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A PREFERENCE-BASED GRADE RECOMMENDER TOWARDS THE ATTAINMENT OF A TARGET GRADE POINT AVERAGE (GPA)

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ABSTRACT

A number of GPA calculators exist to automate the calculations of GPA, and it is used by college students to anticipate the amount of study required to accomplish a desired academic target. However, many of these apps do not sufficiently satisfy the user experience realities of the academic aspect of college life because they require excessive user inputs; grades combination that approximates their target GPA is known through a painstaking series of trials; they do not consider user's subject preference in recommending grades. A model of a grade recommender towards the attainment of a target GPA based on a self-efficacy reports and mathematical optimization is proposed. A prototype was developed as a proof of concept and its viability was demonstrated using three illustrative scenarios. The algorithm assigns lower grades to courses with low subject preference, and upper grades are allotted to courses with higher self-efficacy evaluation towards the attainment of a target GPA. An integration of the full implementation of the proposed model into a student information system will serve as a very useful resource to help college student achieve their academic goals.

Keywords: *GPA, Academic Achievement, Recommender Systems, Optimization-based Recommendation, Self-efficacy*

1. INTRODUCTION

One of the expectations of stakeholders in higher education from college students is a high academic achievement, and it is measured by high the grade point average (GPA) [1], [2]. The GPA is a standardized means to measure a student's academic achievement, and it is computed as the average of the total earned grades in the courses offered and the total number of credits units of all the courses so far in the duration of a course of study of the student. Hitherto, academic success in college requires that students set goals of attaining a target GPA, and through self-regulated learning behaviors, exercise themselves towards achieving the set goals [3], [4]. Unfortunately, some college students still end up as low-achievers, largely occasioned by their inability to either set or pursue attainable and realistic academic targets [3]. Consequently, underachievement contributes to the increase in the rate of college drop-out [5], which impacts negatively on the internal efficiency of an academic institution. Meanwhile, low-achievers also suffer from psychological problems such as depression and low self-esteem; if not treated, these psychological problems can lead to more fatal eventualities such as suicide [6]. To determine the extent of work needed to emerge as academic high-flyers, college students are usually interested in knowing the specific grades needed in each course to attain a target GPA.

Information and communication technologies are increasingly being deployed to enhance a number of academic-related tasks, and a number of academic productivity apps to automate the calculations of

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GPA exist [7], [8]. Moreover, the proliferation of mobile devices, such as smartphone, tablets and phablets devices have made these apps ubiquitous and accessible to a wide variety of college students. A number of college students now use these apps to anticipate the amount of study required to accomplish a desired academic target for a semester, term or school year. The GPA calculator apps, compared to the use of pen and paper to manually calculate GPA, are less cognitively demanding, as they enable students to readily discover how the grades in specific courses will contribute to their target GPA. Besides, the students can perform a variety of what-if scenarios through the use of these apps by exploring grades combinations that would lead to the attainment of their target GPA; the students can then device a study strategy based on the most suitable grades combination [8].

Although a number of GPA calculator apps exist, these apps do not sufficiently satisfy the user experience realities of the academic aspect of college life. The drawback of most of the GPA calculator apps is such that they require excessive user inputs, which impacts negatively on the overall user experience [9]. Some of these apps are mostly generic in nature, not tailored to the grading policy, curriculum and academic processes of specific colleges or universities. The excessive amount of user inputs demands that the users inputs all the relevant courses and their respective credit units, as well as the user's desired grades in each of the courses. The amount of user inputs is further increased, when the user needs to include previous courses taken, together with outstanding courses yet to be taken, in order to arrive at a target GPA that covers the duration of the student's academic program in the college. Furthermore, the GPA computed by these apps is solely dependent on the inputs by the user, thus, the user can only know the grades combination that approximates their target GPA through a painstaking series of trials. Although some GPA calculator apps recommend specific grades that must be acquired to attained a target GPA, these grades are however rigid in nature (e.g. all A's or B's) and are tied to the number of credits that must be passed. In addition, subject preference, which is an important factor in academic achievement, is not part of the user inputs of most of the GPA calculator apps and thus is not considered when suggesting the best grades combination.

