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Design and Development of a Course Recommender System for Undergraduates

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***Abstract*:** *A recommender system in an e-learning context is a system that tries to "intelligently" recommend actions to a learner based on the learner's activity and other learner's activity on the system. This recommendation system could be an on-line activity such as doing an exercise, reading different topic articles or commenting on different subjects/topics. Recommendation systems are being used in e-commerce to suggest products to the buyer. Advertising in search engines use this to feed users with adverts based on their previous activities online. This concept can be used to build a system that recommends courses for students based on the activities they do on the system. This paper investigates techniques that can be used to create the system. It also discusses the how cognitive thinking and decision making play a role in a student choosing a particular course to specialize in. These two concepts also play a role in the development of the system.*

Keywords: *Course Recommendation Systems, Assistive Decision making, Knowledge-based systems, Learning Management systems*

1. Introduction

This research aims at the provision of a Course Recommendation System for undergraduate courses specifically in universities in developing countries such as the Tshwane University of Technology, Pretoria, South Africa. During In the year 1999, Technikon Pretoria in South Africa conducted surveys to improve understanding of industry requirements regarding skills and qualifications of ICT students [20]). With that achieved and implemented a program to help students choose a specialization field is a need to help students in choosing a course. A student's success relies on demographic, academic-environment, socio-economic factors [22]. According to [10], an academic performance or excellence is used to label the observable manifestation of knowledge, skills, concepts, and understanding of ideas [22]. Usually educational institutions use aptitude tests to when they apply for admission into a course. They also use performance from their matric results to measure the academic success of a student. This usually works for admitting students to the faculty but the problem is when the students who have been accepted into this faculty have no clue as to what they should specialize in. The Tshwane University of Technology ICT faculty has a program of enrolling students to the same course for the first year giving them exposure to the field they can specialize in, in their second year/level.

This paper suggests a use of a course recommendation system allowing students to participate in different activities, such as brain teasers, problem solving questions, maths questions etc. The aim is to understand which fields a student excels in. The system will also use the student's yearly marks to help in calculating which field a student can do well in.

Many studies have been put forward on web applications and their various applications in today's society. The flexibility and convenience that comes along with web based applications have made them extremely popular in today's educational systems [3]. Web based applications provides flexibility and convenience. Thus Grove suggests that services and information should be made available with web based applications [15]. The popularity of web based applications and the easier and less operating system compatibilities is the reason I choose to create a web based system or a mobile application. To design and develop a system that guides students in choosing a suitable specialization field.

The objectives of the study are:

- To develop and implement a course recommendation system.
- To investigate the role of cognitive thinking in making decisions.
- Perform an evaluation of the developed system.

This is significant because every first year student is expected to choose a specializing field during their second semester of their first year of studies while students are still familiarising themselves with the IT environment and have less information on the fields to specialize in. Teaching methods are different from lecturer to lecturer, one PHP lecturer can be best understood by students and the other not, which shows that we cannot use subject marks only to decide which field a student would do best in. This project gives a platform for students to get more information about the courses, to test themselves (different to the academic tests) if they can solve real life problems from each specialization field.

2. Literature Review

2.1. Introduction

The ICT field is viewed by most people as one of the fields that offer big money on employment. Therefore, most students from disadvantaged homes choose this field with hope that on completion they will get employment. Motivation of a big pay after completion, wanting to take the easiest course to finish and find work to provide for the family, choosing one over the other because of the belief that one is easier compared to the other, not having confidence in their capabilities contribute to undergraduates to wrong choice of specialization field.

Education is being viewed more and more as an investment by students [1]. An Australian study reveals that students and their parents search for educational courses, universities and varying fees structures, in expectation of a pay-off from their increasing investment in education [26]. Therefore, it could be argued that employment has become one of the reasons why students choose a particular ICT career over the other [8]. With employment being somewhat of the main reason that students choose careers which are available in the market it becomes a problem when they have to further their studies because they will at most times have no genuine interest in that career.

