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Development Of Undergraduate Students Course Recommender System

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***Abstract*— Recommender systems can be utilized to their full potential by suggesting to users the information they need, tailored to their interests and personality. However, researchers in the past have faced a common challenge when developing a recommender system: the "Cold-Start" problem. This issue arises when the system cannot suggest any information to the user due to a lack of data from that user. Individual interests and personalities are strongly influenced by the choices made regarding future careers, including course selection prior to entering university. To address the "Cold-Start" problem, a Course Recommender system has been proposed. The collection of data from users before developing this system is vital to ensure its efficient and effective function. The Agile methodology has been employed in the development of the Course Recommender system, encompassing the discovery of requirements, design to fulfill those requirements, prototyping, and evaluation. Holland's RIASEC personality test is utilized to gather users' interests and personality traits, which then serve as a guide to determine the courses that suit the users best. In a sample of 15 respondents chosen from 105, nine claimed that they were matched with a course of interest, while six did not feel the same way. Hence, the incorporation of Holland's RIASEC personality traits has indeed proven beneficial in selecting courses that best suit the users, thereby enhancing the effectiveness and efficiency of the developed Course Recommender system.**

Keywords*— *Course Recommendation System, mobile application, Holland's RIASEC personality, user testing

I. INTRODUCTION

The university course recommender system could provide significant benefits to students around the globe, as the selection of a course might be a determining factor in a student's future career [1-4]. In many studies, educational recommendation systems are recommended as an effective tool for improving student learning outcomes, even in developing countries [5-8]. A well-matched alignment of interests, skills, and academic performance with the chosen course will undoubtedly assist students in resolving their dilemma [9]. The obstacles faced by students in the 21st century have urged them to prepare more effective strategies for developing their skills and knowledge, aligned with the appropriate courses they choose [10]. Many methods and approaches can be applied to ensure the effectiveness of a recommender system [11].

However, the data obtained by the researcher, including information on students' interests, skills, and academic performance, must be sufficient for the recommender system to function correctly and efficiently. Past research [12-16] has faced the same problem, known as the 'cold-start issue'. The recommender system is unable to come up with the correct course suggestions for new users because there is no data about the user in the system yet [17]. Sawarkar, et al. [12] conducted research on the "Intelligent Recommendation System for Higher Education," with the goal of the study being to help improve and predict students' performance in order to mitigate the risk of future failure. However, the results from the research focused solely on the students' marks and the data was obtained exclusively from engineering students. Recommending courses based only on marks is not practical, as there are multiple factors that need to be considered, such as a student's interests, skills, extracurricular activities, co-curricular activities, and understanding of the subject. Rao, et al. [13] focused on ways to ensure that users, including students, are able to find suitable courses for themselves by using LinkedIn Learning. The researchers encountered the "cold start" problem, where the system has yet to obtain any data from the user, typically a first-time user. This has led to low accuracy in recommending suitable courses for the user. However, the accuracy of the recommender system is expected to increase eventually due to user interaction.

Zhang, et al. [18] focused on improving the accuracy of the course recommendation system by implementing the collaborative filtering algorithm. However, the research highlighted three specific problems. The first is data sparsity, which occurs due to insufficient or the absence of useful information. A lack of feedback from users compounds this problem, as the system is unable to predict based on historical information or provide relevant recommendations to the user. The second issue is the well-known "cold start" problem, commonly faced by many recommender systems, particularly with the presence of new users. The collaborative filtering system needs to wait for a period of time to "mine" the data

from new users; only then will the accuracy of the recommender system gradually improve over time. The third problem is scalability, stemming from the increasing number of users to the point where it becomes unmanageable for the system. The recommender system is unable to provide accurate results for users in real-time because it cannot accommodate such a high number of users.

Samin and Azim [15] conducted a study to develop Machine Learning tools for a recommender system useful to faculty and students in academia, specifically in Pakistan. However, the researchers focused only on Computer Science staff, and the recommender system was not tested with faculty from other programs. As a result, the capability of the proposed recommender system has not been fully tested, and this research still has a long way to go. Additionally, the recommender system does not encompass time dynamics, meaning that the recommendations provided by the system are not up-to-date and may not remain relevant with respect to ongoing research and industry trends.

