Received: 14 January 2017 | Accepted: 1 May 2017
DOI: 10.1002/cae.21841

GPMS: An educational supportive graduation project management system

Mamoun Awad

College of IT, UAE University, Al Ain, UAE

Correspondence
Mamoun Awad, College of IT, UAE University, Al Ain P.O Box 15551, UAE.
Email: mamoun.awad@uaeu.ac.ae

Abstract

Senior Graduation Project highlights a significant milestone for undergraduate and graduate students in their journey of perusing their scientific degrees. It is considered a must-complete requirement in most colleges. No doubt that managing the educational tasks, such as selecting projects, creating rubrics, scheduling, submitting reports, resource managements, assessment, etc., involved in senior projects can be challenging for students and educators. In this paper, we present an innovative Graduation Project Management System (GPMS) to keep track of different senior project educational processes starting from selecting projects going through grading until assessment. GPMS is equipped with data analytic gadget to monitor students' pedagogical habits. This online system is based on open source technologies, namely, Java, Apache/Tomcat, WEKA, and MySql database management system (DBMS), and it is very flexible, adaptable, and configurable for most colleges.

KEYWORDS

ARM, assessment, DBMS, decision trees, Java, rubric, Senior Graduation Project

1 | INTRODUCTION

Higher education institutions have recognized the advantages of conducting research at the undergraduate level long time ago. Undergraduate research helps students build new skills independently and become scientists [10,14]. Normally, programs integrate undergraduate research through undergraduate thesis or senior project. Almost all universities dictate to complete senior project or research thesis as a requirement of graduation [20]. Senior project is based on teaching and learning model popularly referred to as "Project Based Learning" (PBL) [19]. Such model gives students the opportunity to learn independently rather than the traditional lecture-based model. Additionally, Accreditation Board for Engineering and Technology (ABET) stresses on open-ended courses [6], such as senior project, with an accumulated background of curricular components. The premise is that such courses provide senior students with capability in solving "real world," open-ended engineering problems [20].

No doubt that senior project is considered a major milestone before graduation because students acquire experience and connect practical applications with theories [19].

Normally, senior students work on a capstone project in their last year [20]. Each student or a group of students focuses on a particular topic or problem, prepares a plan, and carries out the project based on scientific principles.

In the College of Information Technology at the United Arab Emirates University (UAEU), senior project course is a degree requirement. Students have to finish the project successfully within two semesters. In the first semester, students choose a subject, conduct a literature review, and manage resources and planning. In the second semester, students carry out system analysis, decide on technologies and design, conduct research analysis, interpret the results, and present them scientifically. Consequently, graduation project is one of the indispensable courses of IT and Engineering and it should stay that way [16].

Based on our experience in the College, we have observed many patterns and abnormalities in students' performance and grades. Examples of abnormality include incomplete implementation, bad reports, sloppy presentations, and others. The root causes of that turned out to be lack of management system for senior project, absence of student's grades analysis, and students' deficiency of understanding and finding projects.

Certainly managing different educational tasks in senior project is a challenging task and requires electronic system. This system will keep track of graduation projects details such as deliverables/reports, rubrics, grades, guidelines, resources management, proposals, reporting, announcement, and teaching assessment. In UAEU like in many other higher educational institutions, managing graduation projects is still limited to scheduling, grading, and committee formulation using manual methods such as Emails, Excel sheets, and paper-based rubrics. It is obvious that developing an electronic system will be highly beneficial to all stakeholders.

The literature has few attempts to develop a comprehensive system for graduation project. Khelifi et al. [13] introduced a graduation project software system to improve the ability of all stakeholders to manage academic tasks. However, it lacks assessment, rubric management, and data analytics. Authors of [22] analyzed, designed, and implemented graduation management system. The system dealt with only selecting project topics, supervising, and managing courses, and collecting data. In Ref. [12], Ketari described the design and implementation of an online library for graduation projects (OGPL). OGPL is a web-based application developed to assist universities to maintain graduation projects' documentation in a repository. OPGL is limited to be used in libraries to search and view graduation projects.

Our work is different from [12,13,22] in which we designed and implemented a comprehensive system that can be used and integrated in universities and libraries. In addition to maintaining a repository of graduation project documentation, it supports project proposals, rubric management, scheduling, grading, assessment, and data analytics to improve the educational process. Our contribution in integrating senior project in a centralized system has the benefits of monitoring and comparing student achievements, identifying academic patterns, measuring the scientific level of graduates, utilizing previous experiences and continuing on others' work, and evaluating/assessing current curriculum accordingly. To the best of the authors' knowledge, no dedicated open source management system exists and this is the first attempt to develop one.

We commenced this work by investigating the requirements of institutions for a software tool to manage educational tasks involved in senior project. Based on these requirements, we propose a web-based senior/graduation project management system (GPMS). The software helps academic stakeholders maintain and manage senior projects as follows.

- Advising faculty can post senior project proposals, view deliverables, communicate with students, and post/view grades.
- Examining faculty can view schedule, view project deliverable, grade projects, and post/view grades.
- Students can view/select projects, upload deliverables, view grades, download resources, and view guidelines.
- Coordinator can manage proposals, upload records, create schedule, edit/create rubrics, prepare assessments, generate reports, and discover knowledge.

GPMS is configurable for one-semester based project or two-semester based projects. Additionally, it provides a pre-preparation stage by managing call for senior proposals (CFS), searching current proposals, and grouping students. Also, stakeholders receive notification for deadlines, scheduling, and deliverables. Furthermore, GPMS maintains project deliverables in a repository and can be retrieved, updated, and searched later. Moreover, grading is based on rubric and it is well managed through grading assignment capability and feedbacks. Finally, we have incorporated assessment process that includes developing learning outcomes, mapping outcomes to rubric items, and assessment reporting.

The contributions of this work are as follows. First, we have designed and implemented an open source system based on open source technologies, namely, Java, Apache/Tomcat, Weka, and MySql DBMS, for managing graduation project for educational institutions. Second, the system is adaptable, user friendly, and flexible. Finally, GPMS is equipped with data analytical gadget to help analyze and discover academic patterns.

The remainder of this paper is organized as follows. In section 2, we present an overview of GPMS. Section 3 shows the design of the system. Section 4 explains the educational tasks implemented in GPMS. Section 5 elaborates on the assessment process and learning outcomes mapping. Section 6 explains the tool configurations. Section 7 discusses the reporting and data analytic gadget. Finally, in section 8, we conclude and highlight some future work.

2 | GPMS OVERVIEW

The purpose of this online tool is to manage different tasks involved in senior graduation project, which makes it very beneficial to the educational process and for all stakeholders. Stakeholders include faculty advisor, student, coordinator, and faculty examiner. Educational tasks vary from one stakeholder to another. For students, tasks include searching topics, selecting project, working on the project, uploading deliverables, and viewing grades. For coordinator (administrator) of the course, responsibilities involve calling for senior projects, managing/grouping students, announcements, exam scheduling, developing rubrics, overriding grades, course assessment, reporting, and data analytics. For faculty advisor, tasks include posting projects, accepting student(s), supervision, reviewing deliverables, and grading. For examiners, duties involve grading projects and viewing schedule and announcements. GPMS provides an online, easy-to-use, flexible solution to manage these tasks of all stakeholders. In terms of system functionalities and interactions with the system, Figure 1 presents the use case model of GPMS. The use case diagram models the functional requirements of the system, functional decomposition/relationships, and its interaction with its surroundings/environments. The diagram follows the Universal Modeling Language (UML) standards. In the following is an elaboration of each functionality:

- Registration: Any user of the system must register before using the system. The tool keeps track of user information that includes name, email, user id, department, and password. In addition, there will be a role assigned to the user. User can claim one role, namely, student, faculty, or coordinator. The tool supports account management, which includes login, logout, update user information, update password, and reset password.
- Proposal management: This capability allows faculty to post their senior project details and let students search and view current senior topics. Relevant functions include editing, copying, and deleting proposals.
- Senior allocation: Students can register for certain senior topics. At most four students can register for one senior project. Other relevant functions include deallocation and transfer.
- Project deliverables: Students upload their final reports, presentations, and other deliverables through this functionality. Students can also view, download, and delete deliverables. Other stakeholders can only view students' deliverables.
- Rubric management: Coordinator can create, edit, and, under certain conditions, delete rubrics. The Rubric is a crucial constituent of the system that other functionalities, such as assessment and grading, depend on.
- Scheduling: Coordinator can create a schedule by setting examination date, time, location, and examiners. Once the schedule is finalized, it is broadcasted to all stakeholders, and it becomes visible on the system.
- Grading: Coordinator must select a rubric for grading. Based on the rubric selected for the semester, examiners and advisors assign grades accordingly. There is a separate grade for each rubric item. Once grading is complete, students can view them.
- Reporting: Coordinator can generate reports related to senior projects, students, grades statistics, and others.
- Assessment: Coordinator can create an assessment sheet that comprises a list of learning outcomes. In addition, she can add, edit, and delete learning outcomes. Furthermore, learning outcomes can be mapped to rubric items. Based on such mapping, assessment reports can be generated to assess the learning process.
- Configuration: System must be configured at the beginning of each semester. Configuration includes selecting rubric, setting deliverable due dates, assessments, and others.
- Data analytics: Coordinator can generate patterns based on grades. Discovered patterns can be used to adjust and improve the learning activities.