Blackmon [4] states that general intelligence or various more specific cognitive abilities are important causal determinants of decision making. We all have different cognitive abilities which allow us to make different decisions which affect our lives. Shane Frederick's The Cognitive Reflection Test, shows that every person has different cognitive abilities which can help them make better choices if they are made aware of them.

2.2. Related Works

Recommender systems can be applied in many areas where users are to be supported in their decision-making while interacting with large information spaces [24]. Aspects involved in the development of the Course recommendation system are given below:

2.1.1. Cognitive Ability and Decision Making

We all have different cognitive abilities which allow us to make different decisions which affect our lives. Jensen, 1998, states that people with high IQ on average live longer, earn more, have larger working memories, faster reaction times and are more susceptible to visual illusions. Shane Frederick developed a Cognitive Reflection Test which shows that people with low IQ make decisions based on current events and not thinking of the future. On Shane Frederick's The Cognitive Reflection Test, he tests how people make decisions when solving math problems and investment problems. He found out that the people who had high IQ could answer correct most math problems because they are patient and consider all attributes of the given problem before answering. Shane Frederick's test shows us that every person has different cognitive abilities which can help them make better choices if they are made aware of them. Breşfelean(2005) states that informed decisions are better than uninformed decisions and measuring outcome is advantageous to a business [2]. In relation to course recommendation systems [3] concludes that yearly marks should not be the only data used to help recommend courses. He suggests that students' behaviours should be considered to. Therefore, there is need to make students aware of their ability of handling different topic areas.

2.1.2. Technologies used in developing recommendation systems

Many researchers use recommender systems in e-learning environmental domain. Different researchers use either one of these four filtering approaches, content-based filtering, collaborative filtering, knowledge-based filtering and hybrid filtering. The above mentioned techniques are sometimes used alone, together or with a different built model. Here I will discuss the difference and comparison in the techniques with the output helping me decide on which technique to use in developing the system.

Content-Based Filtering

In content-based filtering the user/learner are recommended relevant items/learning contents that are similar to the ones they preferred in the past [5]. Content-based filtering approach depends on the user profiles that assign consequences to these characteristics [5]. Content-based filtering has a problem within the approach, the problem is called **cold-start, overspecialization**. This problem results when the domain system does not have enough information such as keywords tags and content ratings on both learning content and user's profile. Consequently, the system is unable to acclaim the users interest and unable to recommend the relevant item accurately [5]. Content-based recommender systems are classifier systems derived from machine learning research [13]. These systems are used mostly on online sites to suggest articles to a user. The proposed course recommendation system cannot use this approach because the approach does not deal direct personal input from a user.

Collaborative Filtering

In collaborative filtering the user/learner is suggested content that learners/users with the same interests liked or viewed when go through the content. These systems aggregate data about customers' purchasing habits or preferences and make recommendations to other users based on similarity in overall patterns [3]. Collaborative filtering's setback is **cold-start, sparsity**. This happens when content doesn't receive a lot of views or the learners don't give it enough ratings. This approach won't help us achieve our goal because I are targeting a specific user meaning I need a user to go through all the content themselves answer all the questions so that I can do evaluation on the given answers.

Fig 1: Collaborative filtering process [11]

Knowledge-Based Filtering

Knowledge-based filtering approach does not seek to build long-term generalization of their users/learners but they prefer to generate a relevant recommendation based on matching user's / learner's needs, interests and preferences [5]. Knowledge-based approach is the most ideal filtering approach from the three because it using the data captured from the user profile and what they are interested in most. Therefore, we use knowledge-based filtering method.

