project planning. It may be that students do understand what we mean by functionally (quality) and what it takes to deliver a high quality product or service. Students understand the importance of communicating effectively but fail to understand that communication failures results in higher costs and longer project times. Soft skills are important as we all know but assigning a cost and time seems a difficult concept.
Courses often require (Assurance of Learning AoL) measures to confirm students are meeting the established learning objectives. A qualitative analysis of carefully designed assignments, such as a lessons learned assignment, would provide instructor feedback that the students are grasping and internalized key concepts. Further, this feedback could be used as justification for tenure, post tenure, accreditation, and teaching awards. It also has the advantage of getting students to reflect and communicate effectively in writing.

REFERENCES


