Online Course Registration and Advisory Systems Based on Students' Personal and Social Constraints

Bamo Nadir Faraj
Computer Engineering Department
Engineering College
Komar University of Science and Technology
Sulaimani, Iraq
bamo.nadir@komar.edu.iq

Aree Ali Muhammed
Computer Engineering Department
Engineering College
Komar University of Science and Technology
Sulaimani, Iraq
aree.ali@komar.edu.iq

ABSTRACT

Course registration is a challenging task that students face during the registration process sometimes resulting in enrolling on wrong courses, if proper guidance is not provided.
This paper presents a web-based registration and advisory system which has been developed and implemented by Komar University of Science and Technology (KUST) which facilitates course registration for both students and administrative staff and which ensures that the best possible schedule and course/section combination is available to students based on their personal needs and the requirements of the course.
The system assists students in making appropriate decisions by providing them with collated and analyzed data about each available course including pass rates, average grades, the number of students' friends who have registered for the course or reviewed the course favorably and the number of subsequent courses for which the selected course is a prerequisite. The system can also help to reduce the workload placed on academic advisors, assisting them in this time demanding task. The data implemented in the system is taken from an existing database which collates course registration data from spring 2016 onwards and which will ensure the delivery of accurate results.

1. INTRODUCTION

Many students suffer the consequences of inappropriate choices in course selection made during the registration process; if they are not guided carefully in this regard, it may cause them to miss their optimal study path or even to prolong the time taken to complete their study program unnecessarily [1].

In this paper, we present a registration system which we have designed and implemented which implements an academic advisory feature system to help students select the most suitable courses during registration. Course registration is a routine process that is conducted at the start of each semester but it can be stressful, time consuming, tedious and confusing for students if they are not supported with appropriate guidance and advice. In some cases, the

registration process may result in students choosing unsuitable combinations of courses, a decision which could potentially lead to the student failing the entire semester.

Prior to the opening of the registration period, university administrative staff use a scheduling system to prepare a schedule for the offered courses which ensures that no time overlaps occur between courses for which a student is eligible. This system allows students to arrange their preferred schedule without the need to be worried about any scheduling clashes and ensures that they can obtain the maximum number of credit hours within the given semester. The maximum allowed credit hours range from 15 to 20 depending on the department in which the student is enrolled.

The scheduling feature is part of a larger system that has been in place at KUST since 2016. The data from previous years was also imported from the old system, and this allows the scheduling processes to be broken down into steps. Before the registration window opens, students can log into the system and either send or accept friendship requests to and from other students in the same college or department. For example, all of the students at the College of Engineering, which consists of the Departments of Civil Engineering, Computer Engineering, Petroleum Engineering, and Environmental Engineering can apply to become friends since they share mutual courses throughout their academic career. The system then displays the schedules of selected friends to the student so that he or she can apply for the same schedule during the registration period. This socially aware element of the course recommendation feature is one of the crucial components of the system, as more than quarter of the students at KUST have stated that the ability to study the same courses as their friends is the most influential factor in choosing which courses/sections to register for. Many studies have shown the significant role which the ability of students to study with their friends plays in their performance and their subsequent academic success [2]. Psychological studies have also revealed that students are better off and enjoy improved results when they study together in the same classes as their peers [3] [4].