An important issue that must be addressed is how to determine the most optimal grades a student must obtain in all the courses yet to be taken in order to achieve a target GPA given the subject preferences of the student. Yet many existing GPA calculators do not currently provide the mechanism to address this problem. Moreover, the excessive user inputs can be reduced by relying on the course information available in the curriculum and the student's academic transcript; which further makes the apps compatible with the academic realities of college student's life. The user experience would also be further improved by allowing the users specify the target GPA, after which the app can suggest the possible grades in each course that is required to realize the target GPA. The suggested grades should comprise a variety of letter grades that mirrors the true picture of students' academic performance report. Also, the recommended grades should reflect the user's subject preferences in the courses in focus. It is hypothesized that integrating these dimensions in the design of GPA calculators will significantly improve its user experience.

To overcome the drawback of current GPA calculators a model of a grades recommender towards the attainment of a target GPA is proposed in this paper. The proposed model recommends a personalized grades combination that uses information from the curriculum and academic transcript of the students, as well as reflecting the consideration of the student's subject preferences in the recommendation. In the proposed model, the user sets the target GPA, and indicates their subject preferences based on the user's perception of their self-efficacy, while the app recommends possible grades in each course to realize the target GPA.

The proposed model of grades recommendation is modeled and solved as a linear optimization problem in which the best option(s) is selected from an array of alternatives based on an objective function. In this case, the objective function is to maximize the attainable GPA towards the target GPA subject to the user's subject preferences. The optimal grades combination to realize the target GPA is determined with the aid of an optimization algorithm. The grades recommended would include a combination of lower grades assigned to courses with low subject preference, and upper grades allotted to courses with higher self-efficacy evaluation. The applicability of the proposed model was demonstrated by three illustrative scenarios. The researchers believe that the grades recommended by the proposed model will provide a basis for college students to devise an effective study strategy that will culminate in high academic achievement.

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The remainder of this paper is structured as follows. Section 2 briefly discusses the background of this work by highlighting the factors that affect academic achievements. In Section 3 contains a review of existing GPA calculators according to the gaps identified in this paper. In section 4, a description of the proposed model and a prototype implementation is presented, while illustrative scenarios were employed to demonstrate the applicability of the proposed model in section 5. The implication of the results obtained was discussed in section 6 and this paper concluded with an opportunity for future works in section 7.

2. BACKGROUND

2.1 Academic Achievement and Goal Setting

Academic achievement simply connotes the learning outcomes of the student(s) after a period of exposure to new structured experiences within a formal schooling system. Since the core objective of all academic systems is learning, academic achievement can also be described as learning achievement. It can also be described as the degree of attainment of set goals on a course of study. Such goals could be set by the School Administrators, the Teacher or the Student. Achievement is naturally tied to set goals. It is imperative that the person or group of people should be responsible for driving its achievement. And since learning is the sole responsibility of students, it is imperative they learn how to set 'SMART' goals and be taught how to develop the will-power to drive such goals to fulfillment.

Walberg's theory of academic achievement posits that the psychological characteristics of each student and their psychological environments influence educational outcomes [10], [11]. A meta-analysis of the predictors and correlates of academic achievement indicated that student characteristics show the most significant direct influence on academic achievement [12]. Walberg's research further identified nine key variables that influence educational outcomes as: motivation, student ability or prior achievement, quantity of instruction, quality of instruction, age or developmental level (or maturation), classroom climate, home environment, peer group, and exposure to mass media outside of school [11].

Furthermore, goals are anything that an individual yearns to obtain, execute, realize or experience [13]. A number of studies have confirmed that self-efficacy plays a significant role in achieving academic goals. Self-efficacy refers to an individual's belief in their ability to organize, device and engage in actions in order to achieve a specific level of performance [14]. Bandura also posited that self-efficacy beliefs are, among others, largely influenced by previous performance (particularly mastery experiences) [15]. Hence, college students are able to anticipate their performance in some courses based on their previous performance experiences in similar courses, particularly when those courses belong to the same subject area. In other words, the previous performance in or fondness for a particular subject area influence the student's self-efficacy beliefs and consequently affects the student's agency towards their academic endeavors. The ability to capture self-efficacy beliefs, particularly those influenced by mastery experiences, in setting course-level goals towards the attainment of an overall target GPA will increase the chances of attaining high academic achievement.

