Effectiveness of a Web-Based Advising Tool for an Engineering Program: Students' Perspectives

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Abstract

Effective advising ensures students take the proper classes to stay on track for their graduation. For example, in an engineering curriculum, it is crucial that students maintain the proper sequence of courses that results in the culmination of the program's required capstone design course(s). Any human error during the advising process can risk the disruption of the smooth progression through the program for a student. Thus, a computerized web-based advising tool can be highly useful to eliminate such human errors in identifying the most needed courses during an advising session. Currently, many advising tools are available through commercial businesses or developed by those working in the field of education. In the current work, the development and use of a web-based advising tool have been highlighted. The tool is customized to align with the curriculum of the engineering program at Southern Arkansas University. It takes the completed and currently taken courses as inputs and makes a prediction of courses arranged semester-wise until the student graduates. The user has numerous options while using this app, such as selecting a minor, excluding a course from the advising semester, selecting an option for what semester a particular course will be taken, selecting summer courses, selecting an average number of hours per semester, etc. The advising tool has been used to advise engineering students since it was developed. To investigate the effectiveness of the tool, a set of survey questions were given to those students whose schedules have been made using the advising tool. The collected survey data has been analyzed statistically to determine the tool's efficacy from students' perspectives. The analyzed data indicate that the students were overall satisfied and had positive attitudes towards different aspects of the tool.

Motivation

In any major, preparing an effective and error-free course plan for undergraduate students each semester is crucial for their timely graduation. However, various constraints may arise throughout the student's four-year program, which can cause uncertainties in their graduation timing. Students also often want a clear picture of their projected graduation date, including the number of hours needed per semester and the possibility of taking summer courses to expedite their graduation timeline. To address these needs, a web-based advising app was developed to help faculty advisors create error-free schedules to help empower students to take responsibility for their graduation timeline.

After using the app for some time, it was essential to determine students' satisfaction levels when creating their tentative schedules through the app.

Introduction

Efficient academic advising is critical for putting students on the path to academic success in higher education. During an advising session, a student meets with a faculty member to receive guidance on academic planning for the upcoming semester and for registering for upcoming courses. It also lets the student's advisor monitor their academic progress and offer suggestions for improvement. However, the time-intensive nature of academic advising can be exhausting for faculty already maintaining full loads, thus requiring some automation to reduce the time burden.

Proper academic advising is essential not only for students but also for the institution. It supports students in ensuring a smooth educational experience by enabling them to proceed efficiently through their degree program. Proper and well-executed academic advising aids students in taking the correct courses in the correct order and in the correct semester. This type of advising prevents students from taking unnecessary courses that do not count towards their degree. Additionally, it helps students avoid waiting for a missed course to be re-offered in a later semester. Forbes [1] has reported that the average bachelor's degree graduate in the United States has roughly $38,000 in student loans upon graduation. Reports like this reveal yet another reason that proper academic advising is crucial. Well-executed advising helps students avoid wasting extra time and spending unnecessary money by ensuring they take only the required courses for their degree and avoiding extra ones. This also enables students to join the job market faster, thereby helping to reduce their debt burden further. Perez et al [2] noted that the time it takes a student to graduate is a critical metric used by academic institutions and can be affected by several factors, including social, economic, and planning considerations. Thus, effective academic advising offers benefits in mitigating multiple factors' effects on students.

Academic advising benefits institutions as well. By ensuring that students graduate on time and take only the necessary courses, advising helps universities optimize their resource allocation and maintain higher retention rates. In addition, academic advising provides an opportunity for students to interact with faculty members in a setting outside of their classroom. These additional interactions can aid in professors and students developing more meaningful relationships, which can lead to students having an increased satisfaction with their education. As a result of students being more satisfied, this reduces the likelihood that a student will drop out of their program or even more so out of the academic institution. Habley's research [3] highlighted that academic advising plays a significant role in student retention, making it one of the more critical factors in keeping students enrolled in their major and in the institution. In a study conducted by Terenzini and Pascarella [4], they found that students who received frequent academic advising were more likely to persist and complete their degree program. The study further highlights the importance of ongoing and consistent academic advising to promote student success and retention.