The geographical region in which KUST is located lacks a comprehensive public transportation network, and therefore students are forced to commute to the university using shared taxis with their friends. Based on our observations and the results of a questionary conducted among students of KUST, many cases were identified in which students did not accept offers to study course(s) for which they are eligible due to the fact that they could not afford to travel to the university alone. The questionnaire (See Figure 1) also asked students to state their most important criteria when selecting a schedule, with 155 (25.7%) of the 604 respondents responding that the ability to study with friends was the most significant criteria. 36.1% of participants preferred schedules which allowed them to spend the minimum time possible at the university, while the remaining respondents stated a preference for schedules which offered the maximum number of permitted credit hours. The system implemented at KUST provides a sufficient level of flexibility to satisfy the needs of all of the students from the above-mentioned groups.
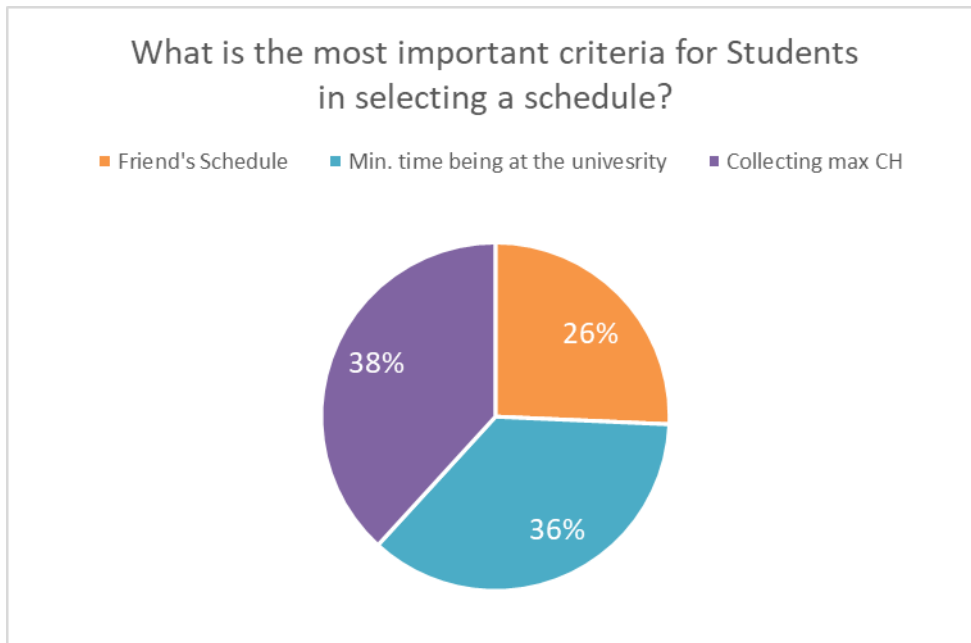
Figure 1: Student Questionnaire

In contrast to traditional course registration systems that offer courses on a "first-come first-served" basis, the proposed system allows students to register for their desired courses/sections without any availability constraints being applied; the courses will be divided automatically into a number of sections at a later date to allow all students who are friends to be registered for the same section. One drawback of the "first-come first-served" approach lies in the fact that courses are offered with a limited number of available places, an issue which is a source of considerable stress for students during registration, but which also places substantial request loads on the server and poor system performance. By removing the availability constraint the system can offer students a stress-free course registration process.

KUST currently offers three categories of courses: university, college and departmental courses. The university courses are those shared amongst the departments and thus large numbers of students are eligible to apply to these courses each semester. At the end of the registration period the system automatically divides the courses with a high number of applicants into multiple sections which are taught on the same day and at the same time while still ensuring that friends are allocated to the same sections. College and departmental courses are shared among students who are studying at the same college and departments, respectively. The teaching plan is a crucial element of student life at university, and any failure to take it seriously will reflect poorly on students' academic performance and may force them to repeat study years. Under the previous arrangement, faculty members were responsible for giving advice to students during registration. This face-to-face advisory service often required the undivided attention of both students and the adviser, an obligation which faculty members often struggled to fulfil given their other professional responsibilities. In order to help students and ease the burden of faculty members, our system automizes each individual process ensuring that the involvement of the adviser is not required.

The curriculum of the prerequisite systems is structured in such a way that a single course or a combination of courses can be marked as the prerequisite for another course. In such a system students can register for a course only once they have completed its prerequisites or earned a sufficient number of credit hours required by the course. This provides each student with the