2.2 Mathematical Optimization

In general, an optimization problem involves maximizing or minimizing a real function, also known as an objective function, by selecting input values from within an allowed set and computing the value of the function in a way that places restrictions on the possible decision choices. In other words, mathematical optimization consists of an objective function or functions, the decision variables, and the constraints that place a restriction on the domain of the decision variables. There exist a number of optimization models including linear optimization, non-linear optimization, multi-objective optimization and bi-level programming [16]. The proposed concept in this paper uses the linear programming approach for recommending optimal grades towards the attainment of a target GPA. Linear optimization (or programming) is a mathematical optimization model employed to find the best result and it consists of objective functions and constraints that are linear in format. Formally, linear optimization is defined as follows:

$$\max_x f(x) = cx \quad (1)$$

Subject to:

$$A_x \leq b \quad (2)$$

Where x = the vector of decision variables; c and b are vectors of known coefficients, while A represents a matrix of coefficients. The expression f(x) represents the objective function to be maximized or minimized. There are a number of algorithms used to solve the optimization problem

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and can be classified into. Linear programming, simplex methods, genetic algorithms and swarm intelligence algorithms.

In the context of this paper, the optimization problem is to maximize the attainable GPA in so much as it approximates a target GPA. This is achieved by choosing the best grade combinations subject to the subject preferences of a student in line with his/her self-efficacy beliefs about the expected outcome of the course. The objective function is to maximize the attainable GPA, while the decision variables are discreet in nature and represent the grades obtained in each course towards the GPA. The constraints on the decision variables are such that they must correspond to the preference of the user, and the GPA must be greater than or equal to the target GPA set by the user. Thereafter, an optimization algorithm can be employed to find the best grades combination in all the remaining courses that maximize the objective function.

3. GPA CALCULATORS

GPA calculators are technology tools that are used by college students to compute the impact of a variety of grades outcome on the student's GPA. The use of GPA calculators eliminates the painstaking efforts expended to manually figure out the impact of various grades scenarios on the overall GPA. Nowadays, there exist a variety of GPA calculators, and this section contains a comparative review of some existing randomly selected GPA calculators. First, a brief articulation of the features of the app is presented, and based on a set of review criteria that underlies the gaps identified in the existing apps; a comparative review of these apps is performed based on the identified criteria.

3.1 Review of Existing GPA Calculator Apps

3.1.1 GPA calculator Spreadsheet

The use of spreadsheet applications, like Microsoft Excel, is a popular method used by college students to calculate GPA. This method, like many others, requires the input of the all the course information including the title, credit units. In addition, the student is expected to indicate the grades he/she desires to have in the courses listed and by the use of inbuilt mathematical formulas in the spreadsheet application, the GPA is computed. One of the many drawbacks of this method is the excessive user inputs required to make it functional.

3.1.2 Fourpoint GPA Calculator

Fourpoint[1] is an iOS-based GPA calculator, available for the iPhone and iPad, which is used to calculate a student's GPA for a single semester or for the entire duration of the student's academic study. It is a personalized mobile unofficial transcript for students such that a student can input the information regarding courses, credit units and grades (acquired or desired) in those courses. The app computes the GPA for each term and the overall GPA towards graduation. Although the app boasts of a very friendly user interface, the user experience is fraught by the excessive inputs required from the user to make the app functional.

3.1.3 Anna University GPA CGPA R13

Anna University GPA and CGPA Calculator[2] is both an online and Android-based application custom developed for Anna University, Chennai, India. All the courses (compulsory and electives) are preloaded on the app, so students do not have to input courses or credit units to calculate GPA. The students select the semester or term and enter desired grades, while the app computes the GPA.