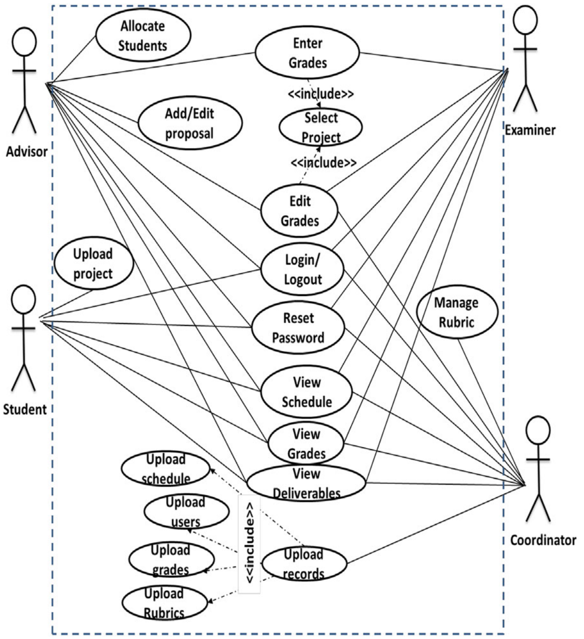


FIGURE 1 Use Case model of GPMS

3 | DESIGN OF GPMS

In GPMS, we keep track of many relevant information that includes user information, project information, student-project allocations, course assessments, exam schedules, evaluation rubrics, students grades, and system configurations. Figure 2 presents the data base design of these entities and their relationship using Entity Relationship Diagram (ERD). In this design, care was taken to create robust and

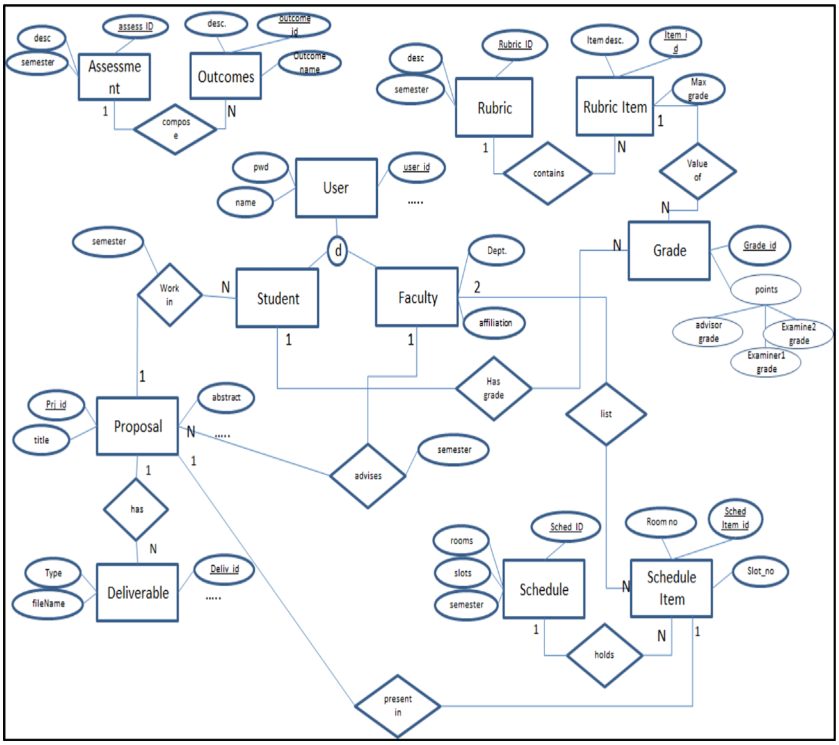


FIGURE 2 ER diagram of GPMS

flexible entities. For example, because rubric can change based on different aspects of the learning process, the coordinator cannot delete previous rubrics, instead she can create new rubric and use it. She can edit the rubric though, as long as no grading was conducted based on that edited rubric. Note that changing the rubric will affect the grading, assessment, and reporting activities. Hence, we have crafted these entities such that old grades/assessments stay intact while new ones can be used.

With regard to architecture, we adopted 3-tier architecture in which the presentation layer (Java Servlet Pages [JSP] and their helpers) communicates with Business and logic layer (entity and business classes). The business layer interconnects with the data layer (MySql Database) in the backend. Figure 3 shows these layers and some of the corresponding classes in each layer. The implementation of such architecture results of developing more than 30 JSP/Servlet pages/classes, 20 entity/business Java classes, and 15 Database managers.

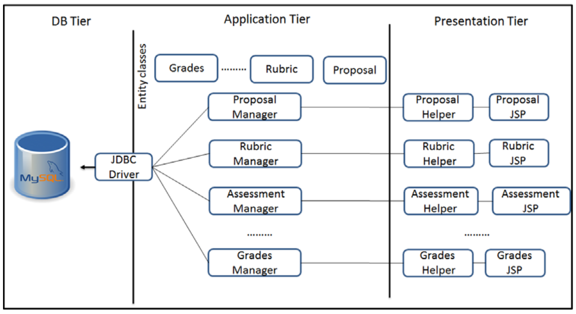


FIGURE 3 3-tier system architecture

The 3-tier architecture is a standard well-known architecture that provides an efficient and robust solution to many recurring design and development problems.

In terms of graphical user interface (GUI), we used the standard HTML/JSP technology for the WEB. We took special care to develop flexible user screens and reduce the amount of typing by using drop down lists, checkboxes, etc. In addition, we equipped the GUI with an upload gadget that allows the user to upload different entities from text or extensible Markup Language (XML) files. In terms of usability, the GUI pages are simple, have same look and feel, and can be edited easily by any novice programmer.

The application logic layer captures the controlling functionalities and manipulates the underlying logic connection of information flows. Specifically, this layer bridges the gap between the presentation layer (user requests) and the underlying database hiding technical details from the user. We have created many entity classes to perform appropriate communications and calculations activities between the database and the presentation layer.

Finally, the database tier (back end) is responsible for modeling the system information and for accessing and persisting the data. The database tier fulfills the requests that come from the application layer. In GPMS, data is one of the most complex aspects and it is essential in structuring the system. We deployed and used MySql database management system in our system.

4 | EDUCATIONAL TASKS IN GPMS

As we mentioned before, there are many educational tasks involved in senior project. Each task is related to different stakeholders. In this section, we will elaborate on these tasks by describing different aspects and specifics of the tool. More elaborate description and step-by-step explanation of the usage of the system can be found in [4].

4.1 | Call for project proposal

A graduation proposal or simply a proposal is the initial stage for students and faculty advisors to kick off senior project course. A proposal is a detailed and precise description of study or research topic to be investigated. Details might be different from college to another; however, information such as title, abstract, description, objectives, and software/hardware tools must be clear to students. In the last semester of study or perhaps before that, senior students approach faculty for project/thesis supervision. At this stage, some students have some idea of the topic to work on; however, most students rely on the faculty to propose topics. A computerized Call-For-Projects can make topic selection easier for students and faculty. For faculty, she can create, edit, reuse, and upload proposals and make them available to all students. For students, they can search proposals and explore more ideas offered by faculty. Once student(s) and faculty agree on the project proposal, the project is allocated to students. In this paper, we refer to the process of assigning students to a proposal as proposal allocation.

In the following, we present the process of managing the call for proposals in GPMS. To manage proposals, GPMS has three views, namely, faculty, student, and coordinator views (see Figure 4). The faculty view allows the faculty to create new proposals, edit unallocated proposals, view proposals, allocate/deallocate proposals to student(s), and display allocations. For each proposal, we keep track of the following sections: title, abstract, objectives, departments, tools, and offered semesters (see Figure 5). Notice that faculty and coordinator can select from previously created proposals or upload proposals from an XML file.

Students can view and search proposals looking for topics of interests. Students search proposals either by using simple search form or by using advanced search form in which they can inquire different fields such as proposal title, advisor name, and semester (see Figure 6). GPMS does not have online allocation of project because normally faculty meets students face-to-face to further explain the project requirements and examine the team before approving the allocation.

While faculty can manage only her own proposals, coordinator has more privileges in managing all proposals. In addition, coordinator can upload proposals in a batch mode (see Figure 7). Coordinator can select type of upload, namely, student records, faculty records, allocation records, grades, and project records. Then she can browse/select a file, and upload the file. For more details about the format of the files see [4].