The course recommender system is likely to be less useful when there is no dataset built into the system [19]. When the course recommender system is unable to assist students in resolving their dilemma, students may turn to friends or seniors to gather information about the course they have decided to take. However, different people will have different experiences, and this represents a risk that many students face, akin to gambling with their future. The choice of course can significantly impact students' grades, potentially leading to negative outcomes if they choose poorly. It is essential for students to select courses that best suit their interests and skills. Therefore, this research proposes the UX design approach to create a course recommender system capable of overcoming the limitations identified in previous studies.

The primary goal of this study is to design a course recommendation system for undergraduate students. Another objective is to evaluate how well the recommender system aligns with user preferences during usability testing.

The remainder of the paper is structured as follows: the second section provides an overview of related work and techniques used; the third section discusses methodologies; the proposed work and its outcomes, along with implementation steps, are covered in the fourth section; and finally, the paper concludes with a summary of the proposed work in the final section.

II. LITERATURE REVIEW

A. Holland's RIASEC Model

Personality refers to a unique pattern of behavior that each individual exhibits when dealing with life's challenges, such as cooperation, stress, anxiety, and decision-making—all of which are vital in the workplace. According to Holland, every human being possesses a particular behavioral pattern for engaging with life's dynamics. This personality significantly influences how an individual behaves in the workplace, and a compatibility between personality types and job roles can enhance both performance and job satisfaction. Holland's theory of personality, often referred to as RIASEC Holland, identifies six personality types and corresponding environments: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C) [20]. Realistic (R) interests encompass activities that involve using hands or tools, such as mechanics or woodworking. Investigative (I) inclinations are suited to academic or scientific fields, such as conducting physics research or working as a psychologist. Artistic (A) inclinations are compatible with imaginative and expressive pursuits, such as painting a portrait or dancing. Social (S) interests align with activities and professions that involve aiding or nurturing others, such as nursing or teaching in elementary schools. Enterprising (E) interests are associated with business-related or influential activities and professions, such as opening one's own store or working as a factory manager. Lastly, Conventional (C) interests involve work that is organized and methodical, such as tracking shipment records or acting as an accountant [21]. John Holland proposed the Personality Type Theory, arguing that an individual's career choice should align with their personality. In Holland's concept, the connection between personality and environment is particularly significant. Personality influences how someone feels about their job, while the workplace is defined by the employers, the setting in which work is conducted, and the behaviors performed. The RIASEC personality type is characterized by preferences and aversions that influence workplace decisions. According to Holland, if a person chooses a career that complements their personality, they are likely to enjoy it and remain in it for an extended period. Although many scholars refer to the circular arrangement and structure of the six RIASEC categories as circumplexes, Holland describes this framework as a hexagon, as referenced in Figure 1.

The subject of validity and reliability is a major discussion point for every measurement used in research. The primary focus is on the creation of a measure that correlates with the construct being assessed. Since social theory concepts can often be complex, confusing, and challenging to examine directly, reliability and validity are essential. Researchers strive for high levels of both measurement validity and reliability. Reliability measures are employed to gauge the consistency of test results and the extent to which external factors affect those outcomes. Higher test reliability enhances the likelihood of consistent evaluations of individual differences [20].

B. Self-report Inventory

A self-report inventory is a type of objective test commonly used to evaluate personality. This method often involves multiple-choice questions or numerical scales, with response options ranging from 1 (strongly disagree) to 5 (strongly agree). These scales are frequently referred to as Likert scales, named after their creator, Rensis Likert, in 1932 [22]. See Figure 2. The Minnesota Multiphasic Personality Inventory (MMPI), first introduced in 1943 with 504 true-or-false questions, is one of the most frequently used personality inventories. It was revised to the MMPI-2 in 1989, expanding to 567 questions.