3.1.4 Grade Calculator Plus

Grade Calculator Plus[3] is an iOS-based application that manages course grades. The application allows a student get Letter grade scoring, as well as the ability to create, change or even remove courses. The application has the capability of storing the courses inputted for future use. A unique feature of the app is the flexibility of defining grading policy, unlike most applications that have a fixed grading format. For example, the grading policy used in American colleges are different from those used American grading policies are different to those in most colleges in African countries.

3.1.5 DegreeWorks GPA Calculator

DegreeWorks[4] provides a comprehensive set of web-based academic advising, degree audit, and transfer articulation tools, including a GPA calculator, to help students achieve their academic goals. The DegreeWorks GPA calculator includes three types of calculators (see Fig. 1): graduation GPA calculator, the term GPA calculator and the advice calculator.

[1] itunes.apple.com/us/app/fourpoint-a-gpa-calculator/id383417299?mt=8

[2] annauniversitycgpacalc.com/

[3] itunes.apple.com/us/app/grade-calculator-plus/id592065111?mt=8

[4] www.ellucian.com/Software/Ellucian-Degree-Works/

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The graduation GPA calculates the GPA needed to graduate based on the remaining and required credits units, and the desired GPA at graduation. The term GPA calculator automatically populates the courses and credit units registered for the term, and the student inputs potential grades for each course and the calculator the new GPA based on the desired grades.

With the advice calculator, the student can explore various paths to achieving a target GPA, expressed with the number of credit units according to a set of grades, e.g. students may require an A+ grade in 41 credit units or A grades in 90 credit units to attain the desired GPA. However, Degree Works GPA calculator is only an estimate and not official recommendations. Also, it does not consider the student's subject preferences.

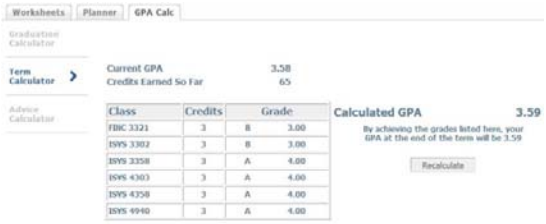

Figure 1: Screenshot of DegreeWorks Term GPA Calculator

3.2 Comparative Review of GPA Calculators apps

This section contains the comparative review of the existing GPA calculators mentioned in this paper as well as the criteria used in the review process. The review criteria are as follows: Integration of curriculum and transcript information; Grades recommendation; users' subject preferences.

3.2.1 Integration of Curriculum and Transcript Information

User experience is improved by integrating course information from curriculum and student academic transcript in the GPA calculator. The curriculum contains the information of all the courses the student is expected to take as stipulated by the graduation requirements, including the course code, title, credit and description of the course. In most colleges and universities, this information is available to the students at the onset of their studentship.

On the other hand, the student's transcript contains the courses already taken by the students and the respective grades obtained in them. Since the GPA averages all the grades obtained so far in the course of study, students would normally set the goal of a target GPA in the light of grades obtain hitherto. The quest is to know the grades required in courses yet to be taken in order to attain a target GPA in the light of their current GPA. Although, freshmen do not have any previous academic records, in which case the app uses only the information contained in the curriculum.

3.2.2 Grades Recommendation

To further reduce the number of inputs being elicited from the user in addition to assisting the students to set SMART goals, there is a need for grades to be recommended rather than the students inputting grades for the courses being offered. The user should only specify his/her target GPA, while the app computes the grades required to attain the target GPA.

3.2.3 User's Subject Preferences

In the previous section, we argued the role of subject preferences in the academic outcome. Some students believe they have flair for some subjects, and would perform well in such courses, while loathing other courses and anticipate a lower grade. Unfortunately, most of these courses are important requirements for graduation and students are expected to pass them.

The extent of passing or the grade obtained is now the question. Some students would not mind obtaining a lower grade in a course they dislike, as long as their target GPA is attained.