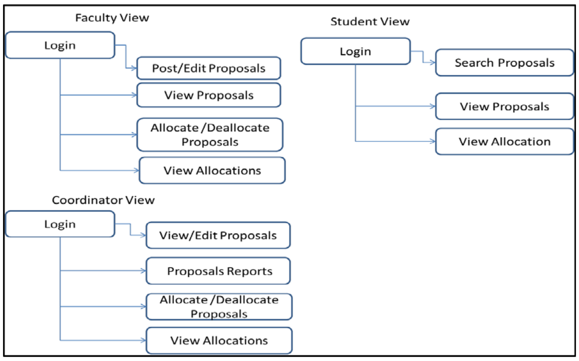
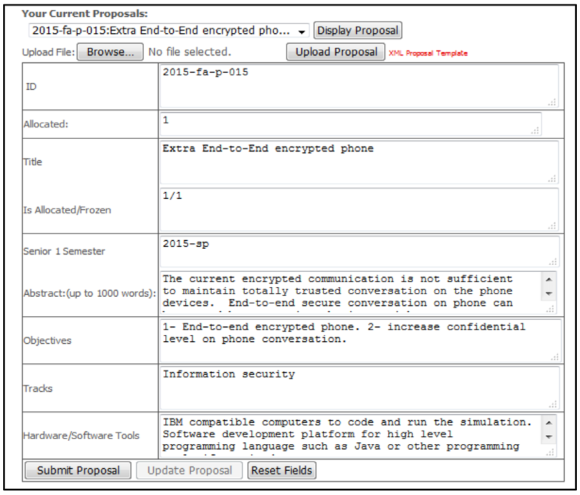


FIGURE 4 Different views in managing proposals

4.1.1 | Project allocation

Allocation and releasing are two tasks that happen heavily at the beginning of the semester. Recall that project allocation means assigning students to projects. On the contrary, releasing sets students free to select other projects. During allocations, faculty selects the proposal and the student(s) from a drop down lists. Only unassigned students will be listed in the drop down list. Faculty can also edit allocation by releasing students and/or assigning other students to projects (see Figure 8). In addition, faculty can view her current projects and students details.

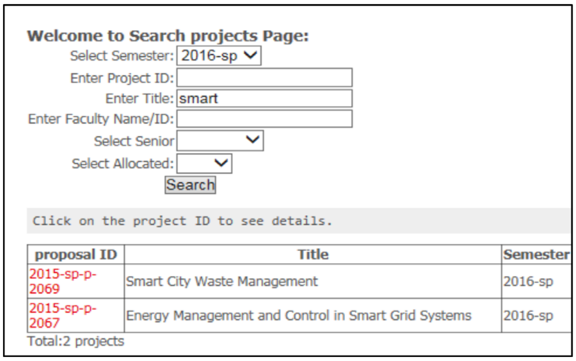


Your Current Proposals: 2015-fa-p-015:Extra End-to-End encrypted pho...

Upload File: No file selected.

ID	2015-fa-p-015
Allocated:	1
Title	Extra End-to-End encrypted phone
Is Allocated/Frozen	1/1
Senior 1 Semester	2015-sp
Abstract:(up to 1000 words):	The current encrypted communication is not sufficient to maintain totally trusted conversation on the phone devices. End-to-end secure conversation on phone can
Objectives	1- End-to-end encrypted phone. 2- increase confidential level on phone conversation.
Tracks	Information security
Hardware/Software Tools	IBM compatible computers to code and run the simulation. Software development platform for high level programming language such as Java or other programming

FIGURE 5 Create/edit proposals-faculty view



Welcome to Search projects Page:

Select Semester: 2016-sp
Enter Project ID:
Enter Title: smart
Enter Faculty Name/ID:
Select Senior
Select Allocated:

Click on the project ID to see details.

proposal ID	Title	Semester
2015-sp-p-2069	Smart City Waste Management	2016-sp
2015-sp-p-2067	Energy Management and Control in Smart Grid Systems	2016-sp

Total:2 projects

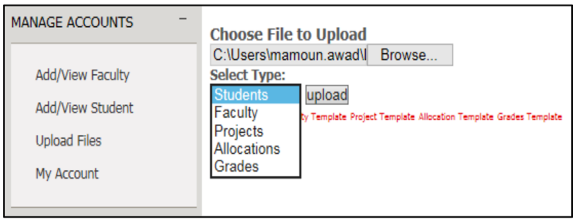
FIGURE 6 Searching projects form

The coordinator can view, edit, and search allocations. Additionally, she can upload allocation records in a batch mode (see Figure 7). Students can search and view proposals details, and their own allocations.

4.2 | Managing accounts

All users of GPMS must have accounts in order to use it. For each user, we store information such as first name, last name, email, ID, role, and affiliation (if applicable). The coordinator is responsible of creating these accounts. The system is flexible, in which it provides the capability of manually creating the accounts (see Figure 9) or batch uploading from a file (see Figure 7). There are five different unloadable records types, namely, student accounts, faculty accounts, project/proposal details, allocations, and grades. It is evident that both manual and batch upload mechanisms are necessary for better records management. Once an account is created, a default password is generated and the user is recommended to change it. Figure 9 shows the coordinator view of adding, editing, and searching faculty information manually. The view of updating and searching student information is similar. In addition, the coordinator can search accounts based on ID and Name.

All users can view and edit their accounts information including resetting their passwords. Users are notified via email when their credentials are changed.

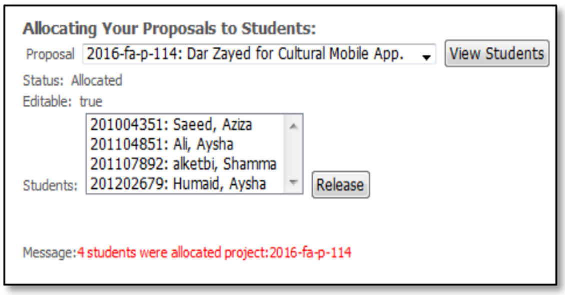


Choose File to Upload

C:\Users\mamoun.awad\

Select Type: Students

FIGURE 7 Uploading different records in batch mode including proposals/projects



Allocating Your Proposals to Students:

Proposal 2016-fa-p-114: Dar Zayed for Cultural Mobile App.
Status: Allocated
Editable: true
Students:
201004351: Saeed, Aziza
201104851: Ali, Aysha
201107892: alketbi, Shamma
201202679: Humaid, Aysha

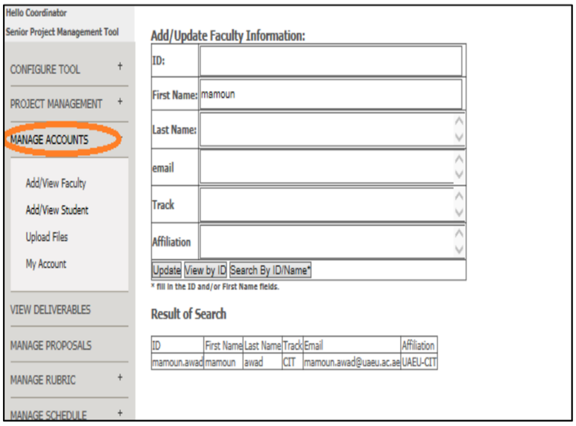
Message:4 students were allocated project:2016-fa-p-114

FIGURE 8 Allocating students to a proposal

4.3 | Students reports and deliverables

While working in senior projects, students make progress and produce different documents. Some of these documents, such as reports, posters, and presentations, must be submitted for grading. In GPMS, students can upload reports, posters, presentation slides, and other documentation. Obviously, maintaining such repository is very beneficial because it provides an automatic workflow of submitting, reviewing, and grading without using manual methods such as emails and hardcopies. In addition, previous reports can be made available publicly so that current students can utilize and build on other senior students work. Furthermore, we can validate the authenticity and originality of reports to fight against plagiarism. Such function is not currently integrated in the system, but it is a candidate function that can be easily incorporated in the future.

In GPMS, we define five customized categories of submission, namely, report, poster, IEEE format report, code, and others. Students can submit files in standard formats such as Portable Document Format (PDF), Microsoft Document format (DOC), and ZIP. Evidently, some rules are applicable in terms of file size, number of submissions, and submission due dates. Figure 10 presents how students can upload files, delete files, and view files.



Hello Coordinator
Senior Project Management Tool

Add/Update Faculty Information:

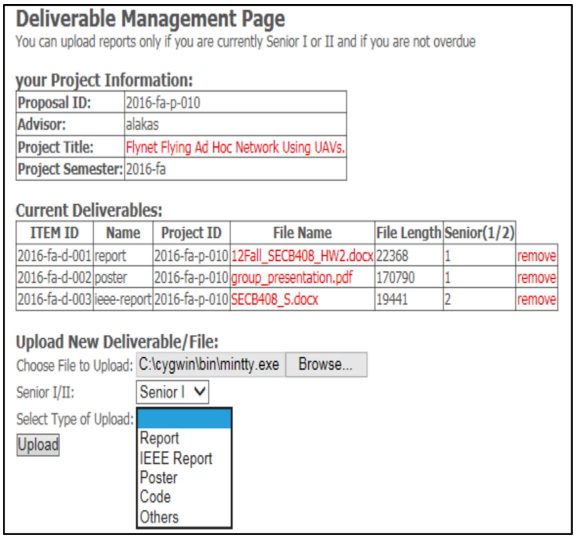
ID:
First Name: mamoun
Last Name:
email
Track
Affiliation

* fill in the ID and/or First Name fields.

