

IMPLEMENTATION OF BLOOM'S TAXONOMY ON SYSTEMS ANALYSIS WORKSHOPS

Aharon Yadin

Computer Science and Information Systems Department

The Max Stern Academic College of Emek Yezreel

aharony@yvc.ac.il

ABSTRACT

This paper presents a case study in which Bloom's taxonomy was used to enhance critical thinking learning in a Systems Analysis and Design workshop. It touches on the importance of information systems, problems in teaching especially "non technical" aspects of Systems Analysis and Design and suggests a workshop structure that has been working for the past five years. The paper briefly describes Bloom's taxonomy and the workshop structure. It describes how the taxonomy levels were implemented in the workshop and the model used for assessing critical thinking learning patterns. The conclusion section provides the findings obtained over time. In this case study, combining Bloom's taxonomy, with an electronic submission system demonstrated clear critical thinking patterns of learning and improved education quality.

Keywords: Systems Analysis and Design workshop, critical thinking, Bloom's Taxonomy, electronic submission system

I. INTRODUCTION

Information Technology plays a major role in modern society. Software based systems manage and control many aspects of our daily activities. On the organizational side and spanning the last two decades, Management Information Systems have matured from an operational supporting tool to a business development boosting infrastructure (Laudon and Laudon, 2005; Bocij et al., 2005). IS2002 even defines Information Systems as a "Technology Enabled Business Development" (Gorgone et al., 2002). In spite the fact that mastering systems development processes, tools and technologies is an important component of MIS curricula, still (too) many systems fail to deliver the expected outcome. These failures and deficiencies of software projects are often rooted in early activities (Minor and Armarego, 2004). Teaching these early activities, especially Systems Analysis and Design, is sometimes difficult due to the large amounts of technical and procedural knowledge to be acquired by students (Tuya and Garcia-Fanjul, 1999). In addition to

the technical and procedural knowledge, MIS graduates will have to demonstrate their proficiency in using technology for developing new organizational processes for achieving organizational goals. (Schatzberg, 2002). For that purpose, IS2002 identifies the required, non-technical knowledge areas such, as critical thinking, interpersonal skills, team skills and business understanding. Mary Boone regards the IS specialist as a "Boundary person" (Boone, 1991). Such a person provides a bridge between technology and the organization and helps defining the "Technology Enabled Business Development".

The Systems Analysis and Design workshop augments the necessary knowledge areas and provides a good exercise for the real world. By addressing various management issues, the practical, team based, workshop holds the potential to strengthen students' project management and conflict resolution abilities. The workshop structure is based on a LEGO like assembly, in which the incremental assignments follow the software development life-cycle. These incremental assignments gradually advance the students' abilities and understanding. The workshop approach is based on Bloom's taxonomy (Bloom, 1956), which is still widely used (Machanick, 2000; Buckley, and Exton, 2003; Lister, 2006; Steinke and Fitch, 2007).

The following sections of this paper describe:

- a. The Systems Analysis and Design workshop structure, including the assignments, grading scheme and the workshop timeline;
- b. Bloom's taxonomy (very briefly);
- c. The adaptation of the workshop structure to Bloom's taxonomy levels;
- d. The workshop various versions;
- e. Critical thinking learning process evaluation methodology;
- f. Conclusions and future work.

II. THE SYSTEMS ANALYSIS AND DESIGN WORKSHOP STRUCTURE

The Systems Analysis and Design workshop was delivered during the past five years. The workshop's general objectives are to prepare the students for their Final Project¹ and the real world challenges they will face. At that stage of their

¹ The Final Project is a yearly project that simulates a real user situation. The students have to collect all necessary information, study and analyze the business case, gather the requirements, analyze and design the system, develop the system, document and present it. This Final Project is considered the highlight of their studies. For many students and in many cases, successful Final Projects served as an entry pass to a new job.