Table 1: Summary of Comparative Review of GPA Calculators

GPA Calculators	Integrates Curriculum	Integrates Transcript	Elicit Subject Preferences	User Input Target GPA	Recommend Grades towards GPA
Anna University GPA Calculator	■	□	□	□	□
GPA Calculator Spreadsheet	□	□	□	□	□
Grade Calculator Plus	□	□	□	□	□
DegreeWorks	■	■	□	■	□
Fourpoint	□	□	□	□	□
■ = Satisfied | □ =Not Satisfied					

4. PREFERENCE-BASED GRADE RECOMMENDER

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4.1 Problem Formulation

Let GPA be the potential GPA of the student at graduation and Let TGPA be the Target GPA ($0 \leq \mathbf{TGPA} \leq 5.00$) specified by the student; such that the GPA of the student at graduation is computed as:

$$\mathbf{GPA = (WA+TW) / (CA+TCR)} \quad (3)$$

Where ***WA*** is the total weight acquired by the students in previous terms, computed aggregating the product of the credit unit and the weighted grade obtained in each course. ***CA*** is the total credit units acquired by the student in previous terms. ***TCR*** refers to the sum total of all remaining credits $\boldsymbol{CR_{i \to n}}$, where ***n*** is the total number of courses that must be passed towards graduation. ***TW*** is the target weight for all the remaining courses required to attain the ***TGPA***, such that $\boldsymbol{TW = \sum (CR_i * TGrd_i)}$ where *n* = number of the remaining courses yet to be passed, and $\boldsymbol{TGrd_i \in [5, 4, 3, 2, 1]}$ is the target grade weight in the i^{th} course required to attain the **TGPA**; such that. However, $\boldsymbol{TGrd_i}$ is determined by the subject preference rating of the student, such that a student may rate a course *High* or *Low*, depending on his/her self-efficacy beliefs.

Therefore, $\mathbf{TGrd_i \leftarrow x}$, where $\mathbf{x \in [3,4,5]}$ and $\mathbf{TGrd_i \leftarrow y}$, where, $\mathbf{y \in [1,2,3]}$ if Preference is High and Low respectively.

The optimization problem becomes:

$$\mathbf{max}_{\mathbf{TGrd} \in [1,5]} \ \mathbf{GPA} \quad (4)$$

Subject to:

$$\mathbf{GPA \geq TGPA} \quad (5)$$

Fig. 2 shows the grade recommendation algorithm, while Fig. 3 outlines the step by step procedure of our Grade recommendation approach to realizing a target GPA. The proposed model of grades recommender app sits on the curriculum and transcript database of the student. At login, the curriculum and transcript information specific to a student is loaded. The student then inputs a target GPA, as well as set the subject preferences, then the app evaluates the target GPA in the light of available credit units and grades already obtained transcript. The optimization process is triggered if the target GPA is attainable; otherwise, the student (user) is required to modify the input.

Inputs Weight Acquired (WA), Credit Acquired (CA), list of Credits Remaining (CR), target GPA (TGPA)
Output TargetGrades

```
Let Total Weight= TW
Let Total Credit Remaining= TCR
Begin:
    TW ← 0
    TCR ← 0
    GPA ← 0
    Optimize (GPA):
        For each course yet to be taken
            If Pref == high then
                TargetGrades[i] ← [3, 4, 5]
            Else If Pref == Low then
                TargetGrades[i] ← [1, 2, 3]
            TW + = CR[i] × TargetGrades[i]
            TCR+= CR[i]
        End For
        GPA= (WA + TW) / (CA + TCR)
        Constraint (GPA <= TGPA ? 0 : GPA)
End:
```

Figure 2: Grade Recommender Algorithm

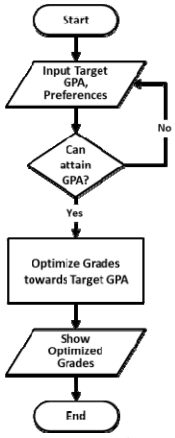

Figure 3: Flowchart representation of the self-efficacy-based grades recommender

4.2 The System Architecture

The system architecture comprises of three (3) modules namely: The user interface module, the application module, and the database layer as seen in the Fig. 4. The user interacts directly with the grades recommender app through the GUI module. It comprises of text boxes and sliders to elicit user's target GPA and subject preferences. The business module contains the business logic and optimization engine that processes the preferences information and optimizes the grades required to compute the target GPA. The business module computes the target grades based on the information from the database containing the student's curriculum and academic transcript.