option to plan his or her own unique study plan throughout the program. Some universities have also developed interactive study plan flowcharts (See Figure 2: Study Plan of Computer Engineering Dept.) allowing students to see the specific number of courses available to them in the following academic year by hovering over the individual prerequisite course [5].
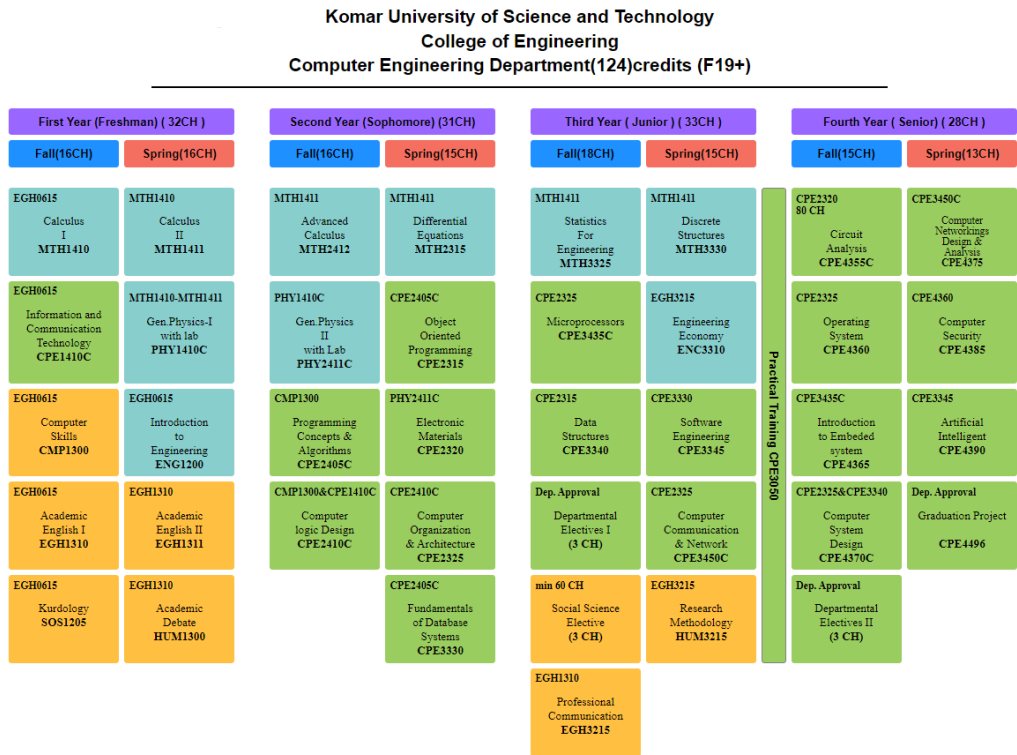
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Komar University of Science and Technology
College of Engineering
Computer Engineering Department(124)credits (F19+)

First Year (Freshman) (32CH)		Second Year (Sophomore) (31CH)		Third Year (Junior) (33CH)		Fourth Year (Senior) (28CH)	
Fall(16CH)	Spring(16CH)	Fall(16CH)	Spring(15CH)	Fall(18CH)	Spring(15CH)	Fall(15CH)	Spring(13CH)
EGH0615 Calculus I MTH1410	MTH1410 Calculus II MTH1411	MTH1411 Advanced Calculus MTH2412	MTH1411 Differential Equations MTH2315	MTH1411 Statistics For Engineering MTH3325	MTH1411 Discrete Structures MTH3330	CPE2320 80 CH Circuit Analysis CPE4355C	CPE3450C Computer Networkings Design & Analysis CPE4375
EGH0615 Information and Communication Technology CPE1410C	MTH1410-MTH1411 Gen.Physics-I with lab PHY1410C	PHY1410C Gen.Physics II with Lab PHY2411C	CPE2405C Object Oriented Programming CPE2315	CPE2325 Microprocessors CPE3435C	EGH3215 Engineering Economy ENC3310	CPE2325 Operating System CPE4360	CPE4360 Computer Security CPE4385
EGH0615 Computer Skills CMP1300	EGH0615 Introduction to Engineering ENG1200	CMP1300 Programming Concepts & Algorithms CPE2405C	PHY2411C Electronic Materials CPE2320	CPE2315 Data Structures CPE3340	CPE3330 Software Engineering CPE3345	CPE3435C Introduction to Embeded system CPE4365	CPE3345 Artificial Intelligent CPE4390
EGH0615 Academic English I EGH1310	EGH1310 Academic English II EGH1311	CMP1300&CPE1410C Computer logic Design CPE2410C	CPE2410C Computer Organization & Architecture CPE2325	Dep. Approval Departmental Electives I (3 CH)	CPE2325 Computer Communication & Network CPE3450C	CPE2325&CPE3340 Computer System Design CPE4370C	Dep. Approval Graduation Project CPE4496
EGH0615 Kurdology SOS1205	EGH1310 Academic Debate HUM1300		CPE2405C Fundamentals of Database Systems CPE3330	min 60 CH Social Science Elective (3 CH)	EGH3215 Research Methodology HUM3215	Dep. Approval Departmental Electives II (3 CH)	
				EGH1310 Professional Communication EGH3215			

