

Team-Based Peer Review as a Form of Formative Assessment - The Case of a Systems Analysis and Design Workshop

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ABSTRACT

The present study was carried out within a systems analysis and design workshop. In addition to the standard analysis and design tasks, this workshop included practices designed to enhance student capabilities related to non-technical knowledge areas, such as critical thinking, interpersonal and team skills, and business understanding. Each task was reviewed and assessed by both the students and the instructor. The main research study objective was to examine the effect of team-based peer-review on the students' learning process in an information systems workshop, What is presented is data referring to the grading process, to students' enhanced learning reflected in the narrowing gap between the instructor's and the students' grading, as well as the students' reflections demonstrating their perception of the workshop's components.

Keywords: peer review, team-based peer review, formative assessment, SOLO taxonomy, systems analysis and design.

1. INTRODUCTION

Software based systems manage and control many aspects of the daily activities of modern society. Management Information Systems (MIS) not only offer organizations tools for better management, but have become business boosting infrastructures (Laudon and Laudon, 2005; Bocij et al., 2005). The systems analysis and design workshop is a significant component of the Management Information Systems (MIS) curricula, and in addition to *learning the ordinary analysis and design themes*, it aims, to provide students with non-technical knowledge areas, such as critical thinking, inter-personal skills, team skills, and business understanding. The workshop served as a framework within which students could demonstrate and augment their understanding of the ways technology usage can develop new organizational processes and achieving organizational goals.

Bearing in mind student difficulties regarding these non-technical knowledge areas, the workshop structure employed many team-based activities and assignments. In addition to the ordinary technical assignments, such as planning, analyzing, and designing the project, the students were engaged in reviewing and evaluating their fellow students' projects. We term this form of evaluation 'team-based peer review' (TBPR), a type of formative assessment. As in the ordinary software development life cycle, the workshop assignments' complexity level rose incrementally,

along with the cognitive skills needed to successfully accomplish them. Hence the workshop stages followed the SOLO (Structure of the Observed Learning Outcomes) taxonomy (Biggs and Collis, 1982) and elevated students' overall understanding of the processes to a higher level of abstraction. This paper describes the workshop structure and the encouraging results that were obtained.

2. CONTEXTUAL FRAMEWORK

Aware of the crucial role assessment plays in higher education's overall quality of teaching and learning, different variations of evaluation processes have been developed over the years. A well-designed assessment sets clear expectations, establishes a reasonable workload, and provides opportunities for students to self-monitor, rehearse, practice, and receive feedback. Formative assessment is among the different variations of evaluation processes. For MIS graduates who are required demonstrate their proficiency in technology-enabled business development, assessment and peer review are important cornerstones in the MIS curriculum (Gorgone et al., 2002).

In our MIS program, students working toward their B.A. degrees are required to participate in certain courses that are not traditional lecture-based classes. In these courses students have to take full responsibility for both their own learning processes and for teaching a certain topic to their classmates. Many researchers recognize the benefits and the

importance of using Formative Assessment (FA) during the learning process (Wiggins and McTighe, 2000; William and Thompson, 2007; Saphier, 2005). Aware of these advantages, we asked students to take an active part in the assessment process. At this stage of their studies, students were already familiar with the technical aspects (Unified Modeling Language (UML) notation) of information systems engineering. The main objectives of the workshop were to provide knowledge, tools, and expertise in the various components of systems development. In addition to understanding systems life-cycle methods and models, the workshop strengthened the systems analyst non-technical qualifications. The workshop structure was based on incremental assignments (with increased complexity levels) that followed the software development life-cycle. By incremental complexity we mean an increase in the level of abstraction needed to properly complete the assignment.

Each assignment was reviewed and assessed by both the students and the instructor. The assessment and grading templates were provided for the students and were discussed in class. During the first stage, each team member was asked to evaluate the assignment of the other group and during the second stage each team had to reach an acceptable common evaluation. It should be stressed that the students were graded not only for their assignments, but also for their assessments, since the main research study objective was to examine the effect of employing TBPR in a computer science and information systems workshop on students' learning processes.

3. THEORETICAL BACKGROUND

In this section, we present a brief theoretical background concerning assessment methods in higher education, specifically in regards to formative assessment and the advantages of peer review. In addition, we briefly present the SOLO (Structure of the Observed Learning Outcomes) taxonomy which relates to the various stages of higher-order learning. The SOLO taxonomy provides a theoretical framework in which to explain the obtained results.

3.1. Assessment in Higher Education

Achieving a higher level of students' self-directedness in learning, and enhancing students' development of learning autonomy (Ljungman & Silén, 2008), are among the motivations for having student-based assessments. According to James et.al. (2002), the examination of student learning supports three objectives for quality in student assessment in higher education: (1) assessment that guides and supports effective approaches to learning; (2) assessment that validly and reliably measures expected learning outcomes, in particular the higher-order learning that characterizes higher education; (3) assessment and grading that defines and protects academic standards.

The relationship between assessment practices and the overall quality of teaching and learning is often underestimated, yet assessment requirements and the clarity of assessment criteria and standards, significantly influence the effectiveness of student learning (Gulknecht-Gmeiner, 2005). Carefully designed assessment guidelines directly influence the ways in which students approach their studies,

and therefore contribute indirectly, but effectively, to the quality of their learning. For most students, assessment requirements literally reflect the curriculum. Assessment is therefore a powerful strategic tool for educators to clarify which kinds of learning will be rewarded and to guide students into effective approaches to study.