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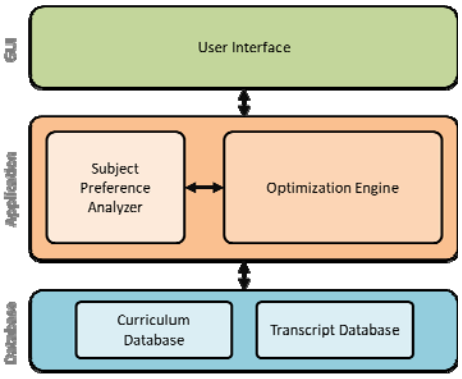


Figure 4: System Architecture of Grade Recommender

5. ILLUSTRATIVE SCENARIOS

A prototype of the model proposed in this paper was implemented as a proof of concept using Java in the Net Beans IDE. Also, the optimization engine employed the MOEA framework, a free and open source Java library for multi-objective evolutionary algorithms. The framework supports a number of evolutionary algorithms including particle swarm optimization algorithm which was employed in the prototype. Meanwhile, the curriculum and transcript database was implemented in the MySQL RDMS.

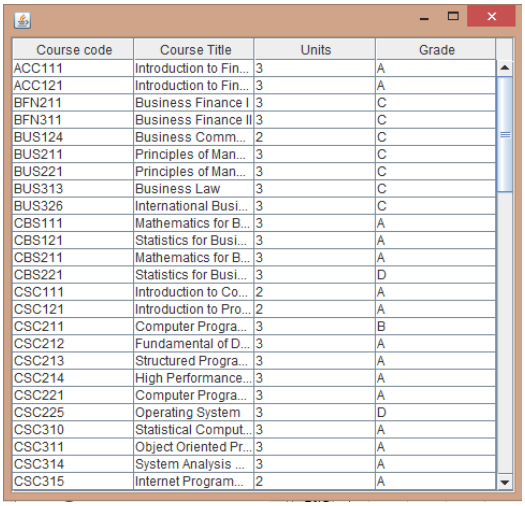
Three illustrative scenarios were employed in order to demonstrate the plausibility of the proposed model. For simplicity, the scenarios were limited to the curriculum of the Management Information Systems (MIS) program in a Nigerian university. Based on the Benchmark for Academic Standards (BMAS) the approved curriculum for MIS programs in Nigeria the courses were categorized into three subject areas for the purpose of this illustration, namely: mathematics-related, business-related and practical-inclined courses. Also, the BMAS specifies that the letter grades obtainable are A, B, C, D and F, which corresponds to grade weights of 5, 4, 3, 2 and 0 respectively.

Table 2: Summary of Scenarios, Target GPAs and Subject Preferences

Scenario	Target GPA	Subject Preferences		
		M-RC	B-RC	P-IC
100 level (ID-16CH014371)	4.60	High	Low	High
300 level (ID-13CH014357)	4.60	High	Low	High
200 level (ID-12CH014325)	4.50	Low	Low	High
M-RC = Mathematical Related Courses B-RC = Business Related Courses P-IC = Practical Inclined Courses				

In this illustration, the user is expected to specify subject preferences, either high or low, for the various categories. Below are the outcomes of the scenarios.

(a)



Course code	Course Title	Units	Grade
ACC111	Introduction to Fin...	3	A
ACC121	Introduction to Fin...	3	A
BFN211	Business Finance I	3	C
BFN311	Business Finance II	3	C
BUS124	Business Comm...	2	C
BUS211	Principles of Man...	3	C
BUS221	Principles of Man...	3	C
BUS313	Business Law	3	C
BUS326	International Busi...	3	C
CBS111	Mathematics for B...	3	A
CBS121	Statistics for Busi...	3	A
CBS211	Mathematics for B...	3	A
CBS221	Statistics for Busi...	3	D
CSC111	Introduction to Co...	2	A
CSC121	Introduction to Pro...	2	A
CSC211	Computer Progra...	3	B
CSC212	Fundamental of D...	3	A
CSC213	Structured Progra...	3	A
CSC214	High Performance...	3	A
CSC221	Computer Progra...	3	A
CSC225	Operating System	3	D
CSC310	Statistical Comput...	3	A
CSC311	Object Oriented Pr...	3	A
CSC314	System Analysis ...	3	A
CSC315	Internet Program...	2	A