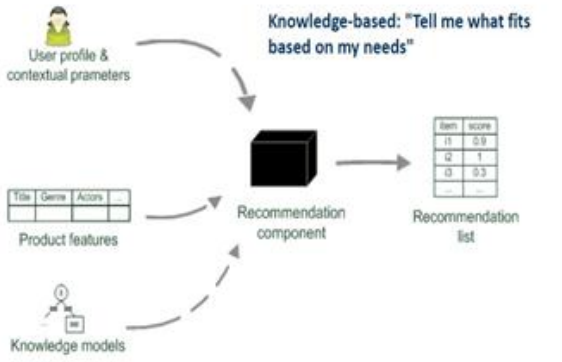

Fig. 2: Knowledge-based filtering process Jannach, Zanker and Friedrich (2013)

2.3. Document Modification

Recommender systems: filtering approaches

TABLE I: Recommender Systems

	Advantages	Disadvantages
Content-based filtering	No knowledge engineering effort, serendipity of results, learns market segments	Requires some form of rating feedback, cold start for new users and new items
Collaborative filtering	No community required, comparison between items possible	Content descriptions necessary, cold start for new users, no surprises
Knowledge-based filtering	Deterministic recommendations, assured quality, no coldstart, can resemble sales dialogue	Knowledge engineering effort to bootstrap, basically static, does not react to short-term trends

2.4. The Summary of the Literature Review and Uniqueness of the Study

The uniqueness that comes with this study is the combination of different proposed theories and useful innovative inputs from students. As it is a challenge for student to choice courses that are well best suited for

them, the researched and studies theories of minimizing this problem will help. The combination of using the theory behind Knowledge-based recommender systems, Cognitive thinking of people and taking advantage of learning management system Moodle, which been used and tested worldwide, in developing the systems.

3. Research Methodology

3.1. Overview of Methodologies used

In conducting this study, the methodologies used are the User Participatory Design and Prototyping Methodology. These methodologies are used to enable the developer to interact and work with users in the process of conducting the study therefore, inviting valuable feedback from intended users.

3.2. Survey

The population consists of a group of individuals who represented the specific target population of under graduates. The type of sampling used for this study is stratified sampling.

Stratified sampling uses subsets of the target populace wherein the participants possess one more common characteristic with each other. With this research, it is suitable to use stratified sampling because all of the participants are well-read, the only difference is the standards of their education and literature because we are looking at the population on under graduates.

3.3. Prototyping

This is a stage where the software prototype is built, this prototype has some of the characteristics of the complete system to test the functionality, for users to test system usability, the look and feel design and give feedback to work on. I specifically focus on aspects that need outline the solution to the research question. Prototyping also helps in ensuring that the designed system conforms to the user's expectation and to also test alternative designs [17].

Prototyping can be conducted with two main methods namely the throw away methodology and the evolutionary methodology [10]. The throw away prototyping refers to building the functionality limited software model which incorporates poor understood functions and requirements. During the processes when designers and users are interacting, these functions and requirements are thoroughly studied, and the software specification is updated.

The evolutionary prototype is similar to the end product by its functionality. The desired improvements and clarifications are implemented into the model during the participatory design process. Evolutionary prototyping methodology was used because the aim of this project is to design and develop an online course recommendation system.

The system is built using PHP, Javacsript, and HTML. It using a MySql database runs on a linux share web server. The system is an online system which can be access using any web browser on any computer operating system.

3.4. The Design Science Methodology

Number The Design Science methodology will be used. According to [7], a suitable methodology for research involving software development is Design Science. In line with [27] as observed by [7], a typical design science research effort as illustrated in figure 1 follows:

Awareness of a Problem

This can come from multiple sources such as new developments in a field of interest in specific discipline or in the industry. Reading widely is critical in providing opportunity for the awareness of a problem that can be researched. The result of this phase is a proposal, formal or informal, for a new research effort.

Suggestion

The resulting output of the suggestion phase is a tentative design in which new functionality is envisioned. This could likely include the performance of a prototype based on the design. In the absence of an output of this phase, circumscription involves looping back into the problem awareness phase, else the proposal will be set aside.