Assessment is treated by educators and students as an integral and important component of the teaching and learning process rather than as a final add-on (Ljungman & Silén, 2008). The powerful motivating effect of assessment requirements on students is understood and assessment tasks are designed to encourage valued study habits. There is a clear connection between expected learning outcomes, what is taught and learned, and the knowledge and skills assessed. Assessment tasks evaluate student's abilities to analyze and synthesize new information and concepts rather than simply remember information previously presented (Van den Berg, Admiraal & Pilot, 2003). A variety of assessment methods is employed so that the limitation of any one particular technique is minimized. Assessment tasks are designed to appraise relevant generic skills as well as subject-specific knowledge and expertise. There is a steady development in the complexity and demands of assessment requirements in more advanced courses. Assessment tasks are weighted to balance developmental ('formative') and judgmental ('summative') evaluative functions. Grades are calculated and reported on the basis of clearly articulated learning outcomes and criteria for levels of achievement. Students receive descriptive and diagnostic feedback, as well as numerical grades.

Students study more effectively when they know what is expected of them. They appreciate and expect transparency in the way their knowledge acquisition will be judged. They wish to see a clear relationship between lectures, tutorials, practical classes, and subject resources, and the knowledge they are expected to demonstrate. They also wish to understand how grades are determined and expect feedback that not only explains the grade received, but that rewards achievement appropriately. In addition they look for suggestions that enable them to improve themselves as learners.

Capturing the full educational benefits of a well-designed assessment requires that many of the conventional assumptions about assessment in higher education be reconsidered. For the academic staff, assessment is often a final consideration in the planning of their curricula. This is not to imply that staff underestimates or undervalues the role or importance of assessment, but assessment is often considered only after other curricular decisions have been made. The primary concerns of academic staff are often with designing learning outcomes and planning teaching and learning activities that will produce these outcomes. In contrast, students often work 'backwards' through the curriculum, focusing first and foremost on how they will be assessed and what they will be required to demonstrate they have learned (Ljungman & Silén, 2008).

As was previously mentioned, assessment tasks are weighted to balance developmental ('formative') and judgmental ('summative') evaluative functions. An elaboration on formative assessment - the assessment method which we employed in the present study - follows.

3.2 Formative Assessment

One of the assessment methods used in evaluating teaching and learning outcomes is Formative Assessment (FA). One of its main characteristic is to enhance the evaluation processes through continual assessment. An evaluation of one stage, for example, takes into consideration the previous stage and as a result improves its performance. FA assignments provide both teachers and students with feedback which might prompt revisions in the way teachers teach and students learn. FA necessitates constant follow-up and as a result the teacher is regularly informed regarding the students' progress or difficulties and can adjust his/her teaching accordingly. Through FA the teacher can know whether what has been taught has been learned. It allows teachers to reflect on their practice and to make incremental changes that improve that practice in powerful ways. William and Thompson (2007) suggest five strategies for establishing effective FA: (1) understanding, cooperation, and perception of the learning aims and setting criteria for success with students. Wiggins and McTighe (2000) support a two-step process in which the learning aims are clarified and then clear criteria for success are set (considered 'understanding'); (2) using effective class discussions, tasks, and activities which reflect the course of reaching the learning aims; (3) providing the students with feedback which can promote the learning process. This feedback should include verbal recommendations (Saphier, 2005), or encourage the students to reflect on their own learning processes (Hogen and William, 2006), or discuss ideas with classmates; (4) encouraging the students to take responsibility for their learning processes; (5) cooperative work. Slavin et al. (2003) showed that students mutually operating as learning resources benefited more when it came to understanding the learned topics. However they said that two conditions must be fulfilled: the learning environment must provide the learners with group aims, and each learner needs to have a sense of personal accountability toward his group. In fact, the assessment method which we employed in the present study took into account these five strategies. We will broadly refer to them later.

3.3 Peer Review in Higher Education

Peer review is a form of external evaluation carried out by professional colleagues. Peers can be experts in the field but can also be classmates who assess the work of other students. Peer review is a widely practiced form of certifying quality in higher education (Herndon, 2006).

A relatively large number of studies which examine the effects of peer and self-assessment have been conducted under the rubric of educational research over the last two decades. Recommendations advocating student involvement in evaluation activities is now frequently found in higher education literature (Boud et al. 2001; Biggs 2003; Falchikov 2004; Bryan & Clegg 2006). Self and peer assessment have been found to enhance learning processes and outcomes (McDonald & Boud, 2003; Boud, 2000; Willey & Gardner, 2009), but they also advance students' own learning (Boud, 2000; Gibbs and Simpson, 2004). Peer assessment is not only a grading procedure, but is also part of the learning process through which assessing skills are developed (Brown, 2001).

Peer review is generally said to encourage critical examination, promote the exchange of ideas, reduce non-academic interference, guide academic discourse, and reinforce academic values (Boud & Falchikov, 2007). Involving students in peer review provides opportunities for reflection and feedback to complete the learning cycle (Willey & Gardner, 2008)

Peer review assumes the existence of norms by which a peer's work may be judged. Through critical examination, norms are used to compare a peer's work to accepted practices. If a peer's work deviates significantly from accepted norms, then an attempt to correct it will likely occur. In reviewing the literature regarding peer review, we found that it is mainly used in higher education for evaluating various processes such as the awarding of research funds, evaluating academic publications, reviewing faculty performance for tenure and promotion, and granting regional and disciplinary accreditation (Herndon, 2006).

The combination of self, peer, and co-assessment enable teachers and students to work together in a constructive way to reach higher levels of understanding by means of negotiation (Dochy et al., 1999). When students are involved in activities previously performed exclusively by teachers, the role change provides them with insights into the assessment process (Mills & Glover, 2006). Longhurst and Norton (1997) said that students' involvement in assessment focuses their attention on metacognitive aspects of learning. Involving students in peer review processes, improves their work skills, autonomy, self-directed, lifelong learning and can raise their levels of responsibility towards the learning process (Boud, 2000; Black and Harrison, 2001; Sluijsmans et al. 2001). Students' engagement in peer assessment can play an important part in a student's learning experience through provision of immediate feedback (Race, 2001; Hall, 2006; Mills & Glover, 2006).