(b)

Figure 5: Scenario One- (a) Input Elicited; (b) Grades Recommendation

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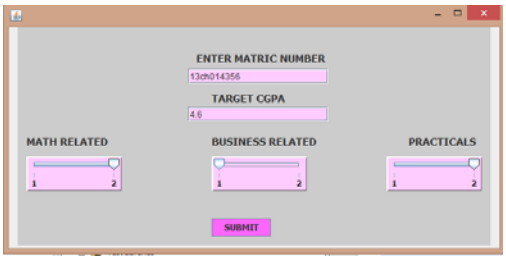

(a)

Course code	Course Title	Units	Grade
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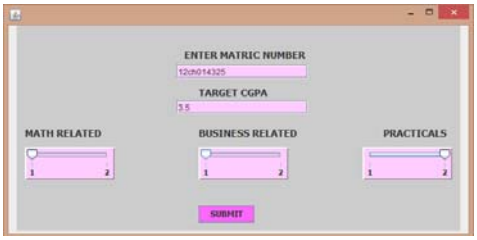
BUS221	Principles of Man...	3	C
BUS313	Business Law	3	C
BUS326	International Busi...	3	C
CBS111	Mathematics for B...	3	A
CBS121	Statistics for Busi...	3	A
CBS211	Mathematics for B...	3	A
CBS221	Statistics for Busi...	3	A
CSC111	Introduction to Co...	2	A
CSC121	Introduction to Pro...	2	A
CSC211	Computer Progra...	3	A
CSC212	Fundamental of D...	3	A
CSC213	Structured Progra...	3	A
CSC214	High Performance...	3	A
CSC221	Computer Progra...	3	A
CSC225	Operating System	3	A
CSC310	Statistical Comput...	3	A
CSC311	Object Oriented Pr...	3	A
CSC314	System Analysis ...	3	A
CSC315	Internet Program...	2	A

(b)

Figure 6: Scenario Two- (a) Elicited Inputs; (b) Grades Recommendation

From the Grades recommendations shown in Fig. 5(b), it is observed that the algorithm recommended higher grades (A) in scenario 1 for mathematics-included courses, such as statistics for business CBS211 and mathematics for business CBS22, compared to business-related courses that had lower grades (C) assigned them (e.g. principles of management BUS211, based on the preferences specified by the student in the scenario (see Fig. 5(a).



(a)

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BUS326	International Busi...	3	D
CBS111	Mathematics for B...	3	C
CBS121	Statistics for Busi...	3	C
CBS211	Mathematics for B...	3	D
CBS221	Statistics for Busi...	3	D
CSC211	Computer Progra...	3	B
CSC212	Fundamental of D...	3	B
CSC213	Structured Progra...	3	A
CSC214	High Performance...	3	A
CSC221	Computer Progra...	3	A
CSC225	Operating System	3	A
CSC310	Statistical Comput...	3	C
CSC311	Object Oriented Pr...	3	A
CSC314	System Analysis ...	3	A
CSC315	Internet Program...	2	A
CSC318	Operation Resear...	3	C
CSC413	Engineering High ...	3	B
CSC414	Artificial Intelligence	3	B
CSC416	E-Commerce Tec...	3	C
CSC422	Data Communicat...	3	A

(b)

Figure 7: Scenario Three- (a) Elicited Inputs; (b) Grades Recommendation

Likewise for scenarios 2 and 3 (see Fig. 6-7), where the target GPA is computed with a grades recommendation that is lower for courses classified as practical-inclined compared to others classified as business-related. For example, Business Finance (BFN211) was assigned grade D in scenario 2 because the user specified low preference for Business-related course. Mathematics for Business (CBS211) was assigned letter grade D in scenario 3, while letter an A was recommended for Computer Programming (CSC211) based on the user's preference set as low and high for mathematics-related and practical-inclined courses respectively.