Result of Search

ID	First Name	Last Name	Track	Email	Affiliation
mamoun.awad	mamoun	awad	CIT	mamoun.awad@uaeu.ac.ae	UAEU-CIT

FIGURE 9 Student accounts manual updating/searching



Deliverable Management Page

You can upload reports only if you are currently Senior I or II and if you are not overdue

your Project Information:

Proposal ID:	2016-fa-p-010
Advisor:	alakas
Project Title:	Flynet Flying Ad Hoc Network Using UAVs.
Project Semester:	2016-fa

Current Deliverables:

ITEM ID	Name	Project ID	File Name	File Length	Senior(1/2)	
2016-fa-d-001	report	2016-fa-p-010	12Fall_SECB408_HW2.docx	22368	1	remove
2016-fa-d-002	poster	2016-fa-p-010	group_presentation.pdf	170790	1	remove
2016-fa-d-003	ieee-report	2016-fa-p-010	SECB408_S.docx	19441	2	remove

Upload New Deliverable/File:

Choose File to Upload: C:\cygwin\bin\mintty.exe

Senior I/II: Senior I

Select Type of Upload:

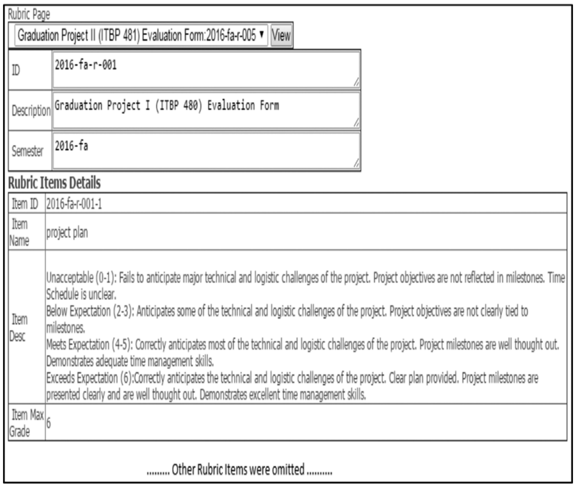
FIGURE 10 Documents/deliverables page

For faculty advisors and examiners, reports will be part of their grading assignments and they can view/download these reports through the tool.

4.4 | Rubric management

A Rubric is defined as a scoring guide used to evaluate quality of students' constructed responses. A rubric has three essential features: evaluative criteria, quality definition, and scoring strategy [17]. The use of rubric in grading has been recommended in science projects and oral presentation. In addition, some studies have showed that rubric has a potential to influence students learning positively and improve instruction [3,8,11]. In the College of IT at UAEU, we observed discrepancies in grading among faculty because each one has different grading perspective and focus. As a result of that, grading projects was inconsistent and in many cases students enjoyed easy "A" even without doing excellent work. After using rubrics, we witnessed balanced, well-distributed, and justified grades by faculty.

Many studies emphasize on validating and improving rubrics as a continuous educational process [15,18]. Hence, rubrics need to change over the years to incorporate and edit different criteria and to cope with changes. In GPMS, examiners grade projects based on a rubric; hence, without a rubric grading is not possible. Rubric creation and editing are restricted to the coordinator. Each rubric has an ID, Name/Description, and list of grading items. In GPMS, we define grading item (or rubric item) as an evaluative criterion with scoring and quality definition. Each grading item has an ID, name, description, and maximum achieved points. Figure 11 shows a sample rubric with rubric ID 2016-fa-r-001. The figure shows the details of only the first grading item, namely, "Project Plan." Observe that in the description entry, the coordinator can specify grading scheme details. In addition, notice that the maximum points of the rubric item "Project Plan" is six points. At the beginning of the semester, the coordinator sets the rubric to be used in grading, see section 6. Once the rubric is set, grading will be based on that rubric and GPMS will show rubric items during grading for advisors and examiners, see section 4.6. It is not uncommon, however, to evaluate and edit the rubric to improve grading. In the College of IT at UAEU, rubric evaluation is conducted through the graduation project committee chaired by the coordinator. The committee assesses the rubric every 2 years and decides any changes. In GPMS, the coordinator cannot edit/remove previous rubrics, instead, she can create new rubric to incorporate any new changes. Notice that both grading and course assessments depend on rubric; hence, previously used rubrics cannot be deleted/edited. In addition, the coordinator cannot use two rubrics for the same course in the same semester.



Rubric Page

Graduation Project II (ITBP 481) Evaluation Form:2016-fa-r-005

ID	2016-fa-r-001
Description	Graduation Project I (ITBP 480) Evaluation Form
Semester	2016-fa

Rubric Items Details

Item ID	2016-fa-r-001-1
Item Name	project plan
Item Desc	Unacceptable (0-1): Fails to anticipate major technical and logistic challenges of the project. Project objectives are not reflected in milestones. Time Schedule is unclear. Below Expectation (2-3): Anticipates some of the technical and logistic challenges of the project. Project objectives are not clearly tied to milestones. Meets Expectation (4-5): Correctly anticipates most of the technical and logistic challenges of the project. Project milestones are well thought out. Demonstrates adequate time management skills. Exceeds Expectation (6):Correctly anticipates the technical and logistic challenges of the project. Clear plan provided. Project milestones are presented clearly and are well thought out. Demonstrates excellent time management skills.
Item Max Grade	6

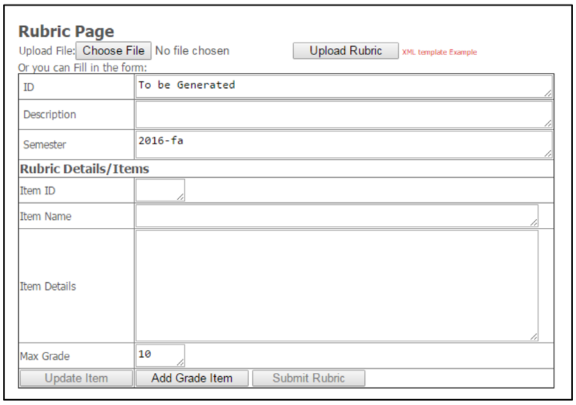
.... Other Rubric Items were omitted ....

FIGURE 11 Rubric sample

In terms of flexibility, the coordinator can manually view, create, and upload rubrics. Uploaded rubric must be in XML format (see Figure 12). For details about the XML format of the rubric file see Ref. [4]. Once a new rubric is created, the coordinator should active it by editing GPMS configuration, see section 6.

4.5 | Scheduling

Many institutions have special senior day in which all senior students present their work before an examination committee. Depending on the institution, an examination session might have oral presentation, poster session, and/or project demonstration. In GPMS, coordinator can schedule examination sessions for senior projects. For each project, we record the date, time, location, and examination committee. Each session has at most two examiners. Currently the coordinator can create a schedule for each semester for all projects. Once



Rubric Page

Upload File: Choose File No file chosen   Upload Rubric   XML template Example

Or you can Fill in the form:

ID	To be Generated
Description	
Semester	2016-fa
Rubric Details/Items	
Item ID	
Item Name	
Item Details	
Max Grade	10

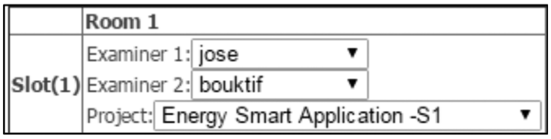
Update Item   Add Grade Item   Submit Rubric

FIGURE 12 Coordinator can create rubric manually or upload an XML rubric file

the schedule is created and finalized the coordinator makes it visible to all stakeholders. Figure 13 shows a sample time slot in a schedule. Notice that the coordinator selects a project, the first examiner, and the second examiner from drop lists. GPMS provides scheduling conflicts discovery capability and notifies the coordinator accordingly. Additionally, GPMS allows the coordinator to set/update only one slot separately without checking for conflicts as Figure 14 shows.

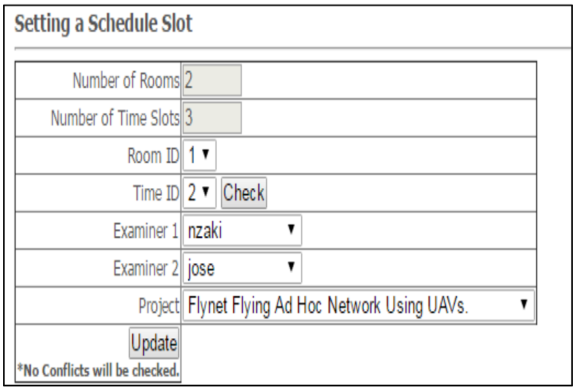
4.6 | Grading

Typically, an examination committee of two faculty grades each project. In some institutions such as UAEU, the final grade is split between the advisor's grade (60%) and the committee grade (40%). Grading criteria is based on a rubric preselected by the coordinator (see section 4.4). Consequently, examiners and advisors have to assign a grade for each rubric item. Additionally, they can provide an overall feedback on the project. Figure 15 shows the grading web form of a project. Advisor/examiner first selects one of the projects assigned to her from a drop list. Then, the corresponding rubric items and students are displayed as columns and rows, respectively. GPMS makes it easy to assign grades by copying first row, validating grades, and providing links for each rubric item details. Students and advisors can view the grades as in Figure 16. Notice that examiners can only see the grades assigned by them meanwhile students can see grades of their advisors and examination committees. GPMS provides several reports for the coordinator and advisors to view and search students' grades. For example, the coordinator can display all students' grades for a given semester. She can also search grades by student information (name and ID), semester, senior type, and combination of them. Furthermore, the coordinator can search grades by project ID, senior, semester, and combination of them. The advisor can view her students' grades per project and semester. She can also search for student's grade by student name, id, semester, and a combination of them. In all grades reports, detailed grades are displayed for each student.