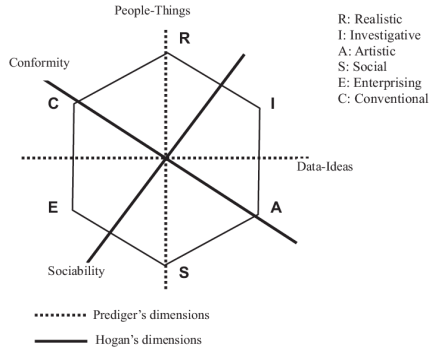

Fig 1. Structure of Holland's Hexagonal *(retrieved from: https://www.researchgate.net/publication/26762648/figure/fig7/AS:668699124060162@1536441703161/Hollands-hexagonal-model-of-vocational-interests-with-Hogans-and-Predigers-dimensions.png)*

The new inventory was based on a more representative national sample to allow for better standardization, in contrast to the original MMPI, which relied on a small, limited sample largely composed of Minnesota farmers and psychiatric patients. The MMPI-2 takes one to two hours to complete, and the responses are scored to create a clinical profile consisting of ten scales: social introversion, schizophrenia, hypomania, psychopathic deviance (social deviance), masculinity versus femininity, paranoia, and obsessive-compulsive traits. A scale to identify risk factors for alcohol abuse is also available. The test underwent further revision in 2008, resulting in the MMPI-2-RF, utilizing more sophisticated techniques.

	Strongly Disagree	Somewhat Disagree	No Opinion	Somewhat Agree	Strongly Agree
I am easygoing.	O	O	O	O	O
I have high standards.	O	O	O	O	O
I enjoy time alone.	O	O	O	O	O
I work well with others.	O	O	O	O	O
I dislike confrontation.	O	O	O	O	O
I prefer crowds over intimacy.	O	O	O	O	O

Fig 2. Example of Likert Scale *(retrieved from: https://pressbooks.bccampus.ca/psychologyh5p/chapter/personality-assessment/)*

This edition contains just 338 questions and takes approximately half as long to complete. Despite the advantages of the new test, the MMPI-2 (see Figure 3) remains more well-known and frequently used. Computers are typically employed to administer the exams. Although originally developed to assist in the clinical diagnosis of psychiatric disorders, the MMPI is currently used for occupational screening, including in law enforcement, and for college, career, and marriage counseling [23].

C. The Big Five Personality Trait

Long-standing trait theories of personality have aimed to identify the exact number of traits that exist, and different numbers have been proposed by various theorists. For example, Raymond Cattell identified 16 personality factors, Gordon Allport provided a list of 4,000 personality traits, and Hans Eysenck proposed a theory based on three factors.

	True	False
1. I like gardening magazines.	O	O
2. I am unhappy with my sex life.	O	O
3. I feel like no one understands me.	O	O
4. I think I would enjoy the work of a teacher.	O	O
5. I am not easily awakened by noise.	O	O

Fig 3. Questions from Minnesota Multiphasic Personality Inventory (MMPI) *(retrieved from: https://pressbooks.bccampus.ca/psychologyh5p/chapter/personality-assessment/)*

Many scholars believed that Cattell's theory was overly complex, and Eysenck's was too limited. To capture the broad characteristics that underlie personality, the Big 5 personality traits were developed. According to many contemporary personality psychologists, the 'Big 5' personality traits are the five fundamental dimensions of personality. These include extraversion (sometimes referred to as extroversion), agreeableness, openness, conscientiousness, and neuroticism. Conscientiousness is associated with thoughtfulness, openness with curiosity and creativity, extraversion with sociability, agreeableness with friendliness, and neuroticism often with melancholy or emotional instability. Without taking a personality traits test, understanding each personality trait and its implications can provide insight into one's own personality. It can also assist in better understanding others based on their positions on the continuum for each of the described personality traits [24].

III. MATERIALS & METHODS

In this section, the methodology is outlined, including the research design, prototype, data collection, and evaluation. Additionally, the relationship among variables that may influence the final results is discussed in the research design. During the development phase, the authors focus on data preparation, model training, model inference, and application integration. This study has been applied and implemented to assist users in finding the courses that suit them best. Wix has been utilized as a tool in designing, developing, and implementing the Course Recommender website (all fonts, text sizes, colors, and images inside the Course Recommender website were fully developed using Wix). A total of 105 users have successfully responded to the online survey (via Google Form), and 15 respondents have been selected for verification. In the website evaluation, 10 participants (among the 105 respondents) were randomly selected to test and interact with the Course Recommender website to assess whether it is effective and efficient.