With the guidance and support provided by a student’s academic advisor, students are better equipped to determine their academic and career goals and how they will need to work to achieve them. In advising sessions, faculty can suggest minor degrees, internships, and additional specialized skills which can help students in reaching their career goals. Additionally, students can get tips and advice on many common problems students face like study skills, time management skills, and communication skills. Moreover, professors may be able to suggest on-campus resources that students can take advantage of, like counseling, tutoring, financial aid, and disability accommodations. For professors to be able to provide students the one-on-one time needed for this support in an advising session, the advising process needs to be as automated as possible.

Academic advising is a crucial part of a student’s education, and technology is starting to enhance its effectiveness. Advising apps are gaining popularity in higher education institutions because they help to streamline the process and improve efficiency and accuracy. Feghali et al. [5] conducted a study that highlights the use of advising apps and expert systems as a means to

complement traditional advising, which primarily depends on one-on-one human interaction between students and their advisors. These programs and apps can help faculty advisors to minimize the effort and mental load it takes to find the best courses for each student to take, freeing up more time for them to build connections with their students during advising appointments. Additionally, advising apps may allow students to access information related to their course of studies, reducing the workload for faculty advisors by reducing the number of frequently asked questions they need to answer in an advising session. For instance, students can use the app to keep track of the courses they have completed, those that are yet to be taken, and the courses that can fulfill specific degree requirements. As a result, during an advising session, faculty advisors can focus on more advanced or uncommon questions that the student may have and engage in meaningful discussions with their students.

Moreover, these apps can help prevent common errors that students make while choosing their courses. In an article by Laghari [6], it is highlighted that errors such as selecting courses with overlapping timings, missing out on essential courses with alternate schedules, picking unnecessary electives, or taking an excessive or insufficient number of credit hours per semester are commonly observed. Advising apps can minimize these errors, ensuring that students make informed choices regarding their course selection.

Another advantage of using advising apps is that it promotes collaboration between faculty members and students. Collaboration between an advisor and student can motivate students to take more ownership of their academic progress and scheduling, leading to higher level of student satisfaction.

Many apps and expert systems have been developed by commercial businesses and individuals in academia to support academic advising. For instance, Mihali et al [7] developed an advising app for undergraduate computer engineering students, which prepares a list of courses that will enable them to graduate as quickly as possible. Covenant University's Course Advisory Expert System (CAES) [8] is another example of an academically developed expert system that is both affordable and has a satisfaction level of 77.8%.

At the University of West Georgia, the CLIPS system [9] has been successfully used as an expert system in academic advising, while the Online Advisor program at the American University of Beirut [5] creates academic schedules, shows completed and remaining courses, and has been found useful and helpful by 79% of surveyed students, with 90% rating it as effective.

An effective advising tool, coupled with proper guidance from advisors, enhances the quality of education for students in four-year degree programs and helps ensure the institution's overall success.

Objectives and Development Plan

This article outlines the development of a web-based advising app for undergraduate engineering students. The app's primary objective is to provide students with a detailed course listing that conforms to curriculum rules, course sequences, and the department's course rotation plan. The development process requires a thorough understanding of the engineering curriculum, course rotation, and basic programming and web development skills.

Using the app is simple - students enter relevant information such as their ACT Math score, completed and current courses, and anticipated credit hours for future semesters. The app then generates a detailed plan for the remaining time until graduation. Students can print the plan or save it as a PDF for future reference.

The app also offers minor options in Mathematics and Computer Science, which provide additional pathways to degree completion. Typically, engineering students prefer a math minor as only a few additional math courses are required to complete the degree in most cases.

As the app has been in use for a while, this article also explores its effectiveness in meeting students' needs.