Being aware of the advantages of peer review, we decided to incorporate it as an integral part of the assessment process in the workshop. Furthermore, we decided to employ TBPR since we believed that engaging the students in TBPR might enhance both their critical thinking skills and their learning abilities.

3.4 The Solo Taxonomy-Mapping Levels of Understanding

The ever-increasing need for MIS specialists capable of solving various business and societal problems requires a more constructivist approach. Among the preferred learning methods are the ones that foster understanding principles and applying them in other contexts (Bloom, 1956; Biggs and Collis, 1982). One of these methods is the SOLO taxonomy which defines five levels of understanding applicable to learners in academia:

The SOLO taxonomy is a hierarchical model suitable for measuring learning outcomes of different subjects, levels, and for assignments of various lengths (Biggs and Collis, 1982). See first two columns in Table 1. We used the SOLO taxonomy due to the objective criteria it provided for measuring students' cognitive attainments (Chick, 1998), which is in line with the workshop structure. The students' knowledge and understanding during the workshop was accrued incrementally, similar to the taxonomy.

4. THE STUDY

In this section we present data regarding the study participants, and the workshop in which the study was conducted. We also present information regarding the assignments given during the workshop, the timetable of the assignments, and the grading scheme. Finally we present information regarding the learning process evaluation methodology.

4.1 About the Study Participants

Our research took place in the systems analysis and design workshop whose general objectives are to prepare the students for their Final Project and some real world challenges they will face. The workshop is a mandatory course taken during the third (and last) year of their studies. At this stage the students have a good understanding of the technical knowledge areas required for the workshop (software engineering, software modeling, UML usage, the Java programming language, Management Information Systems concepts, Database design principles), however, most of them still lack the non-technical knowledge areas (such as critical thinking and abilities to provide meaningful and helpful feedback). For that reason, the workshop augments knowledge and understanding gained in current and previous courses, and is practical, "hands-on," and team based. There were a total of 35 students in the workshop forming 8 teams (5 teams of 4 students and 3 teams of 5 students).

4.2 The Course

The learning assignments in the course were based on team work. Each team received and worked on its own "story." A story was a general description of a virtual customer and a business case. The students were asked to study their story, address the problems presented in the business case, and suggest ways (and a software based system) to solve the problems and achieve the customer's goals (which in many cases were not defined). The workshop structure was based on incremental assignments that followed the software development life-cycle. Students had 2-3 weeks to complete each assignment. They worked by themselves and together, used various collaborative tools, and consulted the instructor (via email, the workshop web site, and personal meetings). The workshop requirements included two types of deliverables (assignments): (1) team assignments, and (2) personal assignments.

4.3 The Workshop Timeline

The workshop structure is quite complicated (as demonstrated by the activities timeline in Table 2 – Appendix III) and the amount of work required was significant. The LEGO like approach of modular assignments required a strict schedule due to the pipeline nature of the assignments submissions as follows: (1) Each assignment was submitted and immediately distributed to a different team for evaluation; (2) Each team was asked to review, assess, and grade a document while they worked on preparing the next document in their own list of requirements. The schedule assured that the feedback (both from the instructor, as well as from the evaluating team)

would be available at least one full week prior to the submission date. This section provides a better understanding of the structure by outlining the students' activities within the semester timeline (a standard 13 weeks), as seen on Table 2 in Appendix III.

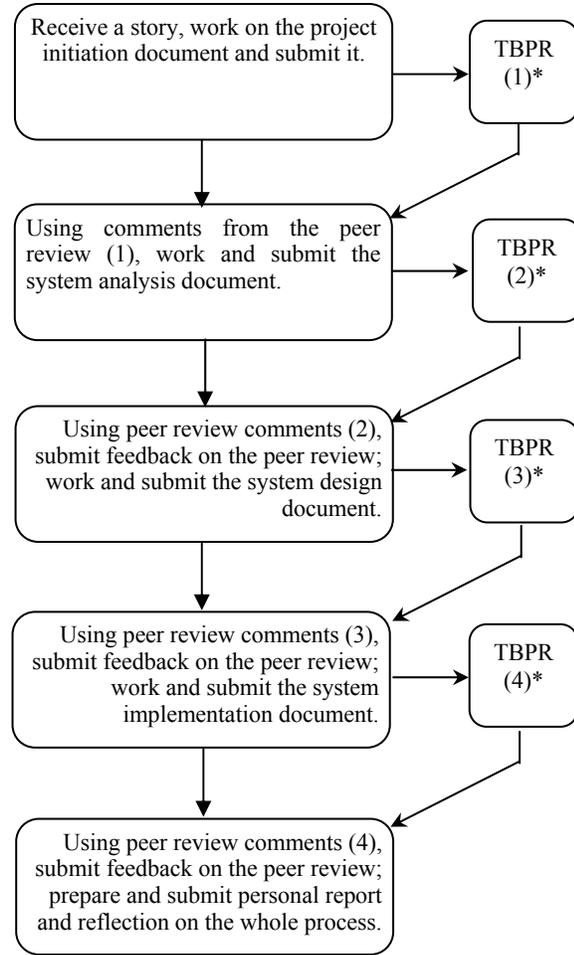


Figure 1: Workshop Process

4.4 Team Assignments

Three types of team assignments were included in the workshop: (1) compiling four documents; (2) reviewing four documents (which were prepared by other teams); (3) preparing and delivering a class presentation.