	Room 1	
Slot(1)	Examiner 1:	jose
	Examiner 2:	bouktif
	Project:	Energy Smart Application -S1

FIGURE 13 Sample time slot in a schedule



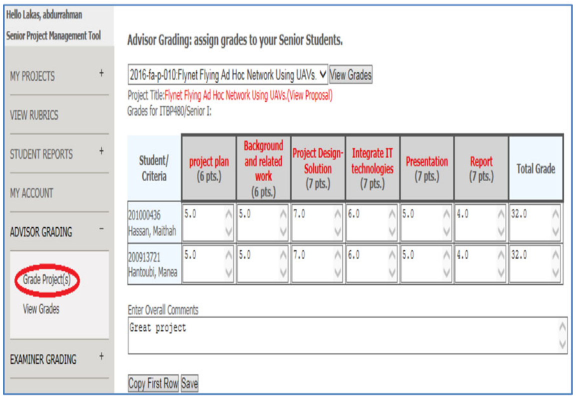
Setting a Schedule Slot

Number of Rooms	2
Number of Time Slots	3
Room ID	1
Time ID	2 Check
Examiner 1	nzaki
Examiner 2	jose
Project	Flynet Flying Ad Hoc Network Using UAVs.
Update *No Conflicts will be checked.	

FIGURE 14 Setting one time slot of a schedule

5 | ASSESSMENT IN GPMS

Assessment is the process of seeking and construing evidence for use by learners and their teachers to decide where the learners currently stand in their learning, what direction they need to steer and how best to get there. Assessment involves the use of collected grades of students to measure the achievement of predefined learning outcomes, refine programs, and improve student learning experience [2]. Assessment of students achievements aims at improve learning and it plays important role in education [7]. In this section, we show how GPMS covers all aspects of managing assessment.



Advisor Grading: assign grades to your Senior Students.

2016-fa-p-010:Flynet Flying Ad Hoc Network Using UAVs.   View Grades

Project Title: Flynet Flying Ad Hoc Network Using UAVs.(View Proposal)

Grades for ITBP480/Senior I:

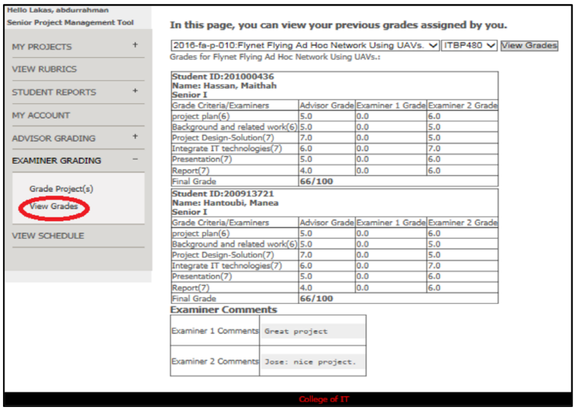
Student/ Criteria	project plan (6 pts.)	Background and related work (6 pts.)	Project Design-Solution (7 pts.)	Integrate IT technologies (7 pts.)	Presentation (7 pts.)	Report (7 pts.)	Total Grade
201000436 Hassan, Maithah	5.0	5.0	7.0	6.0	5.0	4.0	32.0
200913721 Hantoubi, Manea	5.0	5.0	7.0	6.0	5.0	4.0	32.0

Enter Overall Comments

Great project

Copy First Row   Save

FIGURE 15 Grading project form



In this page, you can view your previous grades assigned by you.

2016-fa-p-010:Flynet Flying Ad Hoc Network Using UAVs. | ITBP480

Grades for Flynet Flying Ad Hoc Network Using UAVs.:

Student ID:201000436
Name: Hassan, Maithah
Senior I

Grade Criteria/Examiners	Advisor Grade	Examiner 1 Grade	Examiner 2 Grade
project plan(6)	5.0	0.0	6.0
Background and related work(6)	5.0	0.0	5.0
Project Design-Solution(7)	7.0	0.0	5.0
Integrate IT technologies(7)	6.0	0.0	7.0
Presentation(7)	5.0	0.0	6.0
Report(7)	4.0	0.0	6.0
Final Grade	**66/100**		

Student ID:200913721
Name: Hantoubi, Manea
Senior I

Grade Criteria/Examiners	Advisor Grade	Examiner 1 Grade	Examiner 2 Grade
project plan(6)	5.0	0.0	6.0
Background and related work(6)	5.0	0.0	5.0
Project Design-Solution(7)	7.0	0.0	5.0
Integrate IT technologies(7)	6.0	0.0	7.0
Presentation(7)	5.0	0.0	6.0
Report(7)	4.0	0.0	6.0
Final Grade	**66/100**		

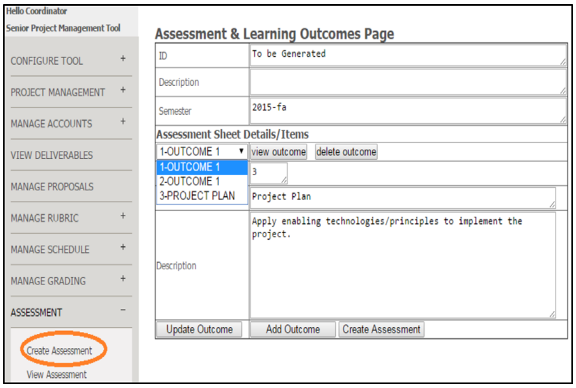
Examiner Comments

Examiner 1 Comments	Great project
Examiner 2 Comments	Jose: nice project.

FIGURE 16 Viewing grades

5.1 | Learning outcomes

The main step of assessment is to create learning outcomes and map them to curriculum activities. A learning outcome describes students' capability to demonstrate in terms of knowledge, skills, and values upon completion of a course, a span of several courses, or a program. Solid and clear articulation of learning outcomes serves as the foundation to evaluating the effectiveness of the teaching and learning process [21]. In GPMS, the coordinator can create assessment sheet, create learning outcomes, and map learning outcomes to assessment tools. Assessment tools are limited to rubric criteria already defined as in section 4.4. Figure 17 presents the web form we use to create new assessment criteria. In GPMS, we refer to assessment criteria as assessment sheet. An assessment sheet contains several learning outcomes in which each learning outcome has ID, name, and description. Each assessment sheet has an automatic unique ID and a description. Since assessment is a dynamic process that gets validated and improved regularly, the coordinator can create sheets, on a need basis, and use them in different academic years accordingly.



Assessment & Learning Outcomes Page

ID	To be Generated
Description	
Semester	2015-fa

Assessment Sheet Details/Items

1-OUTCOME 1 ▾

1-OUTCOME 1
2-OUTCOME 1
3-PROJECT PLAN

3

Project Plan

Description: Apply enabling technologies/principles to implement the project.

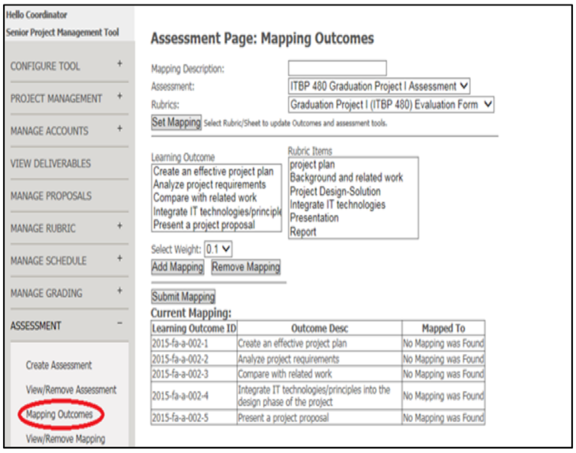
FIGURE 17 Create assessment sheet form

5.2 | Mapping learning outcomes

In order to measure the achievement of learning outcomes, we should assign assessment tools to each learning outcome. Assessment tools include any evaluation method of certain aspect of the course, for example, quizzes, tests, homework, midterms, and final exams. In GPMS, the coordinator maps a learning outcome to an assessment tool and assigns weight to show the contribution of the tool in assessing the outcome. The coordinator can create different mapping based on a pre-defined assessment sheet and a rubric. Figure 18 shows the web form in which the coordinator can map learning outcomes to rubric items. Once the coordinator selects the assessment sheet and rubric, the details of both, namely, rubric items, and learning outcomes, will be displayed in drop lists. Then, the coordinator maps each learning outcome to rubric item(s) and assigns weights for that. Typically, each learning outcome is mapped to one or more rubric items. GPMS allows the coordinator to edit mapping by adding/removing items. Once finished, the coordinator submits the mapping. Each mapping will have an auto-generated unique ID and description. The coordinator can also remove a mapping; however, only those mappings that are not used/referenced can be removed. Figure 19 presents the web form in which the coordinator can select and view a mapping based on mapping description. In addition, the coordinator can remove the mapping. After grading projects, GPMS can generate reports that show the achievement of learning outcomes by students.

5.3 | Assessment report

The last stage of assessment in GPMS is generating assessment report. The coordinator can generate the assessment report as in Figure 20. The coordinator shall



Assessment Page: Mapping Outcomes

Mapping Description:
Assessment: ITBP 480 Graduation Project I Assessment
Rubrics: Graduation Project I (ITBP 480) Evaluation Form

Select Rubric/Sheet to update Outcomes and assessment tools.