According to Jones and Thoma [25], "Agile" refers to a process in which users' requirements or functional needs are described through iterations with the collaboration of self-organizing and cross-functional teams. This "Agile" approach advocates adaptive planning to counter the traditional plan-driven approach, and it encourages the continuous improvement of solutions. As depicted in Figure 5, Agile development encompasses more than just the ability to adapt and advance with emerging technologies. It was first formulated in 2001 by a group of experienced developers as a set of methodologies. The Manifesto for Agile Software Development provided a detailed description of their processes. The entire approach is grounded on four core principles: prioritizing individuals and interactions over processes and tools; emphasizing working software over comprehensive documentation; collaborating with customers over contract negotiation; and responding to change over following a plan. In agile web development, cross-functional teams are utilized to adapt to the continuous creation and refinement of software solutions. This offers a more streamlined and efficient method of implementing flexible adjustments [26].

A few steps will be initiated during the development of the course recommender website. The first step involves discovering requirements from users. The target audiences must be identified at a very early stage to ensure that the process of discovering requirements is conducted correctly. The next step is designing, tailored to fulfill the requirements of the targeted audiences. This includes prototyping, whether in the form of low-fidelity (such as sketches, storyboards, and the Wizard-of-Oz technique) or high-fidelity prototypes (expected to be the final product), as depicted in Figure 4. The final step will be evaluation, for which a cooperative evaluation method will be applied to this project.

An online survey has been utilized to achieve the second objective for this project, which is to develop a course recommender system based on users' interests and skills. In order to obtain data from the user, it is both crucial and vital to reach out to the targeted user first.

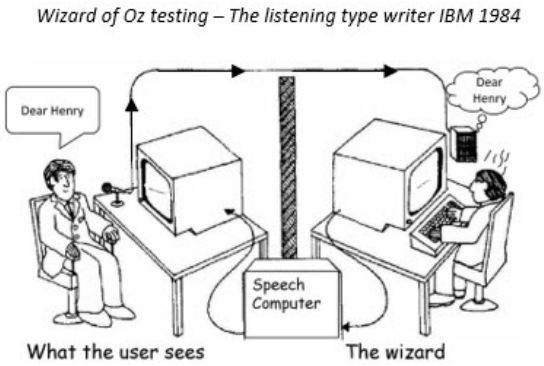

Fig4. Wizard-of-Oz (retrieved from: https://www.simpleusability.com/wp-content/uploads/2018/08/IBM.jpg)

Fig 5. Agile Method

Furthermore, this course recommender system is designed to provide more accurate recommendations for courses to users. Therefore, the collection of users' data through an online survey is a vital step in achieving higher and more precise accuracy in the course recommender system. In the Brainstorm phase, authors define the needs, which include obtaining and analyzing requirements. This process should outline the importance of the projects, as well as the time and effort required to complete them. Based on this information, the authors can assess the technical and economic viability.

Following the identification of the project, the authors must demonstrate how the new features function and how they will be integrated into the existing system. The design of the software is a critical component at this stage, as shown in Figure 6. Once designed, the program should be implemented in the form of a high-fidelity prototype designed.

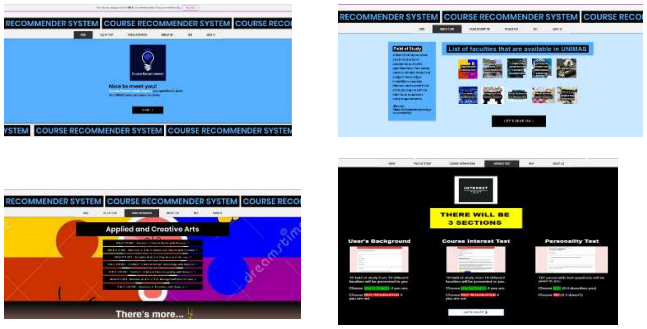

Fig 6. Initial design of prototypes of the mobile application

During the development stage, the authors should implement the solution with the aim of deploying a functional mobile application. In this instance, the program, being a web application, will undergo several phases of development to ensure that it possesses basic and minimal capabilities. The process of iteration and continuous integration will facilitate ongoing evolution. The authors will also conduct a demo at this phase to gather feedback on the program.

In the Quality Assurance phase, testing will be performed to evaluate the software's performance. The authors should identify any flaws or defects and then seek methods to rectify them.

Subsequently, in the Deployment stage, the authors will create an application package and deliver the software for the user's

working environment. Following this, they must finalize the deployment process to provide software production and technical support. The final stage involves gathering feedback after the product has been launched. During this phase, the authors will collect opinions on the software and make necessary adjustments. The questionnaire will serve as the evaluation tool for this study.