4.4.1 Compiling the Documents: During the workshop the students were asked to submit four documents: (1) project initiation and planning; (2) system analysis; (3) system design; (4) system implementation. Each one of these documents had to follow a template which was provided in advance and posted on the workshop web site (see appendices A, B). In addition, for each template, a consistent grading guideline was provided. These guidelines outlined the relative grade assigned to each paragraph in the document. During the document's preparation, the students were asked to consider the various issues related to their

project, debate among themselves, and present the agreed upon solution.

4.4.2 Reviewing Documents: After a document was handed in, it was reviewed and assessed by another student team based on the document template and grading guidelines that were provided. Learning to work effectively as a team member is a vital skill for Information Systems graduates and is one of the objectives of the workshop. The TBPR requires that members have good communication skills, including the ability to give and receive constructive criticism. The review process started with individual reviews followed by a team collaborative meeting in which they were asked to reach agreeable assessment. In the process of reviewing documents prepared by different teams, the students were exposed to new possible solutions.

4.4.3 Presentation: The presentation was a summary of all the team work performed. While all team members had to participate, the grade was given on a team basis. This was done to stress the collective aspect of the work and to raise each member's sense of personal accountability. The presentation started with a brief description of the virtual customer, the business case, and associated problems. The main part of the presentation was a description of the information system proposed as a solution. In addition, the presentation related to risks associated with the project, the expected benefits, the timeframe, and preliminary cost estimates.

4.5 Personal Assignments

The personal assignments consisted of two parts: (1) reviewing, assessing, and evaluating the presentations given by all other teams, and (2) preparing a personal report to reflect a student's thoughts about the work performed and the workshop itself.

4.5.1 Evaluating Presentations: The evaluation form, available on the workshop web site, provided guidelines for the presentation. Every student assessed the presentation as if he or she were the customer. The main questions addressed the proposed solution and whether it convincingly solved the problems raised. The evaluation related to the team as a whole and the evaluating student was asked to provide an average for the team member's performance. Presentation skills (as well as technical skills) varied among the team members; however, it was their responsibility to rehearse as much as needed, so that the team-made presentation achieved the required outcome.

4.5.2 Personal Report: Each student prepared a personal report which consisted of several issues: (1) reflection on the work done by the team and by the student as part of the team, with special emphasis on the new experience gained by the individual student; (2) reflection on the workshop as a whole, relating to benefits as well as suggested improvements; (3) assessment of the proportional contribution of each of the other team members.

4.6 The Workshop Grading Scheme

Each submitted document was reviewed and graded twice: once by the instructor and once by another team. It should be noted that the reviews were carried out in parallel and were not influenced one by the other. Both assessments and grading were performed based on the common grading guidelines available on the workshop web site. The assignment grade was calculated using a weighted average in which the instructor's grade weight was 80%, while the team's grade weight was 20%. The 80/20 split was defined in order to assure that the grade is defined mainly by the instructor grade and not the students' grades. However, this average was calculated only if the difference between the two grades was less than 16 points. If the difference was above 15 points, the students' evaluation grade was not taken into account in determining the submitting team's grade. Choosing 15 points as a cut off marker was done in order to eliminate cases in which a team tried to improve the grades of a fellow team. Use of the grading template served to enforce habits of precise and thorough analysis of documents. It should be noted that there were 4 cases (two in the first assignment and two in the second assignment) in which the difference exceeded 15 points. In these cases the students' evaluation grades were not taken into account.

In addition to the assignment grade, each team was also graded for their review and evaluation of the other teams' documents. This grade was calculated based on the difference between the instructor's grade and the team's grade, and on the quality of the judgment processes expressed by the students and the feedback they provided in their review. The presentation prepared by the team was graded as well and this grade was mainly based on peer review.

5. LEARNING PROCESS EVALUATION METHODOLOGY

In order to avoid different variations of evaluation styles, all documents submitted had to follow well defined templates and grading schemes (Appendices A, B). The fact that each document was graded twice (by the instructor and by another team), provided a framework for a simple learning process evaluation. Under ideal conditions, the instructor's grade should be identical to the evaluating team grade. If during the course of the workshop, a pattern of convergence emerged, it implied that learning occurred. For each of the documents submitted, the difference between the instructor's grade and the evaluating team grade was calculated. Based on the differences, a class average per assignment was calculated. It was quite simple to track the learning patterns of each team. However, one should take into account that (unfortunately) not all teams possessed high cognitive levels. Learning patterns for such teams were somewhat limited. For that reason the class average was used. This average was very general, but it provided a true picture.

The peer review process was comprised of two stages: each team member was asked to provide her/his own evaluation on the work of another team then at the second stage, her/his team members had to arrive at a common agreeable evaluation. In spite of the importance of

correcting the submitted documents after receiving feedback, the tight time schedules did not allow students to correct the documents they submitted. They were required however to consider the feedback in preparing their next document.

Level	Explanation	Implication to Workshop
Pre-structural	The student lacks the ability to perform the task. There is insufficient understanding.	The student lacks the understanding required for the task. Either the "story" is not clear or many of the principles of analysis are still missing.
Uni-structural	One of a few aspects of the task to be performed is taken into account. There is some understanding.	The student understands some aspects of the process principles (gathering requirements, analysis, design, programming, testing), but s/he still lacks understanding of the business situation expressed by the "story."
Multi-structural	More aspects of the task are taken into account; however, the student still lacks the "full picture."	The principles are clear and the student has started to implement these principles in designing a suitable solution for the customer.
Rational	All aspects are understood and integrated as a "whole." The student exhibits understanding of the parts, as well as the relationships between them.	All aspects of the solution are clear and were used for preparing the third and fourth documents.
Extended abstract	The whole derived at the previous level is conceptualized at a higher abstract level so that it can now be used in different settings.	This stage allows the student to understand the solution concept and provide proper feedback for her/his fellow students' solutions. The student develops an abstract understanding of the steps and procedures required for designing a useful and complete solution.