Development:

This involves further elaboration, creative development and implementation of the tentative design. Depending on the artifact to be constructed, this could involve using various techniques including algorithm construction, expert system development using a high-level package or tool, etc. On errors or the absence of an output of this phase, circumscription involves looping back into the suggestion phase. The development stage of the design science approach will use prototyping. According to [21], prototyping refers to a simplified program or system that serves as a guide or example for the complete program or system. Therefore, based on the user experience and their perceptions, a prototype that tend to meet all their needs and expectation is developed. The prototype was run on a cycle of major review and iteration to fix bugs, add content etc. This approach helps to eliminate uncertainties and ensure that the system will do its purpose. This is a good method to identify problems that users encounter when using the system so that an improvement can be made.

Evaluation

After development, the artifact is evaluated according to criteria possibly stated in the awareness phase. Here deviations from expectations, either quantitative or qualitative, are carefully noted and tentatively explained. The evaluation results and additional information gained in the construction and implementation of the software or artifact are fed back to another round of "suggestion" through circumscription.

3.5. Project Workflow

Use **Step 1 –Interviews:** During this stage I will interviewing students to find out how affected are they with not being sure of what they need to specialize in. This process will take 2 weeks. First week I will conduct interviews with 1st year and 3rd year students the 2nd week will be with B-tech students.

Step 2 – Investigate the problem: This stage requires me to search for articles and books that address the problem. This stage is continual because I will be going back to it to look for me articles to solve problems I encounter as I continue with the project.

Step 3 – Write proposal: During this stage I will be reading articles that will give me more information to address the problem. I will look into the best methods and tools to develop the system. This period involves supervision so it will take two months to complete.

Step 4–Develop prototype: This process will take me 2 months. The prototype will consist of two courses for it to be evaluated.

Step 5 – Evaluations / Feedback: This stage will take 2 weeks giving the students a chance to familiarise themselves with the system and give me feedback

Step 6 – Make system changes: Estimating a month to complete the changes recommended by the students.

Step 7 – Report: This stage will take two weeks to complete because I will be documenting activities that happened during the course of the project.

4. Results and Evaluation

4.1. Project Workflow

Step 1 –Interviews: During this stage we interviewed students to find out how affected are they with not being sure.

The demo of the system has been deployed on Afrihost hosting server and it can be accessed with the following uniform resource locator address http://www.blackonblack.co.za/project4

The home page or rather the landing page gives you a brief description about the purpose of the system. As a new user, you are required to sign up in order to access all the privileges that the system offers to its members. You get links to create account, login, forgot password and forgot username.

Sign-up page consists of the mandatory fields that a user needs to provide the information with in order to start participating on the site, the username need to be your student number so that the teacher can identify who the student is. After capturing the right information, you will receive an email of which you need to click on the given uniform resource locator address in order to activate your account. Without an active email, you cannot continue with the system and in order for someone to be participate and be a member, you need to fill this form according to the system's requirement.

As shown on figure 3, once you are successfully registered, you can log in to the system. Now you can go through the content that is available to you so that you can get the idea of the courses offered. You will need to participate in a test one at a time. The test can be attempted more than once in case you feel like you didn't do well in that particular course test.

As shown on figure 3, you can now access the courses that you want to test yourself on. The course have a brief describtion of what they are and what they entail. Under navigation click site home to view available course. To enroll to the course you need to click the title of the course.