Constraints in App Development

Mathematics Requirements

The Bachelor of Science in Engineering (BSE) program at Southern Arkansas University has traditional mathematics requirements that include Calculus I, Calculus II, Calculus III, and Differential Equations. These courses are prerequisites for other upper-level engineering courses and play a significant role in being able to complete the degree requirements successfully. To ensure that students are prepared for these courses, a freshman student is usually placed in Calculus I with an ACT Math score of 28 or higher. However, students who do not meet this requirement must take remedial math courses until they are ready to take Calculus I.

The university's remedial math placement is determined by the student's ACT Math score. Students with a score of 24 through 27 will be required to take Pre-Calculus I. However, students with a score of 23 or below are required to complete College Algebra and Trigonometry before enrolling in Calculus I. The undergraduate catalog provides a detailed breakdown of the remedial math placement based on the student's ACT Math score. While the university does not have a set admission requirement based on the student’s ACT Math score, students with low scores must complete all remedial math courses before being eligible to take Calculus I. As a result, students with lower scores need to expect a longer timeline to fulfill the mathematics requirements of the program, and as a result, it may take longer than usual to graduate.

It should be noted that Calculus I needs to be taken either concurrently with Physics I (calculus-based) or be completed before taking Physics I. Likewise, Differential Equations is a required course for taking other upper-level engineering courses. This means that delaying any of the required math courses will also delay a student's graduation. Therefore, it is essential that students plan their coursework carefully and meet the prerequisites for upper-level engineering courses.

Engineering and science course sequence

In the Bachelor of Science in Engineering (BSE) program at Southern Arkansas University, science, and engineering courses are arranged in sequences that progress in the curriculum. The sequence of courses is essential to maintain the progression of learning and the standards of the curriculum. For instance, engineering students must follow the sequence of Physics I, Statics, Mechanics of Materials, and Machine Design, as shown in Figure 2. In this sequence, Statics is a prerequisite for Mechanics of Materials, meaning that a student cannot enroll in Mechanics of

Materials without completing Statics in a prior semester. Similarly, the program follows another sequence of Chemistry I, Properties of Materials, and Manufacturing Processes.

Figure 1: An example of a course sequence in the engineering curriculum

A course can have multiple prerequisite and co-requisite courses. For example, both Fluid Mechanics and Thermodynamics are prerequisite courses, and Differential Equations is a co-requisite course for Heat Transfer. Since many upper-level courses are offered only once a year, any human error while advising a student can cause an unnecessary delay in the student's graduation. Therefore, it is essential that students plan their coursework carefully and meet the prerequisites for the upper-level engineering courses.

Course rotation

To ensure the effectiveness of the app, it was crucial to take into account the availability and frequency that courses are offered in the program. Upper-level engineering courses are typically offered only once a year, which means that students must plan accordingly to avoid delays in their academic progress. In contrast, lower-level engineering and math courses, as well as general education courses, are more frequently offered throughout the year. Therefore, when designing the app, it was essential to include the course rotation information to enable students to select the appropriate course at the right time.

Development process

The advising app has been made available on the web, accessible through any browser on a desktop computer or a laptop. The app was developed using Microsoft Visual Studio's ASP.Net platform, with Visual Basic as the programming language and HTML/CSS used for web design within ASP.Net. The app was deployed for free on Microsoft Azure, without the use of an external database to keep it simple, so no student data is saved on the server during runtime.

The app takes a student's ACT Math score, completed courses, and currently enrolled courses as input. After entering the required information in the corresponding fields, the app provides a detailed output of proposed semester-wise courses that the student needs to take to graduate on time.

Several DataTable type variables, such as DataTable 1 and DataTable 2, were created to store course-related data. Each course's prefix, number, and title are stored in a DataTable variable. DataTable 1 is dedicated to courses taken in the current semester, which spans from the day a student cannot add any more classes until the end of the semester. All future courses in the degree plan will be placed in DataTable 2, DataTable 3, and so on, corresponding to the subsequent semesters by order.