Learning Outcome
Create an effective project plan
Analyze project requirements
Compare with related work
Integrate IT technologies/principle
Present a project proposal

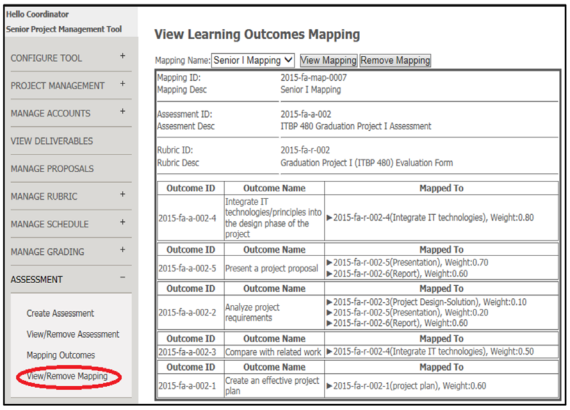
Rubric Items
project plan
Background and related work
Project Design-Solution
Integrate IT technologies
Presentation
Report

Select Weight: 0.1

Current Mapping:

Learning Outcome ID	Outcome Desc	Mapped To
2015-fa-a-002-1	Create an effective project plan	No Mapping was Found
2015-fa-a-002-2	Analyze project requirements	No Mapping was Found
2015-fa-a-002-3	Compare with related work	No Mapping was Found
2015-fa-a-002-4	Integrate IT technologies/principles into the design phase of the project	No Mapping was Found
2015-fa-a-002-5	Present a project proposal	No Mapping was Found

FIGURE 18 Mapping learning outcomes to assessment tools



View Learning Outcomes Mapping

Mapping Name: Senior I Mapping

Mapping ID:	2015-fa-map-0007
Mapping Desc	Senior I Mapping
Assessment ID:	2015-fa-a-002
Assesment Desc	ITBP 480 Graduation Project I Assessment
Rubric ID:	2015-fa-r-002
Rubric Desc	Graduation Project I (ITBP 480) Evaluation Form

Outcome ID	Outcome Name	Mapped To
2015-fa-a-002-4	Integrate IT technologies/principles into the design phase of the project	▶2015-fa-r-002-4(Integrate IT technologies), Weight:0.80

Outcome ID	Outcome Name	Mapped To
2015-fa-a-002-5	Present a project proposal	▶2015-fa-r-002-5(Presentation), Weight:0.70 ▶2015-fa-r-002-6(Report), Weight:0.60

Outcome ID	Outcome Name	Mapped To
2015-fa-a-002-2	Analyze project requirements	▶2015-fa-r-002-3(Project Design-Solution), Weight:0.10 ▶2015-fa-r-002-5(Presentation), Weight:0.20 ▶2015-fa-r-002-6(Report), Weight:0.60

Outcome ID	Outcome Name	Mapped To
2015-fa-a-002-3	Compare with related work	▶2015-fa-r-002-4(Integrate IT technologies), Weight:0.50

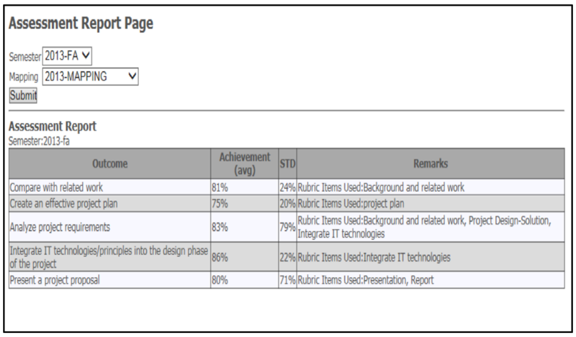
Outcome ID	Outcome Name	Mapped To
2015-fa-a-002-1	Create an effective project plan	▶2015-fa-r-002-1(project plan), Weight:0.60

FIGURE 19 Viewing/removing mapping

first select the semester and the predefined mapping. The grades of that semester are analyzed and used to assess the learning outcomes defined in the mapping. Notice that having grades, assessment sheet, and learning outcomes mapping are pre-conditions to the report generation. In Figure 20, each learning outcome is listed along with its achievement rate. For example, the first learning outcome, "Compare with Related Work," is achieved by 81%, with standard deviation 24%, and the rubric item "Related Work" is used for measurement. In GPMS, the assessment of a certain learning outcome, *L*, is calculated as follows. For each rubric item, T_i, the normalized average of the grades (G_i) in that rubric item is calculated as in Eq. 1, where G_i is a grade, *N* is he number of grades and *M* is the maximum grade. Next, the achievement of learning outcome, *A*(*L*), is computed by calculating the weighted average of those contributing rubric items to *L* as in Eq. 2, where w_r is the weight of the rubric item, *r*, and *N* is the number of contributing/mapped rubric items to *L*.

$$T_{\mathrm{i}} = \frac{\frac{1}{N}\Sigma_{\mathrm{i}=1}^{N} G_{\mathrm{i}}}{M} \tag{1}$$

$$A(L) = \frac{1}{N}\sum_{r=1}^{N} w_{\mathrm{r}} T_{\mathrm{r}}, 0 \geq w_{\mathrm{r}} \geq 1 \tag{2}$$



Semester 2013-FA

Mapping 2013-MAPPING

Assessment Report

Semester:2013-fa

Outcome	Achievement (avg)	STD	Remarks
Compare with related work	81%	24%	Rubric Items Used:Background and related work
Create an effective project plan	75%	20%	Rubric Items Used:project plan
Analyze project requirements	83%	79%	Rubric Items Used:Background and related work, Project Design-Solution, Integrate IT technologies
Integrate IT technologies/principles into the design phase of the project	86%	22%	Rubric Items Used:Integrate IT technologies
Present a project proposal	80%	71%	Rubric Items Used:Presentation, Report

FIGURE 20 Assessment report

6 | CONFIGURATION AND RESOURCE MANAGEMENT

GPMS is a dynamic system in which the coordinator needs to configure it with different parameter values on certain times to reflect the institution or college needs. These parameters are very critical for GPMS to work correctly. This includes database configuration, download folders, static guidelines, resources, tool variables, and organization logo. Tool variables are those values that need to be set every semester and it includes rubric selection, assessment mapping, current semester, and due dates (see Figure 21).

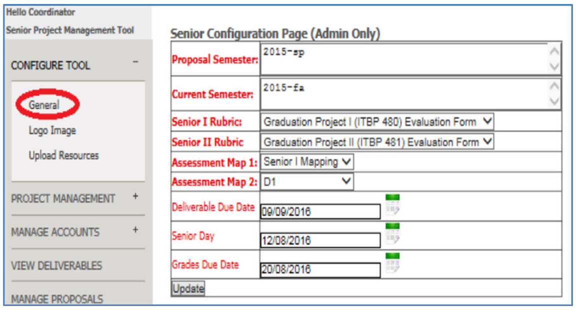
The coordinator can create/update guidelines and resources and publish them to students online. Examples of resources are report template, poster guidelines, and rubric forms. GPMS supports contents management of the resources and guidelines. These guidelines and resources will show up on the starting page of the students when they login. Students can view resources and guidelines at the starting page, or they can download them (see Figure 22). Additionally, the coordinator can remove and edit these guidelines.

The homepage of GPMS users has mixture of important due dates, guidelines, and templates/resources for download.

7 | REPORTS AND DATA ANALYTICS

In GPMS, students' grades are analyzed to generate reports and statistics, and draw conclusions. Reports can be semester oriented or rubric oriented. In other words, a report is generated based on students' grades in a certain semester or based on students' grades spanning many semesters of a certain rubric.

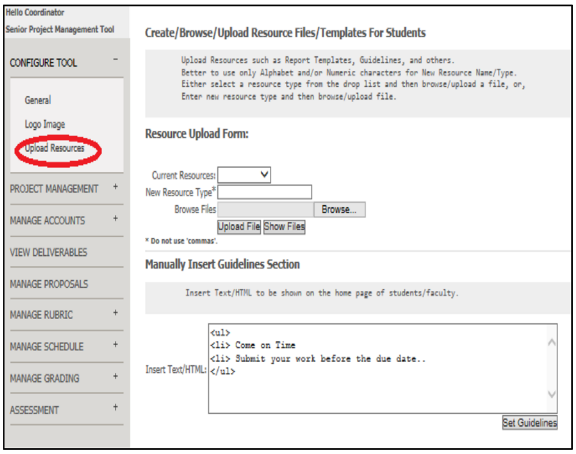
The grades statistics report is the first report in GPMS. It is a summary report that summarizes the grades of students. The report has the following statistics: lowest grade, highest grade, average grade, standard deviation, 5th percentiles, 25th percentiles, and final grade distributions. A percentile is a statistical measure that indicates the value below which a



Senior Configuration Page (Admin Only)

Proposal Semester:	2015-sp
Current Semester:	2015-fa
Senior I Rubric:	Graduation Project I (ITBP 480) Evaluation Form
Senior II Rubric	Graduation Project II (ITBP 481) Evaluation Form
Assessment Map 1:	Senior I Mapping
Assessment Map 2:	D1
Deliverable Due Date	09/09/2016
Senior Day	12/08/2016
Grades Due Date	20/08/2016

FIGURE 21 Configuration of GPMS-tool variables



Create/Browse/Upload Resource Files/Templates For Students

Upload Resources such as Report Templates, Guidelines, and others.
Better to use only Alphabet and/or Numeric characters for New Resource Name/Type.
Either select a resource type from the drop list and then browse/upload a file, or,
Enter new resource type and then browse/upload file.

Resource Upload Form:

Current Resources:
New Resource Type*
Browse Files

* Do not use 'commas'.

Manually Insert Guidelines Section

Insert Text/HTML to be shown on the home page of students/faculty.