IV. Results and Discussion

This section provides an overview of the usability testing results, including an analysis of the questionnaires and a presentation of the findings. These results are evaluated using the method described in Section 2, and they are comprehensively presented in this section for future visualization.

The targeted respondents fall within the age range of 19 to 27 years. Out of 105 respondents who participated in the Course Interest Test, 11 individuals (10.5%) were between the ages of 19 and 21. The majority of the respondents, totaling 88 individuals (83.8%), were between the ages of 22 and 24. The smallest group of respondents, consisting of 6 individuals (5.7%), fell within the age range of 25 to 27. Figure 7 illustrates the distribution of respondents according to faculty at UNIMAS.

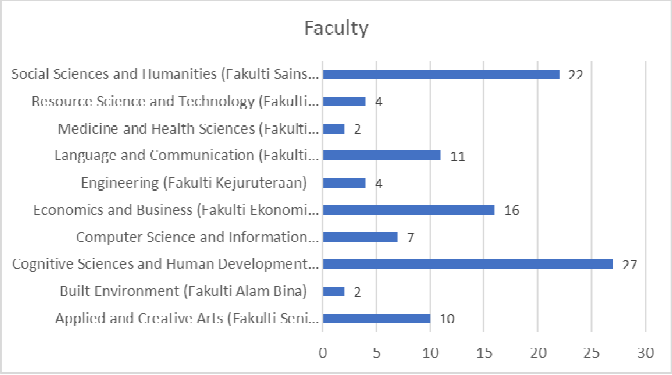

Fig 7. Number of respondents according to faculty

Referring to Figure 7, the researcher managed to gather responses from 105 undergraduate students across 10 faculties. The majority of respondents, 27 individuals (25.7%), are from the Faculty of Cognitive Sciences and Human Development, followed by 22 students (21.0%) from the Faculty of Social Science and Humanities. The Faculty of Economics and Business contributed 16 respondents (15.2%), and the Faculty of Language and Communication had 11 participants (10.5%). The Faculty of Computer Science and Information Technology was represented by 7 respondents (6.7%).

The Faculty of Engineering and the Faculty of Resource Science and Technology each had 4 respondents (3.8%), tying for the same number of participants. Lastly, the faculties with the fewest respondents were the Faculty of Built Environment and the Faculty of Medicine and Health Sciences, each with 2 participants (1.9%).

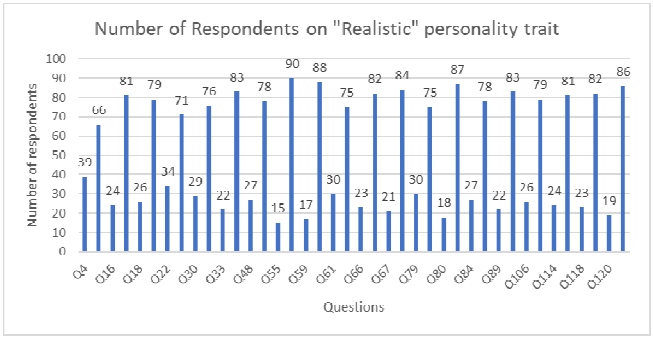

Fig 8. "Realistic" personality trait

Figure 8 shows the "Realistic" personality trait. According to [21], people described as 'realistic' are typically more comfortable with tasks related to tools, such as mechanics, building houses, and car repair. According to the bar graph, question number 55 received the highest number of 'Yes' responses (90 out of 105 respondents, or 85.71%), followed by question number 59 (88 out of 105 respondents, or 83.81%), and question number 80 (87 out of 105 respondents, or 82.86%).