For each course placed in a DataTable, strating from DataTable 2 as shown in Figure 2, it undergoes a series of tests to determine if it meets several conditions, such as prerequisite completion, maximum semester hours, availability in the semester, and, in the case of Calculus I and other remedial math courses, ACT Math course completion. If these conditions are met, the

course is placed in the corresponding DataTable. These courses listed in separate datatables for each semester will be displayed on the webpage using the GridView option in Asp.Net.

The app has options for adding summer courses, minor-related courses, and courses for the advising semester. The app also allows for the reordering of courses, exclusion of courses from the advising semester, and the modification of anticipated hours in the summer semesters.

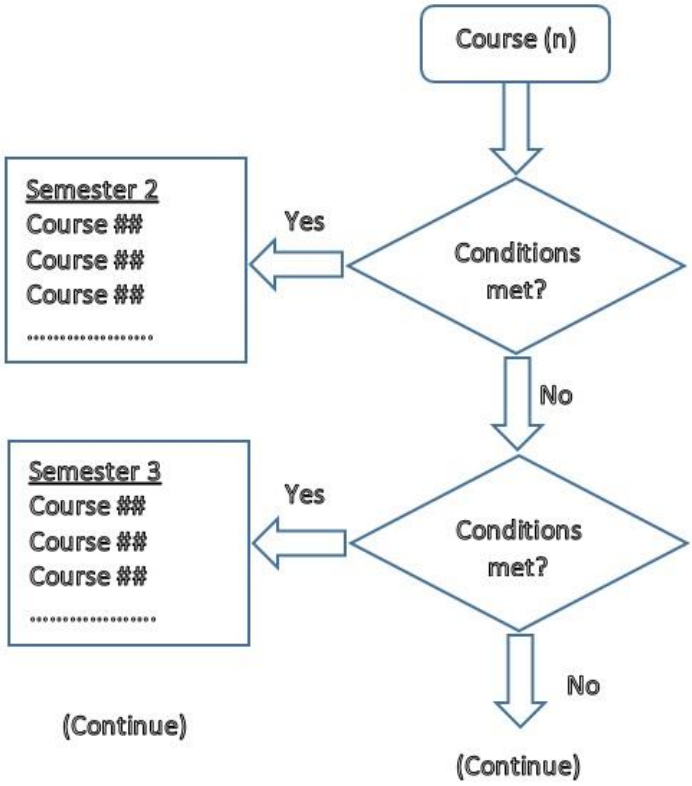


Figure 2: Algorithm flowchart

Some Special Features

The app has a user-friendly GUI displaying all relevant courses in the Engineering program. Course selections are color-coded for better visualization purposes, and a course selection status has four options: 'Not taken,' 'In progress,' 'C or better,' and 'D only.' Courses with 'In progress' status go directly to DataTable 1 and are displayed in the current semester. The course status drop-down list for each course is disabled until the relevant prerequisite course's status is changed to 'C or better.' Two additional DataTables contain course information with 'C or better' status at the bottom of the page.

The app offers increased flexibility during the advising semester compared to other semesters. DataTable 2 is specifically designated for the advising semester, allowing users to easily exclude courses by checking a box and replacing them with alternatives. This enables users to visualize how excluding a particular course impacts their overall graduation plan.

In addition, the app offers other features, such as the ability to reorder courses and adjust anticipated hours in a semester. These features allow students to customize their course plan according to their personal preferences while creating an optimal semester-wise plan for the rest of their time in the program.

The Advising Application in Practice

In this section, a case study of a student named John Smith is examined to illustrate the functionality of the app. John is advised by Emily Davis, and his ACT Math score is 28, indicating that he is eligible to take Calculus I directly. It is noted that the app does not save any personal information, ensuring that there is no risk of identity theft.