studies (third year), the students have already a good understanding of the technical knowledge areas required for the workshop (software engineering, software modeling, UML usage, etc.), however, most of them still lack the non-technical knowledge areas (like critical thinking and abilities to provide meaningful and helpful feedback). For that reason, the workshop that augments knowledge and understanding gained in current and previous courses is a practical, "hands-on", team based workshop. Each team consists of 3-4 students, who remain on the team for the whole duration of the workshop. The team approach is used to enhance the non-technical knowledge areas, such as critical thinking, interpersonal skills and team skills, addressed in IS2002. Each team gets and works on its own "story". A story is a generalized description of a virtual customer and a business case. The students have 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 goals (which in many cases are not defined). The workshop is structured in a LEGO like approach, in which the students follow the software development life-cycle. The workshop requirements include two types of deliverables (assignments):

1. Team assignments;
2. Personal assignments.

TEAM ASSIGNMENTS

The team assignments consist of preparing four documents, reviewing four documents (which were prepared by different teams) and a class presentation. A template for each document is provided in advance and posted on the workshop web site. See appendix I for an example of the template used (in this case the template is for the first document to be submitted). During preparation of the documents, the students are required to thoroughly think about the various issues, debate among themselves, and present (in the document) the agreed solution. The four assignment documents are:

1. Project Initiation and Planning;
2. System Analysis;
3. System Design;
4. System Implementation.

The presentation is a summary of all the team work performed. It starts with a brief description of the virtual customer, the business case and the problems that exist, and includes a description of the information system proposed as a solution. In

addition, the presentation relates to risks associated with the project, the expected benefits, the timeframe and cost.

Each submitted document is reviewed and graded twice: by the instructor and by another team. The evaluation and grading is performed based on grading guidelines that are available on the workshop web site. These guidelines are consistent with the documents' templates and provide the relative grade of each paragraph in the document. See appendix II for an example of the grading guidelines used (in this case the grading template is for the second document to be submitted). The assignment grade is calculated using a weighted average, in which the instructor's grade weight is 80%, while the team's grade weight is 20%. This average is calculated only if the difference between the two grades is less than 16 points. If the difference is above 15 points, the students' evaluation grade is not taken into account in determining the submitting team grade. All course requirements, including the grading scheme, are outlined in the syllabus and are known to the students in advance. The main purpose for the relative small difference in the grades is to enforce habits of precise and thorough analysis of documents (critical thinking) and in order to eliminate cases in which a team is trying to improve the grades of a different (fellow) team.

In addition to the assignment (document) grade, each team is also graded for their review and evaluation of the other document. This grade is calculated based on difference between the instructor grade and the team grade, as well as the quality of the judgment processes expressed by the students and the feedback they provided in their review.

PERSONAL ASSIGNMENTS

The personal assignments consist of evaluating the presentations given by all other teams. Each student evaluates all the presentations (except his/her own). This evaluation is based on an evaluation form that is available on the workshop web site. Each student also prepares a personal report and provides feedback on the proportional contribution of each other team member. This feedback is used to assess the distribution of work among the team members, taking into account the team members' point of view. This feedback also provides socio-metric data, which is interesting by itself, but it is beyond the scope of this paper.

WORKSHOP GRADING SCHEME

The grade for the workshop is calculated by summing up all the assignments' grades. The team grade is a weighted average of the four team assignments (the four submitted documents), the four evaluation and grading documents (grading of other assignments), and the team presentation. Since the main objective of the workshop is to prepare the students for their professional careers, the emphasis in grading is on the documents and not on the evaluation. (Each document represents 15% of the total course grade, while each evaluation is only 3% of the total grade). All team members share this common grade. In addition, the personal grade is based on the student evaluations of other teams' presentations, and the personal reports.

WORKSHOP TIMELINE

The workshop structure is quite complicated and the amount of work required is significant. For that reason and for enhancing critical thinking, debating and team skills, most of the work is carried out in teams. This section is included to provide a better understanding of the workshop structure by addressing the students' weekly activities along the semester timeline (a standard 13 weeks), as seen on Table 1.