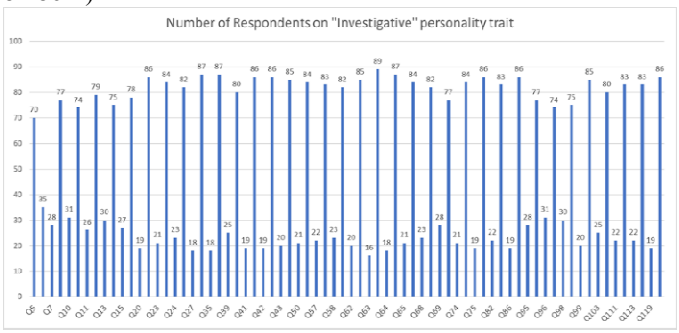

Fig 9. "Investigative" personality trait

Figure 9 above shows the "Investigative" personality trait. According to[21], people with an 'Investigative' personality type are often more inclined to work indoors, such as in a laboratory, rather than outside. Occupations that align with an 'Investigative' personality are typically related to scientific research, such as physics or psychology. According to the bar graph, question number 63 received the highest number of 'Yes' responses (89 out of 105 respondents or 84.76%), followed by questions number 27, 35, and 64 (each with 87 out of 105 respondents or 82.85%).

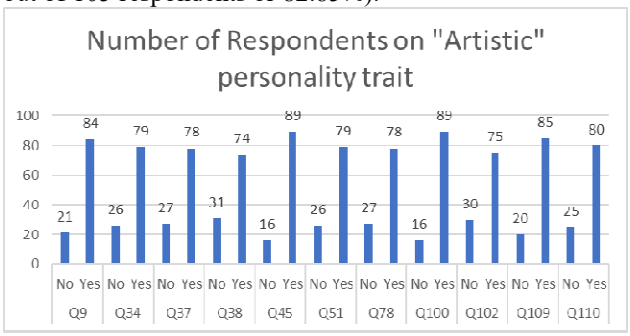

Fig 10. "Artistic" personality trait

Figure 10 above shows the “Artistic” personality trait. According to [21], People with an 'Artistic' personality type tend to be more comfortable engaging in activities related to art, such as music, dancing, painting, and acting (in drama or film). According to the bar graph above, questions number 45 and 100 received the highest number of 'Yes' responses (89 out of 105 or 84.76%), followed by question number 109 (85 out of 105 or 80.95%), and question number 9 (84 out of 105 respondents or 80.00%).

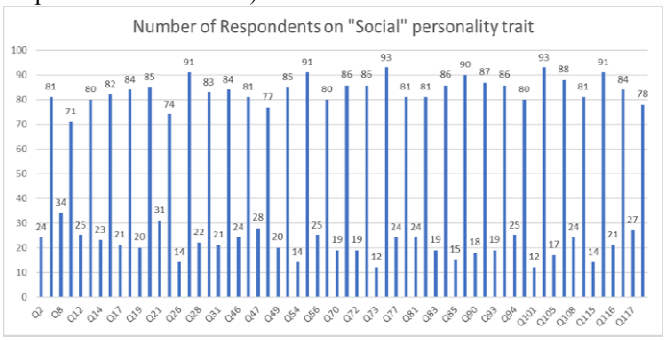

Fig 11. “Social” personality trait

Figure 11. above shows the “Social” personality trait. According to[21], people with a 'Social' personality type are often open and ready to serve the public. Individuals with this personality type tend to be involved in volunteering activities and enjoy helping people in need. Strong communication skills are also a hallmark of the 'Social' personality. According to the bar graph above, questions number 73 and 101 received the highest number of 'Yes' responses (93 out of 105 or 88.57%), followed by questions number 28, 54, and 115 (91 out of 105 or 86.67%). Question number 85 also scored highly, with 90 respondents (85.71%) out of 105 answering 'Yes'.

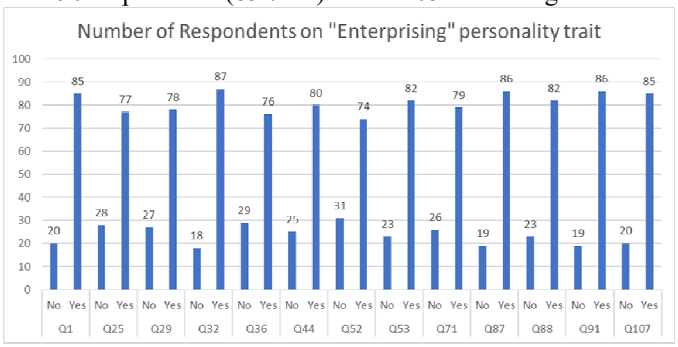

Fig 12. “Enterprising” personality trait

Figure 12 above shows the “Enterprising” personality trait. According to [21], people with an 'Enterprising' personality are often drawn to entrepreneurial or business-related activities. Those with this trait are typically interested in starting their own business or becoming involved in the business world. According to the bar graph above, question number 32 received the highest number of 'Yes' responses (87 out of 105 respondents or 82.86%), followed by questions number 87 and 91 (86 out of 105 respondents or 81.90%). Questions number 1 and 107 also scored highly, with 85 respondents (80.95%) out of 105 answering 'Yes'.