The app is initialized by pressing the initialize button, which enables the relevant remedial math courses based on the rules. As John does not require any remedial courses, Calculus I is enabled. The student has completed several courses with a grade of 'C or better', which are selected from the corresponding drop-down lists and highlighted in green. The courses John is currently taking are marked as 'In progress' and displayed in yellow. Additionally, courses can be selected as 'Fall only', 'Spring only', 'Summer only', or 'No preference', as some courses may be offered multiple times a year.

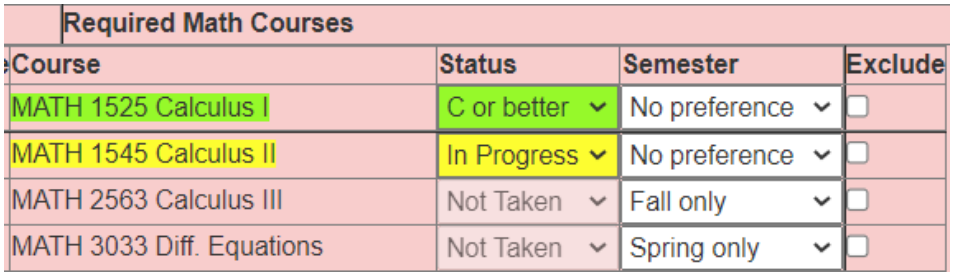


Figure 3: An example of graphical interface for entering course information

The default semester load is 16 hours, which is kept as such. Upon running the app, a detailed list of courses that John needs to take each semester until graduation is displayed as shown in Figure 4. The app shows that John will graduate at the end of Spring 2026 and needs to complete the remaining 92 hours for graduation. A list of completed courses is also displayed at the bottom of the page after running the app, as shown in Figure 5.

Student: John Smith Total Hours to Complete: 92 Hours
Advisor: Emily Davis Date: 2/26/2023
Note:

Spring 2023	15 Hours	
Course	**Number**	**Title**
ENGL	1123	Composition II
MATH	1545	Calculus II
PHYS	2213	Univ Physics II
PHYS	2211	Univ Phys II Lab
ENGR	1023	Intro to Eng

Fall 2023	17 Hours	
Course	**Number**	**Title**
ENGR	1213	Engineering Graphics
ENGR	2033	Electrical Circuits I
CHEM	1023	University Chemistry I
CHEM	1021	University Chemistry I Lab
MATH	2563	Calculus III
CSCI	2103	Computer Science I
CSCI	2101	Computer Science I Lab

Spring 2024	16 Hours	
Course	**Number**	**Title**
ENGR	2143	Statics
MATH	3033	Differential Equations
ENGR	2043	Properties of Materials
CHEM	1123	University Chemistry II
CHEM	1121	University Chemistry II Lab
ENGR	3083	Numerical Methods

Fall 2024	16 Hours	
Course	**Number**	**Title**
ENGR	3043	Mechanics of Materials
ENGR	3101	Solid Mechanics Lab
ENGR	3003	Fluid Mechanics
ENGR	3013	Thermodynamics
ENGR	3143	Manufacturing Processes
ENGR	4033	Control Systems

Spring 2025	16 Hours	
Course	**Number**	**Title**
ENGR	2163	Dynamics
ENGR	4013	Machine Design
ENGR	3023	Heat Transfer
ENGR	3211	Thermal Fluid Science Lab
ENGR	3073	Engineering Economics
ENGR	3163	Comp Aided Eng Analysis

Fall 2025	15 Hours	
Course	**Number**	**Title**
ENGR	4023	Senior Design Project I
ENGR	4153	HVAC
ENGR	4992	Engineering Proficiency
ENGL	3023	Technical Writing
HIST/PSCI	3	US History I/II or Gov.
ENGR	4701	Work Experience Learning I

Spring 2026	12 Hours	
Course	**Number**	**Title**
ENGR	4123	Senior Design Project II
ART/HUM 2	3	Fine Arts/Humanities
Social	3	Social Science Choice
ENGR/PHYS	3	UL Eng/Phys Elective