Fig. 3: Available courses

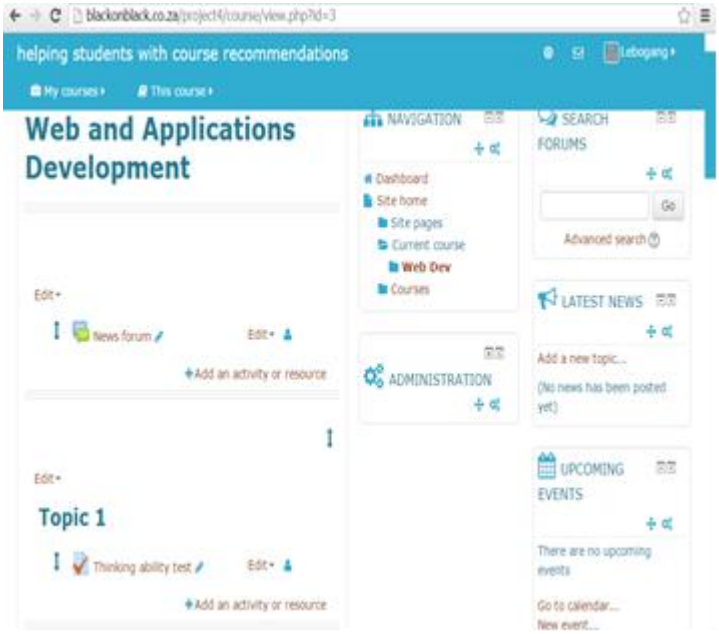

Fig. 4: Example of a Web & Applications development page

This page shows the questions within an activity

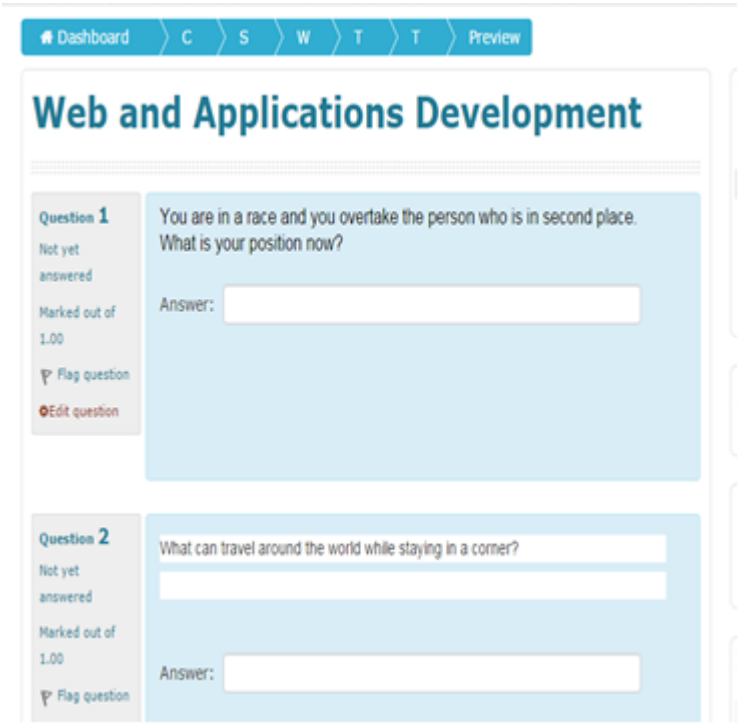

Fig. 5: Activity list

This page shows the student which questions they got right and which they got wrong.