Table 1. SOLO taxonomy and implications to the workshop

6. RESULTS AND DISCUSSION

In what follows we discuss the effect of the TBPR the students were engaged in during the workshop, on the gap between the instructor's grades and the reviewing teams' grades. In addition, we present some of the students'

reflections which shed light on their perceptions regarding their engagement in TBPR during the workshop.

6.1 THE EFFECT OF ENGAGEMENT IN FA ON THE GAP BETWEEN THE INSTRUCTOR AND THE STUDENTS' GRADING

Analyzing the difference between the instructor's grades and the teams' grades revealed that the numbers converged. It should be noted that this difference was based on all students' grades (even the ones that were more than 15 points away from the instructor's grade). The difference in the initial class average was quite low (less than 9 points out of 100), which can be attributed to the workshop structure, the fact the grading was based on identical guidelines, and that the students assimilated the evaluation process. After the fourth assignment the average grade difference was reduced to 6 points (Figure 2). This pattern of convergence implies that the students learned to evaluate. However, taking into account that these are complex evaluations that require addressing and analyzing many different variables (the virtual customer, the presented "story," the business case and its problems, system analysis and design principles, the document being evaluated, the constructive feedback to be provided, and the feedback received), good evaluations were possible only when the evaluator was able to work on the extended abstract level according to the SOLO taxonomy. In this case, the convergence was actually a demonstrator of learning. Our results are consistent with Falchikov and Goldfinch (2000) who found definite evidence of agreement, on average, between peer marks and teacher marks. Moreover, they asserted that a combination of high quality study, an academic task and a global judgment based on consideration of several dimensions or criteria would appear to lead to the highest correlation between peers and teachers.

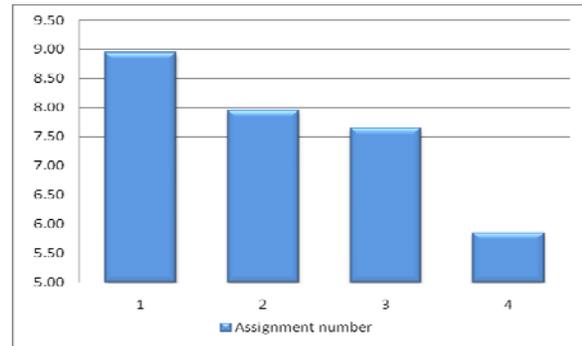


Figure 2. Average Grade Difference

The assignments in the workshop related to the higher levels of the SOLO taxonomy (Biggs, 1996; Biggs and Collis, 1982) - level 4 (Rational) and level 5 (Extended Abstract). Each submitted document was a unit that integrated knowledge and understanding about these aspects and their relationship. Furthermore, the last assignments represent understanding that correlates to the SOLO Extended Abstract level and although these assignments are more complex, the average difference decreased. Each team received its own general "story," but in order to understand the customer and the business circumstances, the students

had to assimilate the ideas presented in class and apply them to the new situation. When evaluating and grading the first documents, the students had to exhibit the Rational level, while for the later document the students had to possess and exhibit cognitive skills adequate to the Extended Abstract level. This entailed understanding the whole solution presented by their fellow students, conceptualizing it, and applying it to different situations. Several times during the workshop, some teams asked permission to modify the solutions presented in their submitted document (it happened twice after the first assignment and three times after the second one). The reason behind this 'odd' request was that during their evaluation of a different document, they realized they could improve upon their own solution. This strongly supported SOLO taxonomy level 5 where a generalized abstraction reflected on oneself:

'Metacognitive understanding, students [are] able to use the taught content in order to reflect on their own teaching, evaluate their decisions made in the classroom in terms of theory, and thereby improve their decision making and practice.' (Biggs, 1996)

6.2 THE EFFECT OF THE TEAM-BASED PEER REVIEW FROM THE INSTRUCTOR'S PERSPECTIVE

The first assignment was relatively simple and one of its main purposes was to develop the students' team work skills in relation to analysis and design. In producing their first document, the students had to apply principles learned in class to the story situation they were given. According to the SOLO taxonomy terminology, it is possible to produce a good document if the team members are on the second level (Pre-structural) or on the third (Multi-structural). In subsequent documents, the level of complexity was elevated. The second assignment required deeper understanding and integration of information from several sources, such as requirements elicitation and analysis and integration of the feedback received for the first assignment. In order to be able to properly perform the second assignment, the team members need to possess the third and the fourth (Rational) SOLO taxonomy levels of understanding. The third assignment required even deeper understanding, since students were asked to design a mandatory database schema which considered and integrated all additional analysis feedback, as well as ideas gained from reviewing other documents. This assignment was extremely difficult for students who were not on the fourth SOLO level since they were asked to produce one complete and coherent solution which was an integration of all the information gathered. The fourth assignment was the hardest. Here students had to think on a higher level of abstraction related to their specific business case, like defining future measurable metrics for assessing their project success, after it was completed. This task augments possible metrics with a deep understanding of the virtual customer, the business situation, the problems, market opportunities and project success factors.