III. BLOOM'S TAXONOMY

This section is included in this paper for reason of completeness and it contains a brief description of Bloom's taxonomy. A group of researchers headed by Benjamin Bloom defined in the early fifties a cognitive taxonomy, which is based on six hierarchical levels:

1. Knowledge – the ability to memorize and recall relevant information (facts, procedures and concepts).
2. Comprehension – the ability to understand the meaning of information and to translate the knowledge into a new context.
3. Application – the ability to use the knowledge (facts, methods, concepts) in different and new situations.
4. Analysis – the ability to identify various components and find hidden information (meaning or logic) embedded in them.
5. Synthesis - the ability to combine several components and to build a new product or idea. Draw conclusions or predict based on different areas.
6. Evaluation – the ability to compare and subjectively assess the value of different approaches.

The taxonomy is built in a meaningful hierarchical structure. Each level is based on and enhances the lower level. Without understanding a lower level, the student will not be able to proceed to higher one.

Table 1. Workshop activities timeline

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

IV. ADAPTING THE WORKSHOP TO THE TAXONOMY

The various workshop stages were defined and adapted to Bloom's taxonomy. Each taxonomy level is being addressed in one or more of the workshop related activities:

1. Knowledge is addressed during the theoretical lectures of the workshop. At this stage in their study, the students are already familiar with many of the concepts, tools and methodologies needed for the workshop successful completion. Even so, the aim of the first lectures is to bring everybody to a common base and provide all necessary knowledge required for the next workshop stages. The taxonomy knowledge level is further addressed in the "story". Since each team gets a different story, students have to understand their "customer" and his/her business environment, before being able to proceed and suggest a solution.
2. Comprehension is addressed in the various documents. Preparing a document implies repeating some of the theoretical concepts learned at class in a different business case. Comprehension is also demonstrated during the simulation lectures. The students use these meetings to gather system requirements. Each meeting is conducted like real-life meeting. The students have to prepare all questions (open/close, questionnaires, etc). These simulation meetings provide accurate indication of the team's comprehension regarding the story and the possible solutions.
3. Application is addressed in every document produced by the teams. The concepts of identifying and selecting projects are reflected in the Initiation and planning document. This means using a theoretical concept in a new situation. The students apply the learned methods to this new business case.
4. Analysis is addressed during the analysis life-cycle phase, in which information gathered from the customer has to be analyzed. The stories are very general and some of the answers during the simulation sessions are vague. This was done on purpose, to drive the students into thinking about the situation. A common answer to a technological question, during the simulation phase, might be:

"Well, I don't know. I am just the user. You are the experts, why don't you suggest something..."

This type of answer sends the students back to prepare their homework. In analyzing a business case, students often seek the answers instead of thinking and inventing them. The vague answers in this sense are part of the education process. The taxonomy Analysis level is also addressed in the evaluation and grading process. During the workshop, each team evaluated and grades four different documents. Evaluating and grading a document means first reading the specific story and only then reading and analyzing the document. In addition to grading, students are required to produce a written report of the evaluation. The students are graded for their report as well.

5. Synthesis is addressed in the system analysis, system design and system implementation documents. For each document, the students have to put together the theoretical ideas and concepts from the lectures, adapt them to the story and take into account the user requirements and the feedback they got on previous documents they submitted.
6. Evaluation is addressed in the evaluation and grading process. The students have to judge the documents they receive. Each team has to criticize the document and compare the approach taken to the approach they used (or any other relevant approach). In many cases, the team is required to defend their approach.

V. SYSTEMS ANALYSIS AND DESIGN WORKSHOP VERSIONS

The Systems Analysis and Design workshop has been used for the past five years. During this time it evolved and matured. Three slightly different versions were developed. These versions correlate to stages in our web based learning support systems and include additional features introduced by these systems, as well as additional changes for enhancing learning patterns. It should be noted, that in parallel to the different versions of the workshop, there was also a sharp decrease in the number of students who attended the workshop.

SYSTEMS ANALYSIS AND DESIGN WORKSHOP VERSION 1

The first version has been used during 2003-2004. The structure was similar to the structure described; however, it used a manual submitting system. Students submitted only paper based documents. Each team submitted two copies. One was evaluated by the instructor and the other by a different team. The evaluating team provided only a grade and a short explanation for reason behind this grade. The

evaluating team did not provide any feedback to the team who prepared the document. The feedback to the submitting teams, for each one of the documents, was based only on the instructor's evaluation.