Practical Training CPE3050

Figure 2: Study Plan of Computer Engineering

The collaborative filtering algorithm/approach [6] is used to recommend which course is more likely the student will pass among his/her eligible courses. For each and every course the student is eligible for also the system recursively queries the database to find students who have completed the course and their grade is less or equal to the student's grade in the course prerequisite. The system then suggests the course to be taken by the student if the passing rate in the course amongst the found students is higher than 60%. For example, let us assume that a student has taken Calculus I and Calculus II and has passed them successfully. One of the courses for which Calculus II (See Figure 3: Prerequisite Graph of Computer Engineering Department) is prerequisite for is Advanced Calculus. The system suggests taking Advance Calculus or not based on the query result. By following the system recommendations, students can reduce the chance of failing courses as a result of a lack of information about the nature of the course for which they are about to register.

In order to determine the relativity of the courses in the program more precisely, the required information is stored in the database relating to the category to which this course belongs. The categories for the computer engineering department include those related to math, physics, programming or hardware, but the categories will change for other departments. While the main purpose of this paper is to present the design and implementation of a registration and advisory system, some preliminary preparations are also required in order to integrate the system within the requirements of scheduling and other preparations from academic and
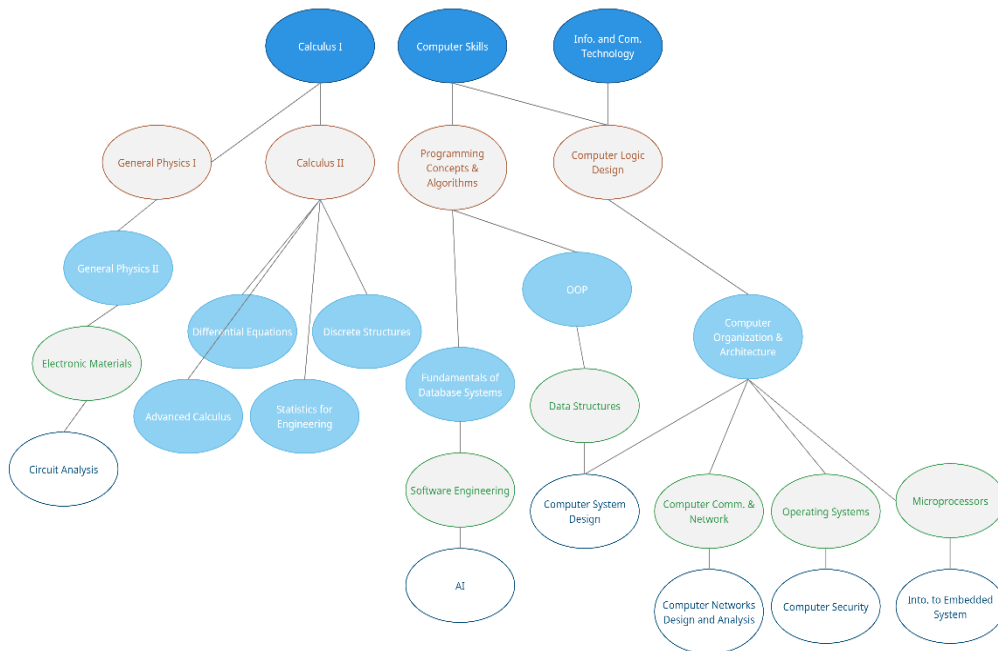
Figure 3: Prerequisite Graph of Computer Engineering Department

administrative staffs. However, the system also has additional range of functionalities including those of grade reporting, transcript and diploma requests, financial related functionalities, student admission, attendance and many more. These features lie beyond the scope of the present paper and will be explored in other future research publications.

2. LITERATURE REVIEW

While previous studies have divided the student advisory process from the function of course registration, our system merges both of these processes into a single solution which provides advisors with a considerable amount of information about students' academic histories and the courses which are available to them.

2.1 Advisory Systems

Traditional methods of advising students are often demanding and require considerable amounts of onerous effort due to the ongoing changes in prerequisite courses and students' desires for unique study paths. Previous research in this field has demonstrated that academic advising is a crucial process, but studies have also revealed that the task is not only restricted to offering advice on courses; it also includes other responsibilities such as ensuring students complete their study programs in time, exploring the options for postgraduate studies and also providing career advice [7].

Many researchers have focused on addressing these issues by designing web-based applications that can facilitate the task of academic advisors and help students to make

appropriate decisions on course selection during the registration period [8][9][10]. Other researchers have used fuzzy logic in their efforts to develop advisory systems [11].