Insert Text/HTML:

```
<ul>
<li> Come on Time
<li> Submit your work before the due date..
</ul>
```

FIGURE 22 Resources and guidelines management

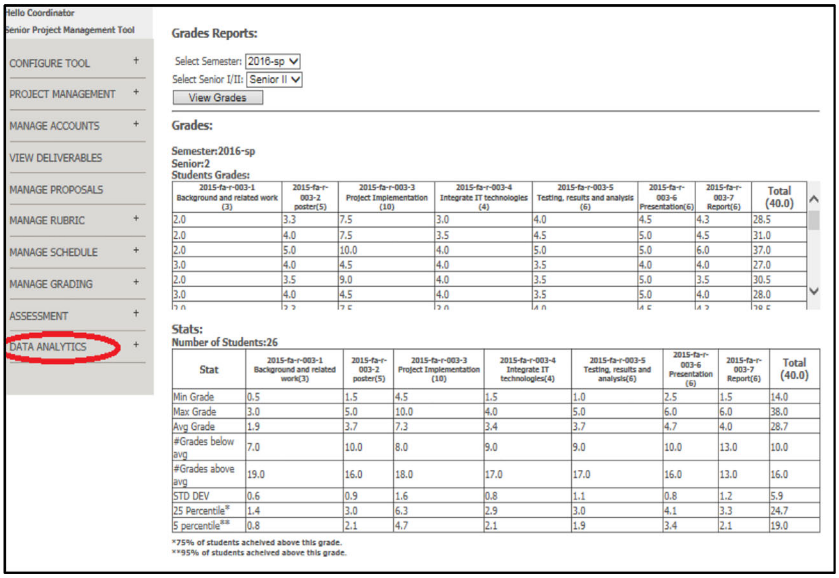
given percentage of observations in a group of observations falls. For example, if the 25th percentile of the final grade of students is 80, then 25% of students has a grade of 80 or less. Conversely, 75% of students has score better than 80. Figure 23 presents a screenshot of the grades statistics of spring 2016 grades of senior II. The first table in Figure 23 shows the list of grades and the second table shows statistics. For example, 95% of students achieved a final grade at or better than 19/40 in senior II, and 75% of students achieved a final grade at or better than 24/40. The coordinator can make use of these statistics in identifying problems and difficulties facing students.

In addition to the summary report, GPMS is equipped with data mining component that analyzes grades of the rubric items. The results of these reports can be used to make decision such as which part of the rubric students should focus on in order to improve their final score. We have incorporated two data mining mechanism to analyze the data, namely, Association Rule Mining (ARM) and Decision Tree (DT). ARM is useful to associate fields together based on a population while DT can predict future grades. Both can help discover hidden patterns in the students' grades; hence, uncover certain behavior of students in conducting senior activities. The implementation of ARM and DT is based on WEKA data mining software [9].

7.1 | Decision trees (DT)

Decision Trees (DT) is a flowchart-like structure that is commonly used in operations research applications and in data mining [5]. DT associates fields and builds a tree that represents the population. Each internal node represents a "test" on an attribute, each branch represents the outcome of the test and each leaf node represents an outcome or decision. The path from root to leaf represents a classification rule. These rules are used to make prediction or judgment. In GPMS, the target is set to predict the final grade of a student given incomplete set of rubric grades. We can also draw conclusions about the effectiveness of the rubric in evaluating students and adjust it accordingly. J48 and C4.5 are examples of decision tree implementations. The reader is referred to [5] for more details about decision trees algorithms.

In GPMS, we used the students' grades to generate J48 decision tree. Notice that, in each semester, the coordinator sets the rubric that will be used for grading. The grades are collected based on that set rubric. DT analyzes the grades of each rubric item, constructs associations between them, and builds tree to predict student final grade. DT analysis in GPMS can be either semester-oriented, to seek patterns in the



Grades Reports:

Select Semester: 2016-sp
Select Senior I/II: Senior II

Grades:

Semester:2016-sp
Senior:2
Students Grades:

2015-fa-r-003-1 Background and related work (3)	2015-fa-r-003-2 poster(5)	2015-fa-r-003-3 Project Implementation (10)	2015-fa-r-003-4 Integrate IT technologies (4)	2015-fa-r-003-5 Testing, results and analysis (6)	2015-fa-r-003-6 Presentation(6)	2015-fa-r-003-7 Report(6)	Total (40.0)
2.0	3.3	7.5	3.0	4.0	4.5	4.3	28.5
2.0	4.0	7.5	3.5	4.5	5.0	4.5	31.0
2.0	5.0	10.0	4.0	5.0	5.0	6.0	37.0
3.0	4.0	4.5	4.0	3.5	4.0	4.0	27.0
2.0	3.5	9.0	4.0	3.5	5.0	3.5	30.5
3.0	4.0	4.5	4.0	3.5	5.0	4.0	28.0

Stats:
Number of Students:26

Stat	2015-fa-r-003-1 Background and related work(3)	2015-fa-r-003-2 poster(5)	2015-fa-r-003-3 Project Implementation (10)	2015-fa-r-003-4 Integrate IT technologies(4)	2015-fa-r-003-5 Testing, results and analysis(6)	2015-fa-r-003-6 Presentation (6)	2015-fa-r-003-7 Report(6)	Total (40.0)
Min Grade	0.5	1.5	4.5	1.5	1.0	2.5	1.5	14.0
Max Grade	3.0	5.0	10.0	4.0	5.0	6.0	6.0	38.0
Avg Grade	1.9	3.7	7.3	3.4	3.7	4.7	4.0	28.7
#Grades below avg	7.0	10.0	8.0	9.0	9.0	10.0	13.0	10.0
#Grades above avg	19.0	16.0	18.0	17.0	17.0	16.0	13.0	16.0
STD DEV	0.6	0.9	1.6	0.8	1.1	0.8	1.2	5.9
25 Percentile*	1.4	3.0	6.3	2.9	3.0	4.1	3.3	24.7
5 percentile**	0.8	2.1	4.7	2.1	1.9	3.4	2.1	19.0

*75% of students acheived above this grade.
**95% of students acheived above this grade.

FIGURE 23 Grades report/statistics

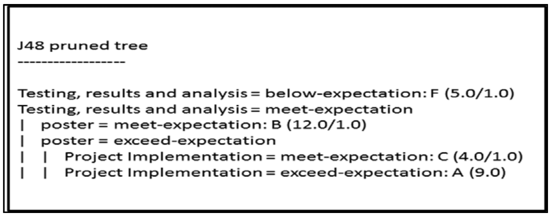
short term, or rubric-oriented, to discover patterns in the long term. Figure 24 presents semester-based grade analysis of 30 students' grades and views the tree in a textual format. Figure 25 visualizes part of the textual format in a form of a tree-like graph. Figures 24 and 25 depict the following rules/patterns:

- R1: IF the grade of a student in “Test, results, and Analysis” is “Below Expectation,” then the student gets grade “F” with probability 80%.
- R2: If the grade of a student in both “Test, results, and Analysis” and “Poster” are “Meet Expectation” then the student gets grade “B” with probability 91%.
- R3: If the grade of a student in “Test, results, and Analysis” is “Meet Expectation,” the grade of “Poster” is “Exceed Expectation,” and the grade of “Project Implementation” is “Meet Expectation, then the student gets grade “C” with probability 75%.
- R4: If the grade of a student in “Test, results, and Analysis” is “Meet Expectation,” the grade of “Poster” is “Exceed Expectation,” and the grade of “Project Implementation” is “Exceed Expectation, then the student gets grade “A” with probability 100%.

For each rule in Figure 24, DT shows the rule confidence represented by two numbers. The first number represents the total number of students' grades applicable to the rule and the second number depicts the number of students misclassified by the rule. For example, R1 convers five students in which one of them is misclassified; hence, probability of R1 is 4/5 = 80%.

To regulate the size of the tree (number of rules), we can adjust different parameters in DT to generate reasonable tree size and comprehensible patterns. Examples of parameters include confidence (to estimate error rates), binary split (to control size of tree), and minimum number of leaves in the tree. It is worth mentioning that mining students' grades requires repeated trials of attempting different parameters to uncover useful knowledge.

Notice that the results of DT are based on the students' grades and having enough grades is very important to obtain valid rational conclusions. Anomalies can be uncovered easily using DT. For example, we have observed a strange situation in the College of IT at UAEU in which students used to reach the end of the semester without having the implementation part of their projects completely done. Such anomaly would have been discovered earlier by applying DT on the grades. After all, the graduation project committee decided to increase the weight of the “Project Implementation” section in the rubric. Consequently, students start getting the final grade “A” only when they have at least “Meet Expectation” grade in the “Implementation” criterion as Figure 24 shows.



```
J48 pruned tree
------------------

Testing, results and analysis = below-expectation: F (5.0/1.0)
Testing, results and analysis = meet-expectation
|   poster = meet-expectation: B (12.0/1.0)
|   poster = exceed-expectation
|   |   Project Implementation = meet-expectation: C (4.0/1.0)
|   |   Project Implementation = exceed-expectation: A (9.0)
```

FIGURE 24 J48 text based tree generated out of 30 students' grades

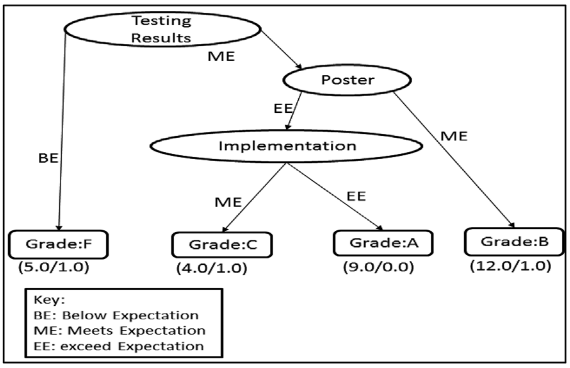


FIGURE 25 J48 tree that corresponds to Figure 24

7.2 | Association rule mining (ARM)

Association Rule Mining is a technique that finds interesting relationships between variables, students' grades in our case, to uncover hidden patters [1]. ARM is based on the concept of item set, *I,* which can be defined as a set of items. ARM generates implications/rules of the form, $X \rightarrow Y$, where $X \in I$ and $Y \in I$. The interpretation of the rule $X \rightarrow Y$ is that if X occurs then Y is likely to occur with a certain probability.