SYSTEMS ANALYSIS AND DESIGN WORKSHOP VERSION 2

The second version has been used during 2005-2006. This version was similar to the first version with very minor modifications. The students used electronic documents and the submission was based on e-mails. During their evaluation and grading the documents, the students were also required to provide feedback and not just to grade the work. Due to this new feedback requirement, the students had to go into an elaborated analysis and evaluation process. For providing meaningful feedback, the students cannot only read the document. They first have to familiarize themselves with the story and the business case presented.

SYSTEMS ANALYSIS AND DESIGN WORKSHOP VERSION 3

The third version has been used during 2007. The main advantage in this version is the utilization of an electronic submission system. There is no change in all other workshop procedures. The electronic submission system provides a common repository, which is open for all. Students can share the documents and the views expressed in them.

VI. LEARNING PROCESS EVALUATION METHODOLOGY

The workshop web site contains templates (see an example in Appendix I) and grading guidelines (see Appendix II) for every type of document to be prepared and evaluated by the teams. These templates were provided in all versions of the workshop. Students were required to use the templates "as is" unless some of the template paragraphs are irrelevant (or missing). The templates and the guidelines provide a simple and unique mechanism for evaluating the learning process. Each document is graded by the instructor and by an additional team, using the same baselines (the templates and the grading guidelines). Under ideal conditions, the instructor grade and the team grade should be the identical or very close. The difference in the grades, between the instructor and the evaluating team was used to measure the learning process. If learning occurs, the difference between the instructor grades and the team grades should decrease throughout the duration of the workshop. It should be noted that this observed learning process relates only to the critical thinking capabilities and not to the whole workshop processes.

The conclusions presented here are based on class average. The Excel files used for the calculations track the learning process patterns of each team. However, one should take into account that (unfortunately) not all teams possess Bloom's taxonomy's higher cognitive levels. This means that for such a team the learning process is somewhat limited. For that reason the class average was used. An average which is very general but it provides the true picture.

VII. CONCLUSION AND FUTURE WORK

The three workshop versions were used for the past five years. As can be expected, the results obtained demonstrate a different behavior in the three workshop versions. See Figure 1 for the various assignments' grade difference over the years. Underneath the year appears the number of teams that participated in the workshop.

In the first version no learning patterns were observed. The students did not provide any feedback, so their involvement with the document under evaluation was minimal. This led to poor document analysis, which later affected the students' ability to synthesize the components into a viable solution. This can be seen in the graph by the large grade difference especially on the last assignment. Furthermore, learning is achieved if the grades difference decreases however in this case it did not happen. The large increase in the average grade of the fourth assignment can be explained by the lack of students' feedback. In this version, during document evaluation, the students were not required to provide feedback, so they only briefly reviewed the documents. This hampered their ability to introduce additional new ideas into their own future documents.

The second version demonstrated overall better understanding (the grade difference was smaller), but no real evidence of learning was observed. The grade difference did not decrease over time. The students understand better the requirements and their evaluation is closer to the instructor evaluation. This is explained by the fact that in this version students were required to provide meaningful feedback. This feedback required a higher degree of investigation (critical thinking), which later was also applied to their own documents. Due to the submission mechanism limitations in this version (submission by email only), students were exposed only to the document at hand. This limitation affected the students' understanding of the documents' hierarchy and prevented the learning process (the grade difference did not decrease).

The third version demonstrated real learning. The grade difference was originally small and it decreased during the course of the workshop. In this workshop version, the students can view all submitted documents, so they can relate not only to the document they evaluate, but to the history of documents submitted. During this version, several teams asked if they are allowed to introduce changes to their submitted documents. The reason was that during their evaluation of other documents, they realized that they can improve their solution. This type of behavior was not observed in previous versions of the workshop.