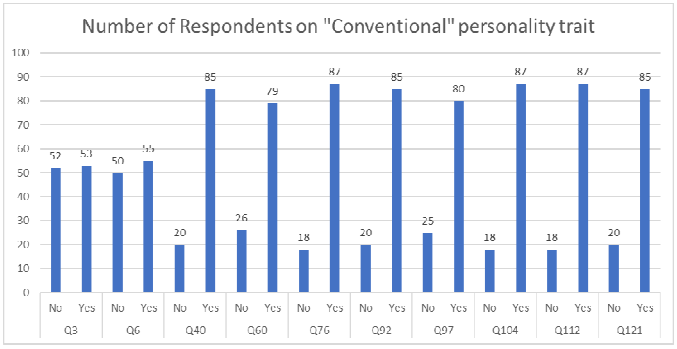

Fig 13. “Conventional” personality trait

Figure 13 above shows the “Conventional” personality trait. According to [21], people with a 'Conventional' personality are generally comfortable working within a structured or procedural order, as opposed to requiring the more complex thought processes associated with the 'Investigative' personality trait. As indicated in the bar graph above, questions number 76, 104, and 112 received the highest number of 'Yes' responses (87 out of 105 respondents or 82.86%). They were closely followed by questions number 40, 92, and 121 (85 out of 105 respondents or 80.95%). Question number 97 also scored highly, with 80 respondents (76.19%) out of 105 answering 'Yes'.

A. System Cooperative Evaluation

According to [27], cooperative evaluation is a process for gathering information about issues users may encounter with software products, enabling improvements to be made.

Ten undergraduate students from UNIMAS were randomly selected to evaluate the developed website. All of the students agreed that the colors, fonts, and text size were suitable (10 out of 10 students or 100%). In addition, all of them agreed that the size of the buttons and the course information were good and suitable (10 out of 10 students or 100%). However, one student (10%) disagreed that the instructions on the developed website were good. The feedback given was regarding the "There's more" instruction on the "Course Information" page, suggesting that it would be better positioned on the left side rather than under the courses button. Referring to Figure 14, these results were obtained through the website evaluation, conducted by applying the Cooperative Evaluation method.

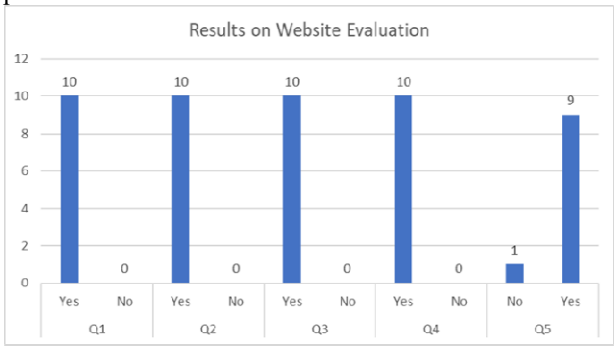

Fig 14. Results on System Cooperative Evaluation

Even though the majority of the students provided positive feedback regarding the design of the developed website, there were a few additional comments aimed at improving the site's functionality. One student suggested that the "Course Information" section should include more details about the course subjects for each semester. Additionally, another student recommended that the website's language include Malay, not just English, to accommodate those who may not understand English well. On a different note, one student felt that the button on the "Course Information" page appeared unclickable due to its 2-dimensional shape. This student also suggested that the "Menu" button would be more user-friendly if shaped like an arrow rather than a rectangle.