2.2 Course Registration

Technology has aided and simplified the process of course registration in a number of different ways. One system has been proposed based on collaborative filtering where courses are suggested based on student performance in previous semesters. This is accomplished by taking the grades of passed courses and the average grades when a course is taken multiple times or when it is passed in the first place in order to gain new experience or to enhance the GPA [12][13][14][15].

Some systems are also integrated with students' social media accounts in order to allow students to see how many of their friends on those social networks are taking a course in which he or she is interested [16]. Course sequence recommendations, which consider the specific course constraints, have also been the focus of research [17]. Another way to tackle the issues of course registration is by utilizing deep learning [18]. According to previous studies these systems are classified into basic computerized systems, single-intelligent systems and multi-intelligent systems as illustrated in Table 1.

System Category	Drawbacks	Strength	Ref.
Basic Computerized	Systems of this type are not integrated with any databases and are therefore difficult to modify in real-time. Data entered by students may be inaccurate and hence inaccurate decisions can be made. [9]	Uses a single interface to eliminate duplication in the advisory process.	[23] [24]
Single-Intelligent	Neither decisions nor recommendations are automated. Neither the student nor the adviser is provided with report documentation.	Eliminates a considerable amount of paperwork and simplifies the process by computerizing and digitalizing the procedures.	[22]
Multi-intelligent	User interfaces are not suitable and it takes much longer to perform complex operations.	The systems are more suitable for students and can support strategic decisions.	[25]

Table 1: Registration Systems Comparison

In addition to eliminating the drawbacks of the previous systems, our system saves time and offers real-time feedback features for both advisors and students without the need for data entry and the potential of human error. Similarly, the system has the huge advantage of integrating the two systems of course advice and course registration.

3. PROPOSED SYSTEM

An overview of our proposed system is shown in Figure 4. The system allows students to view a filterable list of scheduled courses and sections for which they are eligible in the coming semester. Students can select their desired courses/sections from the presented list and apply personal conditions, such as their preferred days, times or their friends' selected courses/sections, in order to filter the list. Each course included in the list is accompanied by important information such as the pass rate of the course in previous semesters, the number of credit hours available and the type of the course to provide students with an overview of the course.

Once the courses have been selected, the system proposes a number of possible schedules sorted according to the number of the student's friends sharing the same schedule and the filtering criteria that the student applied to the list of the selected courses. The student then has the option to register for a particular schedule or to mark it as a favorite. They also have the ability to modify their schedule during the registration process in order to revise their decisions.
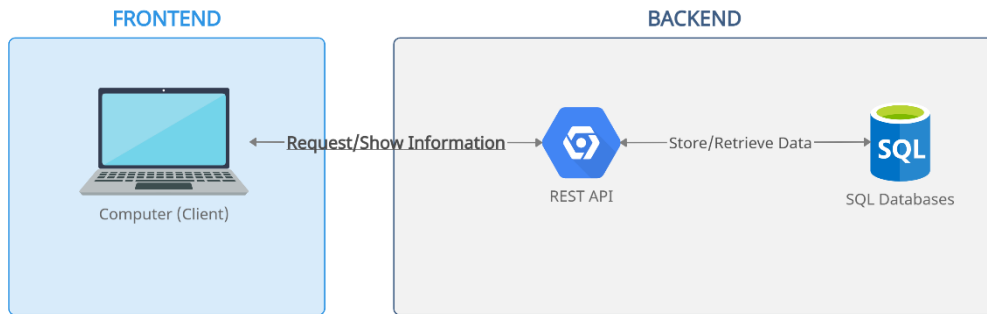