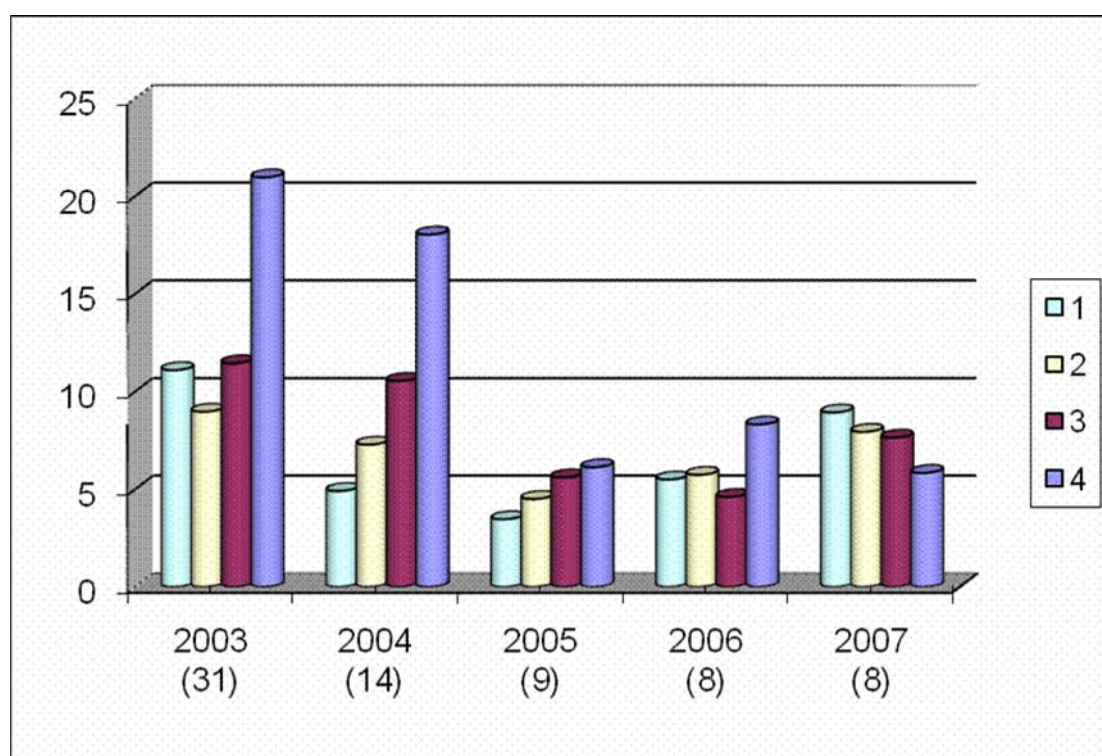


Figure 1. Average Grade Difference

Figure 1 presents a summary of the findings. These results relate to the average grade difference. In the first workshop version (2003-2004), the average difference in grades is quite high (13 points in 2003 and 10 points in 2004), however the important issue here is the fact that the difference is not decreasing. This implies that the critical thinking learning skills did not improve during the workshop. In the second version (2005-2006), the average difference is very small (5 points in 2005 and 6 points in 2006), but once again there is no critical thinking learning pattern. In general, the difference in grades over the four assignments is increasing. In the third version the difference in grades is small (7 points) and it is decreasing, which demonstrates the critical thinking learning process. However, it should be noted that the learning pattern was observed on a small group of teams (only 8) and the

decrease was minimal. The observed process trend (the fact that the difference decreased) is the main contributor to the conclusion of improving the critical thinking learning.

The results achieved demonstrated that Bloom's taxonomy, when combined with a proper workshop structure and supported by an electronic submission system, provided a clear and improved way of teaching the critical thinking aspects of the Systems Analysis and Design workshop. These critical thinking aspects were demonstrated by the evaluation process carried out by the students.

Future work related to this case study includes running the Systems Analysis and Design workshop for an additional year and measuring the effectiveness of the critical thinking learning processes once again.