Figure 4: Semester-wise course plan generated by the app

Completed Courses	18 Hours	
Course	**Number**	**Title**
GSTD	1002	Freshman Seminar
ENGL	1113	Composition I
MATH	1525	Calculus I
PHYS	2203	Univ Physics I

Course	**Number**	**Title**
PHYS	2201	Univ Physics I Lab
ENGR	1021	Intro to Eng Lab
ART/HUM	3	Fine Arts/Humanities I

Figure 5: The completed course list generated by the app

Web App Evaluation through Student Survey

To assess the effectiveness of the web app from the perspective of students, a survey, as shown in Table 1, was conducted among previous users of the app. The survey comprised a set of Likert-type questions where students rated their level of agreement or disagreement with each statement on a scale of 1 to 5. A higher rating indicated greater satisfaction or a more favorable opinion of the app. A total of 27 students responded to the survey, and their responses were analyzed through data visualization using five histograms, one for each question, as shown in

Figure 6. The histograms indicate that the majority of students had positive responses to the questions.

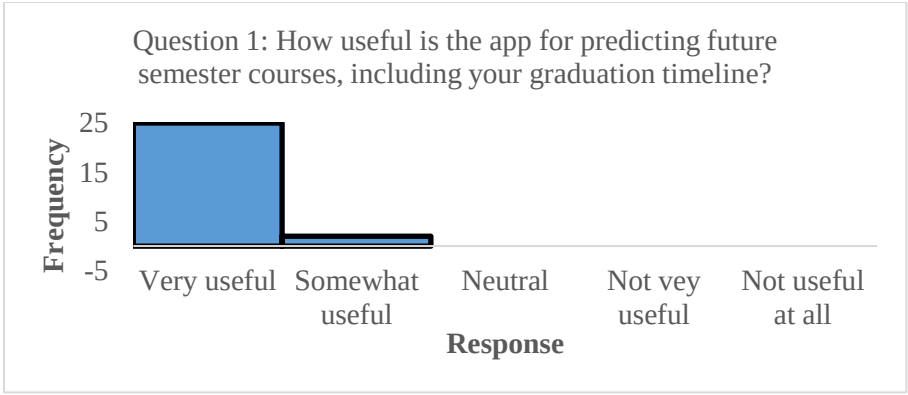
Table 1: Survey questionnaire to collect feedback data from the students

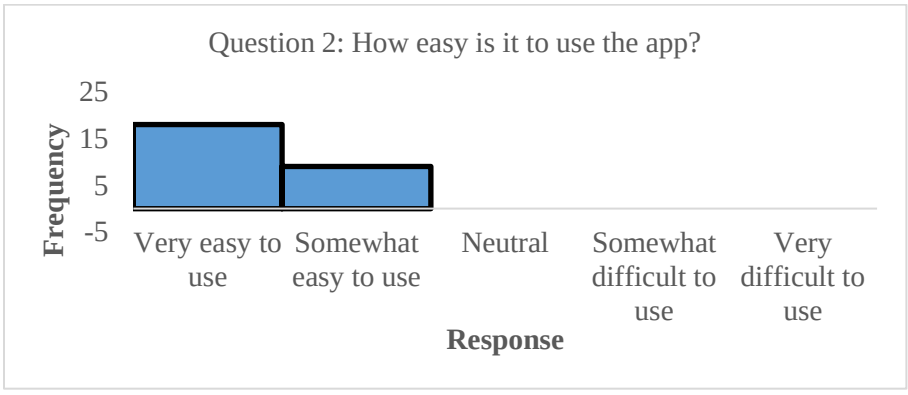
#	Questions	5	4	3	2	1
1	How useful is the app for predicting future semester courses, including your graduation timeline?	Very useful	Somewhat useful	Neutral	Not very useful	Not useful at all
2	How easy is it to use the app?	Very easy to use	Somewhat easy to use	Neutral	Somewhat difficult to use	Very difficult to use
3	How likely is it that the application saves you time by creating a comprehensive plan, including your graduation timeline?	Very likely	Somewhat likely	Neutral	Not very likely	Not likely at all
4	How likely are you to use this app again in the future?	Very likely	Somewhat likely	Neutral	Not very likely	Not likely at all
5	How likely are you to recommend this application to other students?	Very likely	Somewhat likely	Neutral	Not very likely	Not likely at all