Figure 4: System Overview

The system also implements several roles such as those of students, OSAR (Office of Student Affairs and Registrations, administrative staff, accounting office, directory of examinations, and departmental chairpersons, with the two main roles illustrated in the use case diagram below (Figure 5). Students have the ability to modify their scheduling completely during the registration process. OSAR has ultimate authority over the system and there are many more features available to them which are not illustrated in the use case diagram.
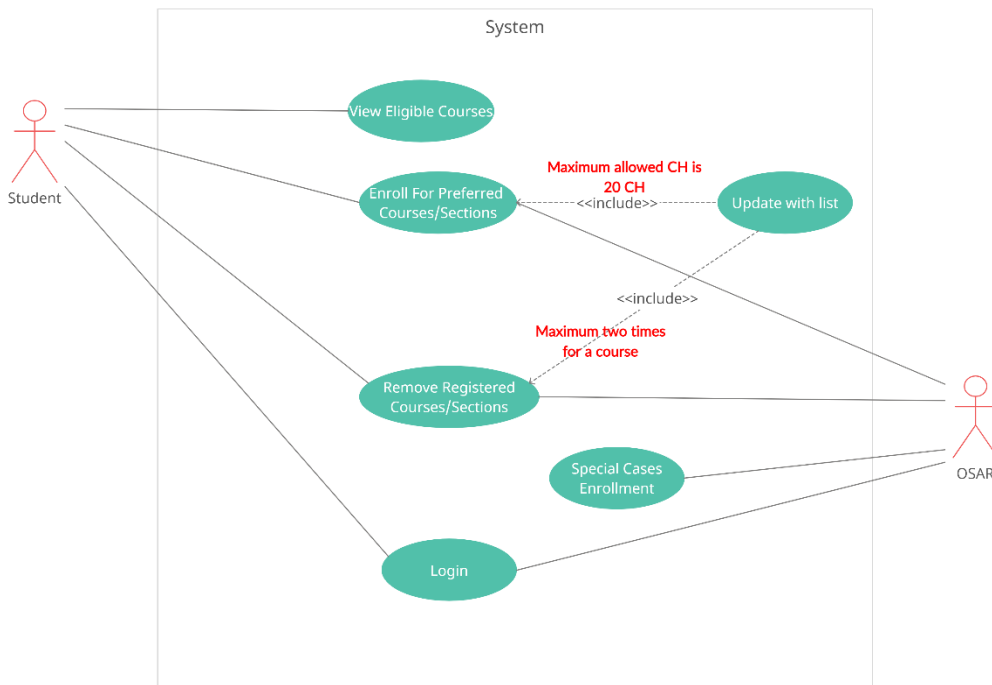

Figure 5: Use Case Study

4. SYSTEM IMPLEMENTATION

The system consists of two components. A backend web server was developed using Spring Framework [19] and backed by a MySQL 5.7.8 [20] database, while the frontend client was developed using the VueJS JavaScript framework [21] and Bootstrap 4 for CSS styling. The web server is a RESTful API which consumes and provides data in JSON format. It also uses JSON Web Token (JWT) for authentication purposes. The backend is separated from the frontend so that it can be accessed by both mobile and desktop applicants should this capability be added in the future. The system is hosted on the Amazon Elastic Compute Cloud (Amazon EC2) to ensure scalability and load balancer integration when required.

Once the student has logged into the system and clicked on the registration button, he or she is presented with a list of all of the courses/sections for which they are eligible. Each course contains information such as the pass rate of the course, the number of the user's friends who have selected the course as their favorite or registered for the course and the weighting of the course.

Pass rate and course weight are the two most important pieces of information. The pass rate shows the percentage of students who passed the course on the first attempt while the course weight indicates the number of courses for which this course is prerequisite. This type of information is crucial during the course registration process as it allows students to make informed decisions when selecting the most appropriate combination of courses. Figure 6 shows a screenshot of the main dashboard of the system from the students' perspective.
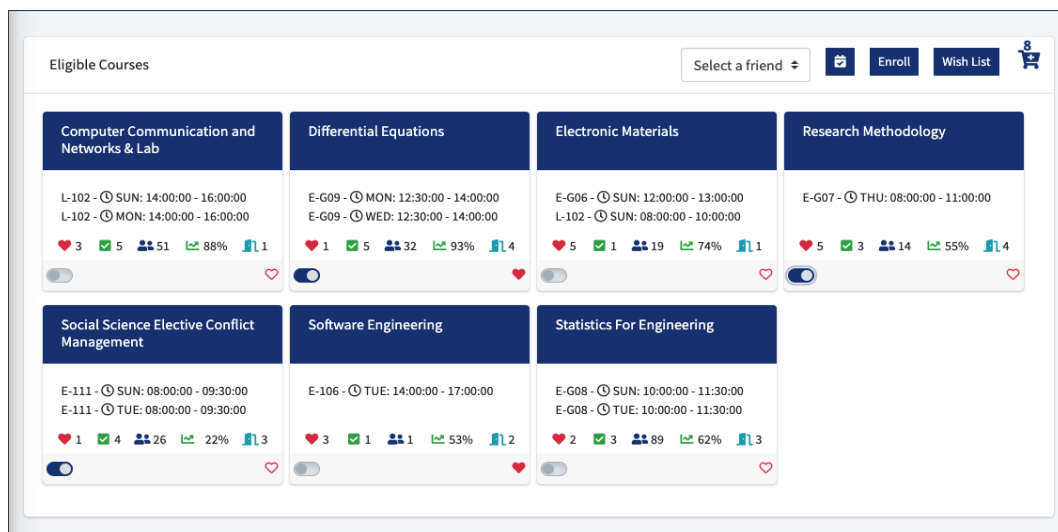