In spite of the increase in the tasks' difficulty and complexity, the teams' performance improved. Most issues addressed (as part of the feedback they received) were handled properly. A thorough review of the documents utilizing the detailed criteria (see Appendix I) revealed that

the team based review the students were engaged in, raised their understanding of their own project. This was observed for example by the fact that all feedback issues were properly addressed in the subsequent assignments. In some cases the feedback provided was intended to raise awareness of a specific point. It was evident that all such comments were addressed, either by considering possible solutions or elaborating on the reasons to ignore them. A very interesting finding was the several instances where a solution was considerably changed, most likely as a result of the feedback students received, or the additional insight they gained from reviewing their fellow students' assignments. During their review process the students realized that trying to understand another team's document (even if it followed a detailed template) was not easy. It should be noted that the detailed templates were not designed to impose the instructors' point of view and to suppress the students' own views. The templates served as a check list about issues considered and was not a definitive method on how to prepare them. Another finding relates to the percentage of the template issues addressed by the students. In the first assignment students did not follow all of the templates' issues and as the workshop proceeded more issues were considered. This is due to the fact that the students realized the importance of these templates and the role they play in producing a good, understandable, and maintainable document. It was noticed that the amount of work spent on the assignments increased as the workshop advanced and this is another positive indication of the students assimilating the importance of the systems analysis and design stages, as well as the documents produced. In addition, the students that followed the templates acquired a logical way of addressing the issues at hand and as a result their own documents improved along with their abilities to review other documents. Working at a higher level in the SOLO taxonomy, provided students with the understanding required to integrate all factors in a whole solution. This was observed in their documents, which improved from one assignment to the next one. This is the main reason behind the grade difference convergence that was observed. An additional important observation relates to the level of cooperation among the team members themselves. The workshop consisted of two simulations in which the students actively participated. Although these simulations were only two weeks apart, during the second simulation all teams expressed a higher degree of performance. They exhibited better preparation, a superior project, greater customer and business situation understanding, and a more coherent approach towards the required solution. Since in these simulations the instructor assumed the role of the virtual customer, it was evident that most teams were deeply engaged with the situation and looked for innovative solutions that superseded the actual requirements. Hence it can be concluded that the engagement in TBPR enhanced the students' critical thinking capabilities as well as their required soft-skills (Covey, 1996). The workshop supports William and Thompson (2007) five strategies for establishing effective FA: (1) Understanding the learning aims and setting criteria for success with students come to fruition in the workshop structure (2) Using effective tasks, and activities which reflect the course of reaching the learning aims was achieved by the incremental

process of the workshop assignments; (3) Providing the students with feedback which can promote the learning process was accomplished by the received feedback both from the TBPR and instructor.(4) Encouraging the students to take responsibility for their learning processes was realized by the students progress within the process augmenting knowledge obtained from various resources; (5) cooperative work was implemented by the teamwork.

6.3 The Effect of the Team-Based Peer Review from the Students' Perspective

Analysis of the students' reflections revealed that the students referred to three main issues: (1) the advantages of TBPR; (2) the effect of the assessment process they were engaged in on their performances; (3) appreciation of the contribution of the workshop's assignments to future employment.

6.3.1 Team-Based Peer Review: In reflections they wrote about their experiences of TBPR, a majority of the study participants expressed comments similar to the following:

"The methodology used was very good. Working in teams provided solutions that one person sometimes doesn't see by herself. Studying the other teams' evaluations was very important and helped us design a better solution. The review we received from other teams (and the instructor) provided additional important knowledge."

From the above excerpt we can learn that in general students found the teamwork method helpful in developing critical thinking and in improving their cooperation skills. This was true both while they worked on their project and when they evaluated the other teams' documents. They also commented on the need for basic preparation before engaging in teamwork and referred to one of the most prominent advantages of teamwork – the combining of cognitive abilities. TBPR helped them design better solutions. As was asserted by McDonald & Boud (2003), Boud (2000), Willey & Gardner (2009), peer assessment has been found to enhance learning processes and outcomes. Our results are consistent with Boud & Falchikov (2007) who claims that peer review encourages critical examination, promotes the exchange of ideas and guides academic discourse. The involvement of students in peer review processes, improves their work skills and autonomy, and might raise their levels of responsibility towards the learning process (Boud, 2000; Black and Harrison, 2001; Sluijsmans et al. 2001).

The feedback the students received from other teams and from the instructor raised their awareness to various nuances of the given tasks and as a result helped them reach better solutions. Using the SOLO taxonomy (Biggs, 1996; Biggs and Collis, 1982) notations, the feedback helped the students move from the Multi-structural level to the Rational Level. The students themselves agreed that the peer-review mechanism provided them with additional information and ways of thinking they originally overlooked. The fact that they realized, for example, that the first document was not good enough, reflects understanding that they lacked the 'full picture.'

They also referred to the effect the feedback they gave to the other teams had on their own performances. This was

mentioned in regards to the teamwork; however, it reflected the understanding that for reviewing, analyzing, and evaluating other teams' documents an integrated team based approach was needed. Once again, team based work helped students move to a higher level on the SOLO taxonomy.

Two students expressed criticism with regard to their lack of experience with team work:

..."We had cases in which the amount of coordination between the team members was not sufficient, and this was evident in the documents submitted."

"In the beginning we had some team problems. It took time before we learned how to work as a team, but by the end of the workshop it was much better."

From the above comments we can learn that students need basic preparation before engaging in team work. Since students had little experience working in this manner, it took them time to adjust to the other team members.

6.4 The Effect of the Assessment Process on the Students' Performances

The TBPR process had an impact on the students' performances in two directions: being reviewed and acting as reviewers at the same time. Regarding acting as reviewers, eighteen students (51%) expressed views similar to the following:

"The first document we produced was not good enough. We understood it from the comments we received as well as from evaluating the other team's document. Based on these comments, we managed to improve the other documents we produced."

Twelve (34%) students claimed: "I've learned a lot from analyzing other student documents."

From the above comments we learn that majority of the students (85% total) felt that acting as reviewers contributed to their learning process. Though their reflections were mostly general and did not indicate in which specific ways they experienced the contribution, they referred to the fact that the exposure to various solutions caused them to improve their own documents. It is consistent with Boud (2000), Dochy et al. (1999) and Willey & Gardner (2009), all of whom have asserted that peer assessment has been found to enhance learning outcomes and to help students improve their own learning.