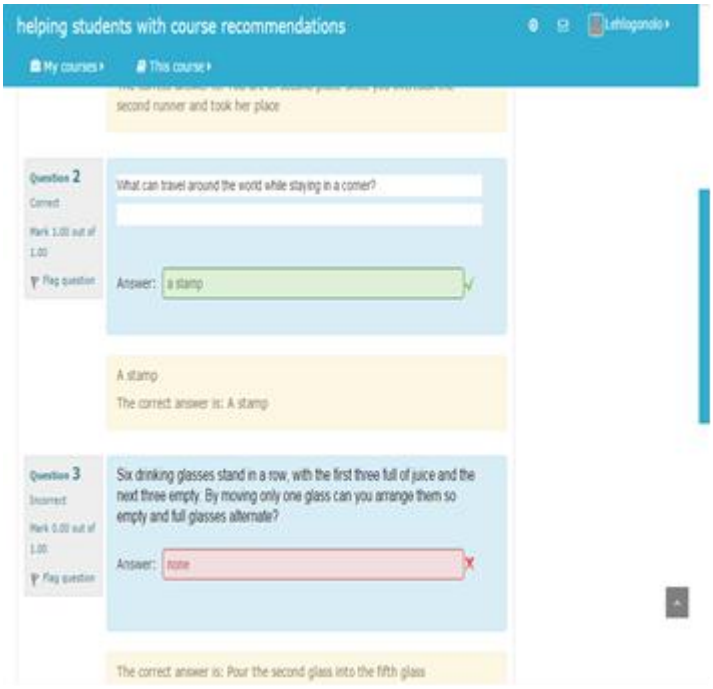

Fig. 6: Marked questions

You can access your results per activity and analysed data that suggests a suitable course based on how you performed. Under administration choice course grade and get your grades.

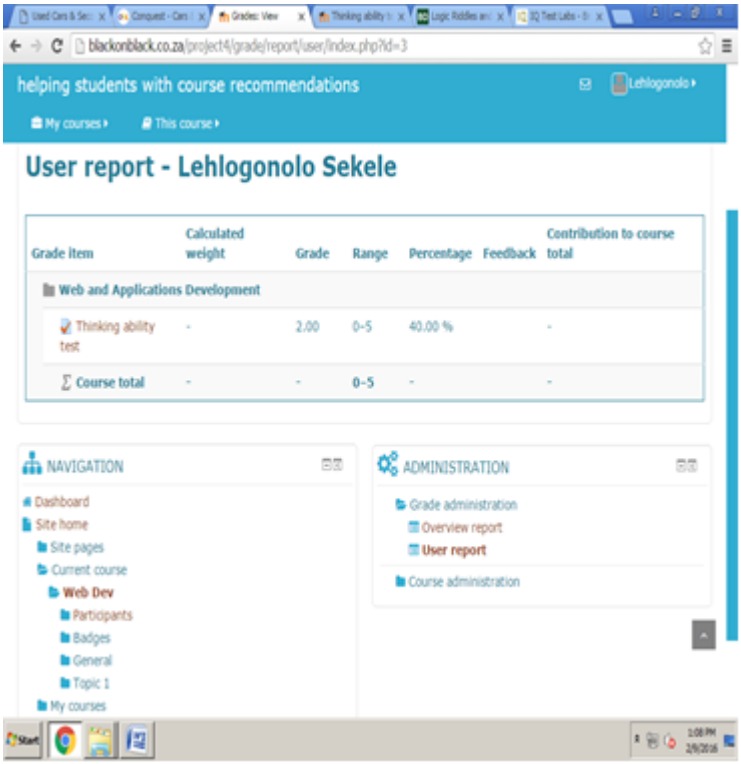

Fig. 7: Results Page

Registered members are allowed to view on other member's profile by clicking on their names, they also get a status of whether they are online or not.