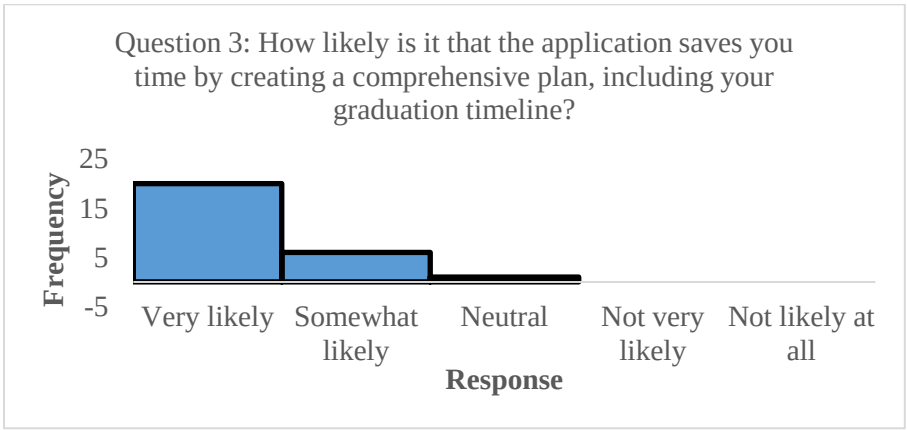
For the first two questions regarding the usefulness of the app and its ease of use, the students overwhelmingly expressed their positive perceptions towards the app. Overall, only a few students had neutral or indifferent perceptions towards the app for the other questions.

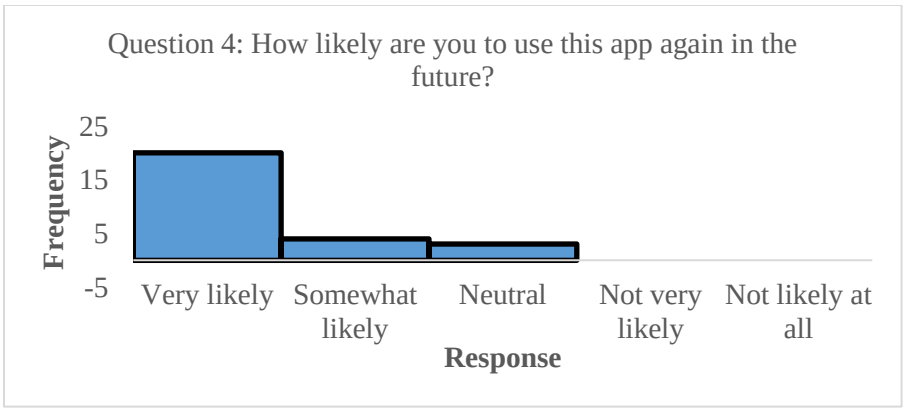
The mean and standard deviation of the ratings for each question were calculated to obtain a quantitative evaluation of the students' responses. A two-tailed t-distribution was used to determine whether there was a statistically significant difference between the mean rating of each question and the neutral response rating of 3. This analysis identified areas where the web app could be improved or where it fell short of students' expectations.

With a degree of freedom of 26 and a 5% confidence level, the critical t-value for a two-tailed test was found to be 2.056. As the t-statistic for all questions was greater than the critical t-value, as shown in Table 2, it can be concluded that the students overwhelmingly exhibited positive attitudes and acceptance towards the app.