Discovering hidden patterns using ARM can help review and adjust overlooked aspects of the educational process. We can find the combination/implication of grades that most come together among students. For example, the following rule indicates that if a student has grade ME (Meet Expectation) in Background (rubric item) then she is likely to have ME (Meet Expectation) grade in IT Technology (rubric item).

$$\text{Background} = \text{ME} \rightarrow \text{IT Tech.} = \text{ME}$$

Rules can be compound to reflect more than one aspect of the data/grades. For example, the following rule indicates that if a student has grade ME in Background and ME in Presentation then she is likely to have grade ME in Poster.

$$\text{Background} = \text{ME}, \text{Presentation} = \text{ME} \rightarrow \text{Poster} = \text{ME}$$

Similar to DT, we can adjust several parameters in ARM to generate results. Examples of parameters include minimum support (which gives indication of how frequent the item set appears), confidence (means how often the rule is found to be true), and number of rules (see Ref. [1] for more details). Table 1 presents a list of rules that is based on Senior II grades for Spring 2016. Based on our experience in College of IT at UAEU, we found that in many cases, students could not make high grade in Senior I and when we looked at the students' grades, we found lack of project planning. This pattern can be uncovered easily with ARM as in the following rule. The rule indicates that in order to get score B then students should have Exceed Expectation (EE) grade in project plan and Meet Expectation (ME) in other criteria.

$$\begin{pmatrix} \text{Plan} = \text{EE}, \\ \text{Design} - \text{Solution} = \text{ME}, \\ \text{Presentation} = \text{ME}, \\ \text{Report} = \text{ME} \end{pmatrix} \rightarrow \text{Final Score} = \text{B}$$

Because of that, we encouraged students to focus on project planning to improve performance.

8 | DISCUSSION AND CONCLUSIONS

In this paper, we investigated the requirements of institutions for a software tool to manage educational and academic tasks involved in senior project. The study realized different educational tasks involved in senior project and contributed to different stakeholders as follows.

- Students can search proposals, select advisors, submit project deliverables, view schedule, view grades, and receive notifications.
- Advising Faculty can post/manage proposals, approve students, view project deliverables, and post/view grades.
- Examiners can view schedule, grade reports, post grades, and view grades.
- The coordinator can manage configuration, upload records (student, faculty, proposals, rubric, etc.), post guidelines, create schedule, send announcement, override grades, generate reports (statistics), assess courses, and view hidden patterns to improve the course.
- Institutions can download, install, configure, and use the system with minimum administration efforts. GPMS can be used for libraries and departments.

TABLE 1 List of rules generated by ARM, parameters: Min support = 10%, confidence = 90%, number of rules = 5

Best rules found
1. Presentation = ME, Report = ME 49 ==> Testing Results = ME 46
2. Testing Results = ME, Presentation = ME 49 ==> Report = ME 46
3. Integrate IT Technologies = EE, Report = ME 48 ==> Testing Results = ME 45
4. Presentation = ME 53 ==> Testing Results = ME 49
5. Presentation = ME 53 ==> Report = ME 49

Key: ME, meet expectation; EE, exceed expectation.

The GPMS is an online, open source, flexible, and easy-to-use system. The technical contributions of this work are as follow.

- The implementation is based on open source technologies, namely, Java, Apache/Tomcat, Weka, and MySql DBMS.
- The GUI is user friendly and flexible in terms of managing proposals, rubrics, reports, deliverables, grading, and assessment. All web pages have same look and feel to make system usage easy to learn. It provides different methods of uploading documents with different formats.
- GPMS is equipped with data analytical gadget to analyze and identify academic patterns.
- All resources in terms of code, documentations, design, and report will be available online.

In conclusion, we designed and developed the system professionally and made it available online. The system provides practical solution for institutions to manage graduation projects. It can be extended for other similar purposes such as master research theses and practicum projects. We provide different resources such as code, database scripts, and user guide manual to help install, configure, and use the system. Furthermore, we incorporated report and data analytics gadget to discover new knowledge.

In the near future, we plan to integrate authenticity function to check against plagiarism. In addition, we intend to extend the design of the assessment and data analytics components to include different advanced reports. Furthermore, we will continue supporting the tool and provide advanced documentation and resources.

REFERENCES

1. R. Agrawal, T. Imieliński, and A. Swami, Mining association rules between sets of items in large databases. ACM SIGMOD Record. **22** (1993), 2.
2. M. J. Allen, *Assessing Academic Programs in Higher Education*. Anker Publishing Company, Bolton, MA, 2004.
3. H. G. Andrade, *Teaching with rubrics: The good, the bad, and the ugly*, College Teaching, **53** (2005), 27–31.

4. M. Awad, GPMS Manual, technical report, May, 2016. Available online at: http://faculty.uaeu.ac.ae/mamoun_awad/GPMS/User-Guide-V1.docx
5. S. Drazin and M. Montag, *Decision Tree Analysis Using Weka*, Machine Learning-Project II, University of Miami, 2012, 1–3.
6. R. M. Felder and R. Brent, *Designing and teaching courses to satisfy the ABET engineering criteria*, J. Eng. Educ. **92.1** (2003), 7–25.
7. N. E. Gronlund, *Assessment of Student Achievement*, Allyn & Bacon Publishing, Needham Heights, MA, 1998.
8. J. Hafner and P. Hafner, *Quantitative analysis of the rubric as an assessment tool: An empirical study of student peer-group rating*, Int. J. Sci. Educ. **25** (2003), 1509–1528.
9. M. Hall et al., *The WEKA data mining software: An update*, ACM SIGKDD Explorations Newsletter, **11** (2009), 10–18.
10. A.-B. Hunter, S. L. Laursen, and E. Seymour, *Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development*, Sci. Educ. **91** (2007), 36–74.
11. A. Jonsson and G. Svingby, *The use of scoring rubrics: Reliability, validity and educational consequences*, Educ. Res. Rev. **2** (2007), 130–144.
12. L. Ketari, Online Library for Graduation Projects Management: The OGPL System. *EdMedia: World Conference on Educational Media and Technology*. Vol. **2011**. No. 1. 2011.
13. A. Khelifi et al., *Graduation project online management system ALHOSN university case study*. Proceedings of the 10th WSEAS international conference on Software engineering, parallel and distributed systems, World Scien. Eng. Acad. Soc. (WSEAS) 2011, 130–137.
14. A. J. Onwuegbuzie, J. R. Slate, and R. A. Schwartz, *Role of study skills in graduate-level educational research courses*, J. Educ. Res. **94** (2001), 238–246.
15. E. Panadero and A. Jonsson, *The use of scoring rubrics for formative assessment purposes revisited: A review*, Educ. Res. Rev. **9** (2013), 129–144.
16. A. A. Polat, Importance of Graduation Project in the Education of Agricultural Engineering: Case Studies from Turkey. IV International Symposium on Horticultural Education, Extension and Training, **672**, 2004.
17. W. J. Popham, *What's wrong-and what's right-with rubrics*, Educ. Leadership **55** (1997), 72–75.
18. Y. M. Reddy and H. Andrade, *A review of rubric use in higher education*, Assess. Eval. High. Educ. **35** (2010), 435–448.
19. J. W. Thomas, A review of research on project-based learning, An executive summary available online at http://www.bie.org/index.php/site/RE/pbl_research/29, 2000.
20. R. H. Todd et al., *A survey of capstone engineering courses in North America*, J. Eng. Educ.-Washington **84** (1995), 165–174.
21. S. Valencia, *Assessment: A portfolio approach to classroom reading assessment: The whys, whats, and hows*, Reading Teacher **43** (1990), 338–340.
22. G. Xiu-juan and C.-G. Wang, *Development and implementation of graduation project management system based on B/S mode [J]*, Comput. Technol. Dev. **3** (2010), 062.

M. Awad is currently an associate professor in the College of Information Technology at UAE University where he teaches and conducts research since August 2006. Dr. Awad received his PhD in Software Engineering from the University of Texas at Dallas in 2005, MSc in Computer Science from Wichita State University in 1999, and BS in Computer Science from University of Baghdad in 1994. His research focuses on the applications of data mining, Big Data, and bio-informatics.

How to cite this article: Awad M. *GPMS: An educational supportive graduation project management system*. *Comput Appl Eng Educ*. 2017;1–14. https://doi.org/10.1002/cae.21841