As to the students' reflections regarding their being reviewed, these reflections can be divided into the following: (1) becoming more aware of the importance of correct design; (2) learning from mistakes; (3) clarifying blur points during the work.

6.4.1 Awareness of the Importance of Correct Design: In what follows we present representative comments from students' reflections regarding their appreciation of the importance of correct design:

"The workshop helped me understand better. The "customer" interview and the feedback we received proved to be extremely helpful. Only after carefully

analyzing the comments we received, did we really understand how much we missed in our original thinking" (12 students).

"Working on an imaginary project is difficult. It is easier to work with a "real" client. Some of the requirements were not clear, but the feedback we received helped us to understand them better. The important thing we learned is that definition of the system and its requirements is a complicated process" (9 students).

"The workshop process (including the comments we received) helped us avoid future possible problems that we initially did not see, or choose to ignore" (7 students).

In the above reflections, 28 (80%) students referred to components of good design, such as the careful definition of the system and its requirements; becoming aware of the fact that good design is a complicated process; the importance of the customer interview; the importance of paying attention to the small details appearing in the problem's demands; the tendency to avoid and/or ignore problems. These results support Dochy et al. (1999) who has asserted that peer assessment enables students to work together in a constructive way, and as a result to reach higher levels of understanding.

There was also a criticism expressed by a number of students (9) regarding the character of the project and some of its requirements. They claimed that working on an imaginary project was more difficult than working on a real one, and that some of the requirements were not clear. However, the feedback they received from other teams helped them to better understand the project.

6.4.2 Learning from Mistakes: An additional aspect raised in the students' reflections regarding their work being reviewed, concerned the issue of learning from mistakes. Twenty (57%) students wrote reflections similar to the following:

"We thought our project was good, but from the comments we received, we understood our mistakes and that there was still a lot of work to be done"

In the above excerpt the students raised the issue of learning from their mistakes. In fact, they were exposed to this issue both as reviewers and as subjects of review. While reviewing their classmates' work, they found mistakes committed by their friends and probably found mistakes in their own work. When they were acting as reviewers, they had to examine the evaluated work according to a set of categories from the relevant template (see for example Appendix I) and following this process they found mistakes both in the evaluated work and in their own. This reviewing process made them rethink the tasks and eventually brought improvement to their own solutions. These findings support Longhurst and Norton (1997) that students' involvement in assessment focuses their attention to the metacognitive aspects of learning.

6.4.3 Clarifying Blur Points during the Work: In their reflections, eleven (31%) students referred to the need for clarification of blur points similar to the following:

"The workshop assignments required a great deal of work and we had to debate on the proper solution. The comments we received helped us decide" (6 students).

"Since it was not a "real" project, it was difficult to decide what was correct and what should be done. The feedback we got, helped us overcome these uncertainties" (5 students).

In the above reflections, the students related to the importance of the peer review in helping them clarify blur points or reach a better decision. In the process of team work, students brainstormed and various solutions were raised. The team had to decide upon their options. The feedback they received from the peer review helped them choose the better path. Going through the process of thinking over the various solutions, raised students' levels of responsibility towards the learning process (Boud, 2000).

6.5 Appreciation of the Contribution of the Workshop's Assignments to Future Vocations

In what follows, we present the kind of reflections that 20 (57%) of the students made regarding the contribution of the workshop's assignments to their future employment:

"The workshop and the submitted documents prepared us for the 'real world.' I personally work in industry and can state that the quality of the documents submitted are by all means equivalent (if not better) than what I am used to receiving and generating at work." (9 students)

"The workshop provided excellent experience for the final project we had to develop as well as preparation for the real world. It provided significant knowledge required in the future." (7 students)

"Working on an imaginary project is difficult. It is easier to work with a 'real' client. Some of the requirements were not clear, but the feedback helped us understand them better. The important thing we learned is that to define the system and its requirements is a complicated process." (4 students)

We conclude that more than half of the students found the detailed documentation very helpful. The various templates of assessment forms for each task helped them think as developers and enhance the problem solving process.

Regarding the effect of their engagement in the workshop on their future vocations, the students found that the workshop's processes provided significant knowledge they would need in the future. Even students already working in industry felt they learned from the workshop and said that they will use the acquired knowledge in their current work. It is consistent with Boud, (2000), Black and Harrison, (2001), and Sluijsmans et al. (2001) claiming that involving students in peer review processes improves their lifelong learning.

6.6 Reflections Regarding Shortcomings of Workshop

The students' reflections included also shortcomings regarding the workshop. Six (17%) students made comments similar to the following:

"Working in a team was very difficult. The work distribution was not identical. It would have been impossible to successfully complete the workshop without the comments and helpful suggestions we received from other reviewing teams".

From the above excerpt we can learn that for part of the students working in teams was difficult since they felt the work distribution within the team was not even. Various solutions to the problems were raised by members of the team and the group spent time testing each alternative until they decided which one was the best. From the last part of the above excerpt we can conclude that the students developed a sense of appreciation for the feedback (TBPR) contribution they received from other teams.

7. CONCLUDING REMARKS

Functioning as evaluators of other teams exposed the students to ideas different from the ones they decided to use in their own solutions. This exposure, in many cases, made them rethink their task and prompted them to look for better or more efficient solutions. The collaborative team work exposed each team member to various ideas expressed by his/her friends and as a result caused additional thinking about available solution alternatives. An additional effect of the peer review FA was that the students no longer viewed the teaching staff as their sole source of technical information (William and Thompson, 2007).