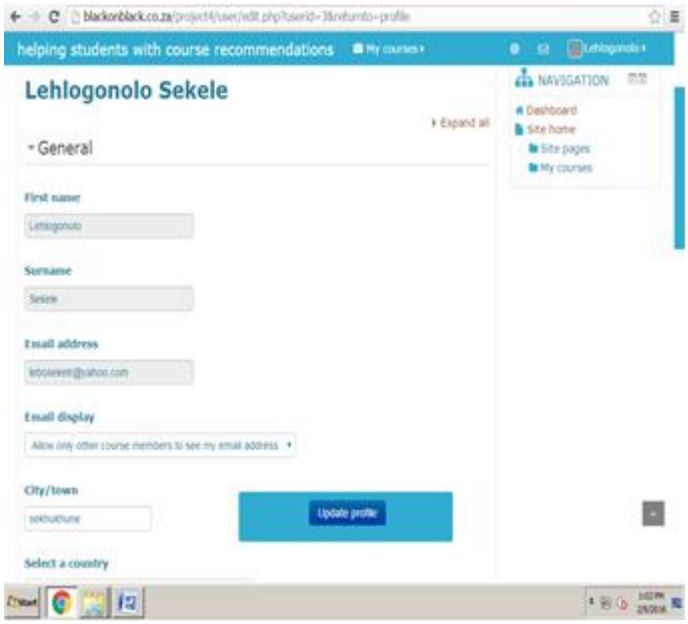

Fig. 8: User Profile Page

4.2. Results of User Participation and Evaluatiion

Use The evaluation process was grouped into three groups 1st year, 3rd year students and B-Tech students. Each group had 5 students. Group 1 which was the 1st year students consists of three students who are repeating the subject DSO15AT which teaches them basic principles of programming. The other two have passed all their subjects and have chosen to specialize in Business informatics and Web and Application Development. The second group which is the 3rd year students is made up of one business informatics student, one multimedia student, one computer science student, one support services student and one communication networks student. The 3rd group which are B-Tech students is made up of, one web and application dev student, one software dev student, one business informatics student, one communications network student and one multimedia student. They were all asked if they see the need of such a system after I explained the main objective of the system

Usability Testing

After a system has been built, it has to be tested and evaluated by developers first and then the relevant users of the system (Mabunda & Dehinbo 2012). It takes time for people to get used to using a system, so we asked for fellow developers to evaluate my system and tell me if it is end user friendly before asking the participants to test and evaluate the system.

System-User Interactivity as a Usability Factor

Salvatori [25] defines interactivity as "the extent to which users can participate in modifying the form and content of a mediated environment in real time" [25] proposes speed of interaction, range and mapping as three major factors affecting interactivity. Speed of interaction is also referred to as response time. The more instantaneous a user perceives their actions in a mediated environment, the higher he or she perceives interactivity. Range is concerned with how many options a user has in making changes in the mediated environment. Mapping deals with "the way in which human actions are connected to actions within a mediated environment".

In simple terms, we can define apparent interactivity as a two-component construct containing of navigation and responsiveness which increases the users' approach towards the web system. This be determined by on how easy your users can navigate to their looked-for pages and how fast they get to obtain an answer from the.

Usability evaluation

A number of approaches have been developed so as to improve and achieve productive design by researchers. User Centered Design (UCD) is touted in the literature as one of the most effective (Barnum 2007).

Usability Testing Results

The following subjects were raised and discussed

Menu: Students raised a concern that the menu should be grouped according to what the function they perform and they found it hard to get to some pages. The navigation wasn't design properly.

Menu relevancy: Students suggested I have a combination of the menu blocks. Not have navigation block and main menu block separate.

Overall design: The students liked the design of the system, which supports mobile devices which was achieved by using bootstrap and JQuery.

Information/Notifications: the easy registration process, the feature of showing them they result group and availability of more information about the specialization fields impressed the students.

Response time/speed: the students suggested I look for a better way of making the website load faster.

The more comments they had about the system is that I should look on improving the website site navigation and having a better way of giving out the suggested course.

5. Conclusion

This study has proven that most B-Tech students see the need for this system because they have made bad decisions when they choose their specialization field. It also shows that there is a need to provide this to first year students because they are not aware of the consequences of making bad specialization choices.

The studied recommendation systems work different to mine; they are most based on ecommerce sites. Recommending products to customers who click to view products in the same category and analysing customer shopping history before recommending a product. Our approach was to use the recommender systems' principles in recommending courses to students. I also included more information so that the students can read and can more information on the courses. The challenge I faced with using Moodle was with suggesting most like activities and same time course suggestion output. The student has to go to the reports page to see the suggested course. The questions type came as a challenge too.

6. Recommendations

As doing what you really enjoy is one of the things that every successful person advices to every young person, more research has to be done to help them understand their way they think and provide systems and applications that will help them in choosing the right career. Most people do not enjoy what they do and it is best to change this. It is best to make such services available to students earlier in their learning path as [12] suggests that the perfect information can help avoid bad future consequences. Systems such as prediction test systems which predict the success of a student in their studies based on their marks only can't help resolve this problem. The university should invest in making sure students can more attention and help in choosing specialization fields because it determines what happens with their lives after graduation day

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