VIII. REFERENCES

- Laudon, K.C. and J.P. Laudon (2005) *Essentials of Management Information Systems: Managing the Digital Firm and Student Multimedia Edition Package, 6th edition*, Upper Saddle River, NJ: Prentice Hall.
- Bocij, P. et al. (2005) *Business Information Systems: Technology, Development and Management for the E-business, 3rd edition*, Financial Times/ Prentice Hall.
- Gorgone, J.T. et al. (2002) "Model Curriculum and Guidelines for Undergraduate Degree Program in Information System", www.acm.org/education/is2002.pdf, pp. 13-14.
- Minor, O. and J. Armarego (2004) "Requirements Engineering: a Close Look at Industry Needs and Model Curricula", [http://awre2004.cis.unisa.edu.au/9 paper awre.pdf](http://awre2004.cis.unisa.edu.au/9%20paper%20awre.pdf)
- Tuya, J. and J. Garcias-Fajul (1999) "Teaching Requirements Analysis by Means of Student Collaboration", *29th ASEE/IEEE Frontiers in Education Conference*.
- Schatzberg, L. (2002) "Applying Bloom's and Kolb's Theories To Teaching Systems Analysis & Design," *The Proceedings of ISECON 2002*, (19) (San Antonio), <http://isedj.org/isecon/2002/342b/ISECON.2002.Schatzberg.pdf>
- Boone, M. (1991) *Leadership and the Computer*, Roseville, CA: Prima Publishing.
- Bloom, B.S. (1956) *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain*, New York: David McKay Co. Inc.
- Machanick, P. (2000) Experience of Applying Bloom's Taxonomy in Three Courses, <ftp://ftp.cs.wits.ac.za/pub/research/reports/TR-Wits-CS-2000-7.pdf>
- Buckley, J. and C. Exton (2003) "Blooms' Taxonomy: A Framework for Assessing Programmers' Knowledge of Software Systems," *iwpc*, pp. 165-174 *11th IEEE International Workshop on Program Comprehension (IWPC'03)*.

Lister, R. (2006) "Driving Learning Via Criterion-Referenced Assessment Using Bloom's Taxonomy," *UniServe Science Assessment Symposium Proceedings*, <http://science.uniserve.edu.au/pubs/procs/2006/lister.pdf>

Steinke, P. and P. Fitch (2007) *Assessing Service Learning*, http://www.virginiaassessment.org/rpa/2/Steinke_Fitch.pdf

APPENDIX I. TEMPLATE EXAMPLE (INITIATION AND PLANNING DOCUMENT)

This appendix contains an example of one of the template documents used in class. In this is example the template for the first document is presented.

The workshop consists of four documents, so four different templates are provided on the workshop web site. The templates are simple Word files with a list of paragraphs to be addressed by the students.

The templates serve only as general guidelines. The students have to consider each paragraph for its relevance to their particular story. It is expected that students will include in their document additional needed paragraphs, if such paragraphs are missing in the template.

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--- 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

Figure 2. Initiation and Planning Document Template

APPENDIX II. GUIDELINES EXAMPLE

This appendix contains an example of the guidelines documents used in class. The workshop consists of four documents, so four different guideline documents are provided on the workshop web site. These guidelines are consistent with the documents' templates and provide the relative grade of each of the paragraphs in the document. The guidelines documents are based on Excel worksheets. The students fill in the worksheet and submit it electronically. The worksheet is locked and only relevant fields are available for the students (the marked fields). The total grade is calculated automatically.

The template presented in this example is for the second document.



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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

Part A		Max		Reason for the grade
Paragraph	Grade	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

ABOUT THE AUTHOR

Aharon Yadin is a Senior Lecturer at the Max Stern Academic College of Emek Yezreel, Computer Science and Information Systems Department. Aharon's primary teaching areas are computer architectures and business/management information systems. Prior to entering the academic world, Aharon worked in the computing industry. He has over 30 years of IT experience including: management, system performance analysis and enhancement, computer center and IS management, communication technologies, wireless networks, document management, research, development, consulting and lecturing on innovative and new technologies.

Aharon has published and presented papers at several conferences, he is the author of 4 books and consults the European Commission on software related projects and technologies.