From the students' reflections and the results received regarding the gap reduction between the instructor and the students' grading, it can be concluded that the engagement in FA during the workshop, the giving and receiving of feedback, raised the students' levels of understanding (Biggs, 1996) and as a result helped them cope successfully with the given workshop assignments. Using the SOLO taxonomy increased their level of understanding and as a result their performance of the given tasks.

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APPENDIX 1: GUIDELINES EXAMPLE

This is an example of one of the review, evaluation and grading guidelines documents used in the workshop. The guidelines documents are based on Excel worksheets. The students fill in the worksheet and submit it electronically, using our Learning Management System. The worksheet is locked and only the relevant fields are available for the students (the shaded fields). The Max Grade column defines the maximum allowed grade for each topic. Students are requested to fill in the header fields: Course, the evaluating team, the original team (the one whose document was evaluated) and the names of the students who prepared the document. In addition, for each topic, the students are requested to fill in the grade and an explanation for the grade. The total grade is calculated automatically. In this specific example a template for the analysis (third document) is provided. The topics to be addressed and graded as part of the worksheet are based on the issues covered during the lectures. The students were asked to review the analysis document they received while applying their understanding of the topic to this business case. Based on the review, they were asked to grade each topic including the provision of constructive feedback, which was delivered back to the original team. The grade, each team received for their review, evaluation and grading of another team's document was based on this template after it was completed.

Guidelines for evaluating and grading analysis documents				
Course:				
Evaluating Team:				
Owner Team:				
Team Members:				
Please grade all paragraphs.				
Only the designated cells can be modified				
	Paragraph	Grade	Max Grade	Reason for the grade
1	Changes to Previous doc.		4	
2	Executive Summary		8	
3	Requirements Strategy		4	
4.1	Req. Plan Review		3	
4.2	Interviews Description		2	
4.3	Relevant Questions		2	
4.4	Interview Transcription		1	
4.5	Questionnaire		2	
4.6	Special Diagnosis		1	
4.7	Other		1	
5.1	Current System Review		3	
5.2.1	Current UC Review		2	
5.2.2	Current UC Description		2	
5.2.3	Current UC Diagrams		2	
5.3	Current Process Model		4	
5.4	Current Data Model		4	
6.1	New System Review		4	
6.2.1	New UC Review		5	
6.2.2	New UC Description		5	
6.2.3	New UC Diagrams		5	
6.3	New Process Model		8	
6.4	New Data Model		8	
Part B				
1	Clear Readable Wording		12	
2	Layout and Design		8	
Total		0	100	

Figure 3. Analysis Document Grading Guidelines

APPENDIX 2: TEMPLATE EXAMPLE (INITIATION AND PLANNING DOCUMENT)

This is an example of the documents' template used in the workshop. These are simple Word files with a list of topics to be addressed by the students. The templates serve only as general guidelines and not as mandatory topics. The students are asked to consider each paragraph for its relevance to their particular story. It is expected that students will include in their document additional topics which are needed but missing from the template. The topics in the template are based on the issues explained during the lectures. The students were asked to apply their theoretical understanding of each topic to the business case they were working on (the "story" they received). This specific template is for the first assignments (The Initiation and Planning Document). Each of the four assignments has a specific template that defines the content of the document to be written as part of this assignment. The students are asked to relate to the review, evaluation and grading guidelines (see Appendix I), which contain the relative importance and the relative grade of every topic in the document. The relative importance of each topic is relevant since due to the nature of the workshop, students have to decide on how to use their limited time in the most efficient and effective way (by concentrating mainly on the more important topics).

--- TEMPLATE ---

Initiation and Planning Document

1. Executive Summary
2. Current System Description
3. Problems with the existing system
4. Preliminary requirements
 - a. New system objectives
 - b. New system potential benefits
5. Feasibility Study
 - a. Technical feasibility
 - b. Economic feasibility
 - c. Organizational feasibility
6. Preliminary project plan and staffing
7. Project borders
8. Required standards
9. Preliminary Risk Analysis
10. Recommendations

APPENDIX III: ACTIVITY TIMELINE

Week	Class Activity	Students Activity
1	Lecture (Business Environment, Project Initiation & Management)	Form team; nominate team leader; receive story
2	Lecture (Project identification and selection, requirements engineering)	Work on Project Initiation and planning document (1st assignment). Apply learned principles to story.
3	Lecture (Software modeling – part 1)	Start requirements analysis; finalize 1st assignment
4	Lecture (Software modeling – part 2)	"User" requirements gathering simulation (part 1); submit 1st assignment and receive a document for review and grading.
5	"User" requirements gathering simulation (part 2),	Submit review and grade for evaluated document; work on the Analysis document (2nd assignment). "Customer" interviews.
6	System modeling class (hands-on laboratory)	Finalize 2nd assignment by addressing review comments and suggestions.
7	System modeling class,	Submit 2nd assignment and receive a document for review and grading.
8	User meetings simulation (Design requirements),	Submit review and grade for evaluated document; work on the Design document (3rd assignment).
9	Lecture (Project implementation)	Finalize 3rd assignment (address review comments and suggestions); start working on customer presentation.
10	Presentations	Submit 3rd assignment; start working on Implementation Document (4th assignment); evaluate presentations and receive a document for review and grading;
11	Presentations	Finalize 4th assignment by addressing review comments and suggestions; evaluate presentations
12	Presentations	submit 4th assignment and receive a document for review and grading; evaluate presentations
13	Presentations	Evaluate presentations; submit review and grade for document evaluated, and prepare personal report.

Table 2. Workshop Activities Timeline



STATEMENT OF PEER REVIEW INTEGRITY

All papers published in the Journal of Information Systems Education have undergone rigorous peer review. This includes an initial editor screening and double-blind refereeing by three or more expert referees.

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