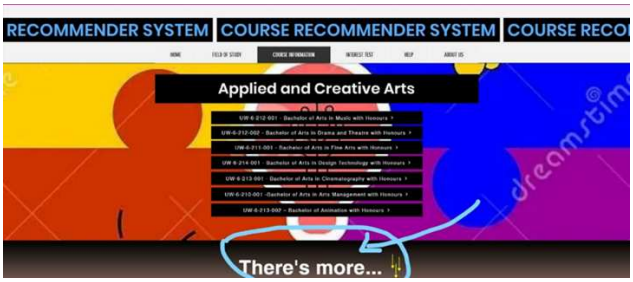

Fig 15. 1 out 10 students' complaint about the position of the "There's more" instruction

Referring to Table 1 below, 15 out of 105 respondents were randomly selected as samples for this study. The majority of the sampled respondents, 12 out of 15, scored the highest in the "Investigative" personality trait. Respondent number 5 was the most dominant in this trait among the sampled respondents, with a score of 31 affirmative answers, followed by respondent number 12 with 27, and respondent number 13 with 25. Three out of the 15 respondents scored the highest in the "Social" personality trait. Respondent number 6 was more dominant in the "Social" personality trait, scoring 24 affirmative answers, followed by respondent number 11, who scored 21.

Table I. Collected Data from 15 Respondents

	Res 1	Res 2	Res 3	Res 4	Res 5	Res 6	Res 7	Res 8	Res 9
R	15	4	5	10	19	9	13	11	12
I	20	22	16	21	31	23	22	12	23
A	5	3	9	4	10	4	6	9	7
S	13	18	9	12	30	24	21	15	20
E	4	5	5	5	13	8	8	4	7
C	8	5	7	7	9	5	3	4	8

	Res 10	Res 11	Res 12	Res 13	Res 14	Res 15
R	10	18	9	16	15	9
I	21	18	27	25	22	16
A	4	5	7	7	7	3
S	14	21	22	20	19	16
E	5	6	8	7	10	4
C	7	7	8	8	7	7

After the results of the RIASEC personality test have been collected, the career listings from the O*NET Interest Profiler will be used as a manual to help in determining the courses that are suitable for all the respondents, by referring to the career listings [28].

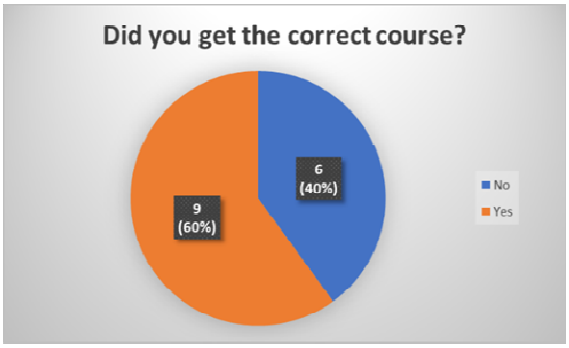

Fig 16. Results on whether the respondents get the correct course or not

As a result, 9 out of 15 respondents stated that they were matched with the correct course, while the remaining 6 respondents claimed that they did not get the appropriate course.

V. CONCLUSION

The development and design of the Course Recommender website have played a crucial role in assisting targeted users, namely undergraduate students, in determining the courses that suit them best. Holland's RIASEC personality test has been employed as a tool to gauge students' interests and skills, the data from which was then collected. This personality trait assessment served as a guide for the researcher to ascertain the courses that best align with users' interests and skills. The information was gathered through an online survey using Google Form.

O*NET Interest Profiler was utilized to assist the researcher in identifying courses that would best suit the students. This was done manually by referring to the O*NET Interest Profiler's guidelines. Cooperative Evaluation was implemented for website testing, emphasizing the importance of the correct evaluation method to leave room for continuous improvement. Feedback and comments from users will undoubtedly aid the researcher in pinpointing the website's weaknesses and areas for enhancement.

The information provided on the Course Recommender website should assist undergraduate students in forming a clear and positive initial impression of the courses available at UNIMAS. The Course Interest Test is intended to promote self-discovery regarding talents and strengths. The results from the collected data will be instrumental in identifying the personality traits that best describe the target audience. By possessing detailed information regarding interests and skills, it will be easier to ascertain courses that are the best fit for the target audience, which could also apply to career search.

Several limitations were encountered during this research. The location was confined to UNIMAS, and the sample size was limited to 105 respondents (students currently pursuing degrees at UNIMAS). Moreover, an interest test comprising 121 questions proved to be time-consuming and challenging for respondents, possibly serving as a deterrent for potential participants. This could explain the difficulty in recruiting a larger sample size, such as 200 or 300 people, as some may have been dissuaded by the length of the test. Thus, future research could consider implementing machine learning to streamline the process.

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