Question 1: How useful is the app for predicting future semester courses, including your graduation timeline?
Frequency
25
15
5
-5
Very useful
Somewhat useful
Neutral
Not vey useful
Not useful at all
Response


Question 2: How easy is it to use the app?
Frequency
25
15
5
-5
Very easy to use
Somewhat easy to use
Neutral
Somewhat difficult to use
Very difficult to use
Response


Question 3: How likely is it that the application saves you time by creating a comprehensive plan, including your graduation timeline?
Frequency
25
15
5
-5
Very likely
Somewhat likely
Neutral
Not very likely
Not likely at all
Response


Question 4: How likely are you to use this app again in the future?
Frequency
25
15
5
-5
Very likely
Somewhat likely
Neutral
Not very likely
Not likely at all
Response

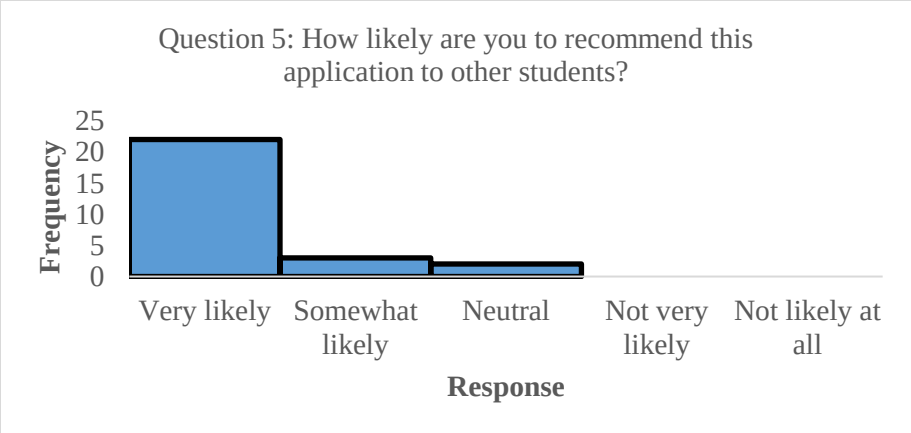


Figure 6: The frequency distributions of the responses

In addition to the Likert-type questions, students were allowed to provide comments through the survey responses. While the majority of students provided positive feedback, a few comments were made that will be used to further improve the app. For example, one student mentioned that "the app does not always exclude courses that are checked as 'Exclude'". This error will be corrected in the later version.

Table 2: Survey questionnaire with analyzed data

#	Questions	Mean	St. dev.	t-stat
1	How useful is the app for predicting future semester courses, including your graduation timeline?	4.93	0.27	37.50
2	How easy is it to use the app?	4.67	0.48	18.03
3	How likely is it that the application saves you time by creating a comprehensive plan, including your graduation timeline?	4.70	0.54	16.34
4	How likely are you to use this app again in the future?	4.63	0.69	12.31
5	How likely are you to recommend this application to other students?	4.74	0.59	15.22

Overall, the survey results indicate that the web app is highly effective from the students' perspective. It provides detailed graduation plans, is easy to use, and saves time in preparing plans. The positive feedback from students highlights the app's effectiveness in meeting their needs, and the suggestions for improvement will be taken into consideration for future updates.

Conclusion

In conclusion, the development of a web-based advising tool for the engineering program at Southern Arkansas University has proven to be an effective method to ensure students take the necessary courses to progress smoothly through the program. The tool eliminates the risk of human error in identifying the most essential courses during advising sessions. The tool's efficacy was assessed through a survey of students who used the tool to schedule their courses. The results indicate that the tool was positively received by students, who were satisfied with its

various features and options. This study highlights the potential benefits of computerized advising tools in supporting students' academic success and progress towards graduation. Further research can explore the tool's impact on retention rates and the broader implications of implementing similar tools in other academic programs.

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