Figure 6: System Screenshot of Student

Students also can view their friends' schedule by clicking on the combo box to choose a friend from the list. As was mentioned above, students from the same college can send friendship requests to an unlimited number of students but in order to complete the process, the request needs to be approved by the other students. Once students have accepted the friend request, this item of information will become visible on the course panel to inform students of how many students among his/her friends have taken the course along with the ability to view their schedule (Figure 7).
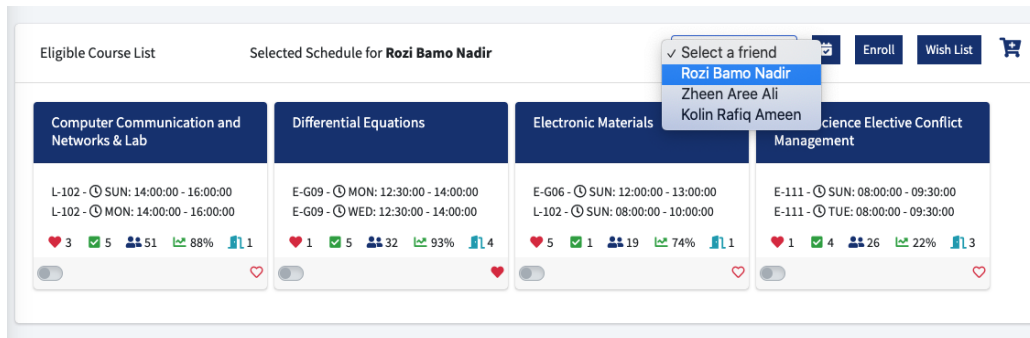

Figure 7: Friend's Schedule Screenshot

In order to make the system more student friendly, students who are friends in the system can also send course suggestions to each other. This allows many groups of students to ensure that they stay together and speeds up the process of planning during registration; in theory, a single student can plan a course combination which can then be followed by the others, reducing the need of every student to explore every single case scenario when it comes to course selection. As was mentioned above, students will be provided with useful information such as the number of courses for which a particular course is a prerequisite; in order to see the course titles, they will only need to click on the specific number that represents the total number of courses that will be offered to them once they have successfully passed the current course.

The system also provides concise information about all of the courses eligible during registration; by clicking on the course names, students will be redirected to a page where they can view course descriptions, instructor names, locations and the number of their friends who have taken the course previously (if any).

5. CONCLUSION

In this paper, we have presented a course recommender and academic advising system that can be used by tertiary education institutions during the course registration process. The processes of scheduling, registration, and academic advising are among most important of the routine tasks of higher education institutions, but these tasks are becoming increasingly challenging due to the increase in the number of students and the need to manage curricula in which individual students can select unique study paths. Our research focuses on a system of registration and automated academic advising that can facilitate this process for students and faculty members, and also greatly aid university administrative staff. Students can be relieved of stress during the registration process as place numbers in courses are no longer a source of concern, with students able to register for any course at any time during the process. In addition, students can ensure that they can attend classes with their friends who are following the same academic path and who have a similar eligibility for the offered courses.

We would like to stress here that we do not consider this system as a full replacement for the role of traditional academic advisors. In fact, neither this system nor any other advancement in technology has ability to make decisions which are unfailingly accurate, because in many cases human beings will always have a greater understanding of the wider context of the decision-making process. Nonetheless, our system can serve as a valuable assistant in the

advisory process, facilitating the role of advisors and permitting them to make better decisions in a more efficient and time-effective manner. Our system aims to ensure that by reducing their workload academic advisors' involvement will remain as crucial as ever.

The distinct advantage of the system is that combines the advisory and course registration systems, leveraging and analyzing the historical data to present the students with sufficient information to make a proper decision on what courses they should register for without the need of academic advisors.

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