6. DICUSSION

A number of GPA calculator apps exist as web apps or mobile apps available on app stores. However, the review of selected apps reveals that these apps are generic in nature and do readily meets some of the advisory needs of many college students. Besides, the proposed grades recommender as a personalized GPA calculator is a very useful resource for college students, as well as academic advisors and the lecturers.

The grades recommender when fully integrated into the student information systems is regarded as a type of technology-aided advisory services that helps students maximize their academic potentials [8], [17]. The proposed model will reduce the contact hours that students would have to spend with human advisors, since anticipating student performance and recommending the best plan of action is a critical component of an advisor's responsibilities [18]. Thus, advisors can better provide targeted and personalized academic advice,

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having known in advance the student's expected performance at the end of the semester or school year.

Furthermore, the faculty member, in the know of the distribution of expected grades from the students registered for a course, will device appropriate pedagogy, while also offering personalized support services to assist the students to achieve their academic goals.

A college student may be interested in knowing what minimum grades are required in courses yet to be taken in order to attain a target GPA at graduation. Furthermore, when compared to regular GPA calculators where the user inputs courses, the credit units and desired grade, the model proposed in this paper ensures that the excessive user inputs are minimized. The user is only expected to enter a target GPA, and indicate subject preferences for a course category, while the app computes the best set of grades that can realize the target GPA. In addition, the benefit of integrating the curriculum and transcript for the student in focus is that the grades recommended can be personalized to each student.

The SMART goal-setting methodology requires that people set high but realistic goals given the available resources. Setting the goal of a target GPA becomes realistic through the use of the proposed grade recommender because it encompasses the limitations posed by the remaining academic credit load of the student on top of the student's perception of his/her academic abilities. In most cases, college students resume a new session or academic year with the desire of a GPA they want to attain and having more specificities as to what is required in terms of mini-goals (grades in each course offered) will increase the chances of success. Furthermore, self-efficacy is an important predictor of academic achievement as confirmed by several studies [19]–[21]. Therefore academic goals set based on perceived self-efficacy, particularly as regards specific courses or subjects areas, are expected to motivate self-regulated learning behaviors towards the attainment of the set goals. Subsequently, it is envisioned that goals set as a result of the grades recommended through our app will contribute immensely towards improving the academic performance of college students. Particularly true when the student has certain preferences for, and by implication perform better in some course compare to others. For example, a student not comfortable with mathematics may desire to attain a C grade so far as the target GPA at the end of the term is attained; that same student would need to make up with an "A" grade in a management or finance course.

Also, the grades recommender proposed in this paper automates or completely eliminate time-consuming tasks of finding the right grades combinations that will amount to a target GPA. By so doing, the students can focus their energies on the activities and activate agency towards achieving their set academic goals. The model is a type of academic planning tool that helps a student graduate with better GPA. For college freshmen, the app will serve as a tool to get focused on the onset and set an academic success roadmap for the duration of the course of study. Also, sharing the information with other colleagues, friends and family can also serve as a support system that will both hold the student accountable to the goals they have set for themselves and provided the necessary practical and emotional support required to attaining high academic achievement.

7. CONCLUSIONS

In this paper, we propose a model for grades recommendation towards the attainment of a target GPA using mathematical optimization having considered the subject preference of the user. The proposed model overcomes the drawbacks of regular CGPA calculators in that it reduces the number of user inputs by using information from the curriculum and the student's transcript. The grades recommender allows the users to only the target GPA as well as their self-efficacious ratings based on the subject preference (or liking), after which the app suggests the possible grades in each course required to realize the target GPA. The model using a penalty based function to assign lesser grades (e.g. D or E) to low preferred courses while recommending higher grades (e.g. A or B) to courses with high subject preference. A full integration of the proposed model into a student information system will serve as a very useful resource to help college student achieve their academic goals. Possibilities for further work include the ability to generate a study-plan based on the recommended grades and the current timetable of the student. The design and development of the full model are currently underway, and when it is fully deployed in a real college setting, a more comprehensive user study will be carried out to ascertain the quality of user experience in various usage scenarios.

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