# RECOMMENDATION SYSTEM FOR COURSE SELECTION IN HIGHER EDUCATION: A CRITICAL SURVEY

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**Abstract**

The recommendation systems are widely applied in a variety of industries, including medicine, e-commerce, tourism, TV shows, music, movies, education, etc. These systems use particular algorithms and filter useful information from a lot of information created dynamically based on a given object's preferences, interests, or pursuit behaviors. Systems for recommending courses are developed by taking into account students' general information, backgrounds, and aptitudes to assist students in finding the right study fields. Different techniques have been put forth by researchers for course recommendations in higher education. This critical survey reviews the course recommendation system for the students that advise them, guide a learner in choosing the courses for higher education that best suit their needs, and various strategies for creating course recommendation systems for higher education.

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## 1. INTRODUCTION

The choice of educational path shapes our lives, so it is essential to get it right. A good education one receives as children and young adult can have a big impact on their life later. When choosing their college courses, students from different backgrounds are impacted by a variety of variables, thus it is crucial to convey enough knowledge about the courses any educational institution is offering for higher education. The correct course of study must choose following the need and interests of the student. Additionally, the choice of university will have a long-term impact on the student's ability to achieve their educational goals. Numerous scholars have examined a variety of elements that impact students' decisions to register for a specific course for their higher education. The primary factors that may affect students' career decisions include their parents' choices, their educational backgrounds, their monthly income, as well as other factors like peers' advice, the course they choose in 12th grade, their passions, and factors like examining the market demand for the course, employment goals, and many more [1]**.** Often, in a further career, a professional choice of subject or stream cannot be altered. Choosing the wrong subjects because of parental repression, insufficiency of knowledge, etc. can limit one's success in the chosen field [2]**.**

Inappropriate course selection results in a mismatch between a student's aptitude, ability, and area of interest [3]**.** There are numerous data mining techniques, including clustering and association rules, are applied to the subject of education [4]**.** Systems for making recommendations are widely employed in the modern world, including in the news, movies, mobile applications, and banking sectors. Additionally, recommender Systems have a wide range of applications in higher education, including generating appropriate learning materials for students as a result of the increasing number of online learning resources. To make it simple for students, readers, and researchers to locate the right books based on their faculties and book categories, a library service recommendation system can be utilized in university education library websites. In research and publications, a field recommendation system can suggest conferences and journals to authors. Faculty Recommender Systems can be used to endorse faculties to students, administration, instructors, and other employees in institutions [5]**.**

Personalized product recommendations, by generating a list of suggested products, help buyers identify items they want to buy. In learning, a mechanism called the course recommendation system recommends the most interesting combinations of subjects for the students [6]**.** The widespread availability of options does not always result in satisfied customers because there are times when it is challenging to find a product that one would like to buy. After all, there are so many options. Online stores have widely adopted recommender systems to combat information overload [7]. Students pursuing degrees in higher education confront two challenges: a wide range of options for courses to pick from and a lack of knowledge about which courses to take and in what order. It would be beneficial to assist students in finding courses of interest through the use of a recommender system. Once relevant student data is identified, a course recommender system can use to forecast the best courses for current students [8].

The motivations for students' course selections are viewed as indicators of their expectations of the program. According to the model of self-determination, motivations can be intrinsic or extrinsic, where intrinsic reasons relate to self-realization, acquiring a broader education, or seeking a new learning experience, and extrinsic reasons relate to externally imposed conditions, social recognition, and the pursuit of economic and professional advantages. These ideals inspire students' behaviors and aid in the consolidation of their life goals [9].

One of the primary reasons for the necessity for a recommender system in current culture is that people have far too many options to choose from due to the popularity of the Internet [10].

**Influencing Factors for Student Course Selection**

The factors that influence a student's academic choice include both internal ones like self-crisis and family as well as external ones like environment and society. In this paper, the researcher examines the usage of highly effective psychological factors, academic performance, and socioeconomic factors [4]. When enrolling in higher education institutions, students may be influenced by a variety of factors, including personal interests, career objectives, and social standing, as well as course-specific factors like the course's native language, GPA value, lecturer characteristics, course structure, timetable, and exam procedures [5].

In the year 2021, the Authors of the paper [11] examine the elements that influence commerce students' course choosing, the primary data were gathered via a structured questionnaire with the primary goal of the study being to understand why students choose a certain course and what influences them to do so. A survey of about 100 students from Chennai's SDNB Vaishnav College for Women was conducted. Each questionnaire was coded, and the results were analyzed using the statistical software SPSS (Statistical Software for Social Sciences) tools used were Percentage analysis, one-way ANOVA, and T-Test. According to their analysis, the respondents chose their path of study on their initiative and without the influence of their parents. The majority of respondents chose courses in business because they were less stressful than other courses, helped them develop skills for their jobs, and helped them plan their future careers.

While picking up a particular course to study students also consider the type of university to attend as according to paper [12] major influences on a student's decision on which institution to attend for higher education include the media, parents, teachers, friends, and other family members. They used a sample of 541 people from various institutions in the state of Uttarakhand, employed the questionnaire method for data gathering, and used statistical techniques for analysis. They found that students expect adequate library and lab facilities when choosing a higher education school and that course information was the most deciding factor. Also, this paper [13] examined students' university preferences as well as their levels of satisfaction with the support provided by Ghanaian universities. About 30800 students from two separate colleges were chosen at random. The SPSS software was used to analyze the data after it had been collected, and the Pearson Chi-square test was used to determine the importance of each of the factors that affected a student's decision to attend a particular university. They concluded that courses offered and areas of specialization, high caliber lecturers, employer recognition of qualification, well-stocked library and internet facility, international accreditation by qualification, and flexible lecture schedule were the top six important factors influencing students' choice of university and students are impacted by a wide range of other factors while picking which university to attend.

Universities should equip themselves in a variety of areas, including facilities, the environment, and other areas apart from teaching and learning. [14].

According to a review of the research, environment, opportunity, and personality are the three life factors that have the biggest impact on students' decisions about their careers. Each of the three has a unique effect on career outcomes. [15]. The authors of the paper [16] discussed all of the variables that affect Grade 12 students' career decisions in 2019. According to that paper, the most significant factors are high salary expectations, career expectations, employment experience, knowledge and aptitude, family environment, social status, and educational environment. Other elements that might be taken into account include their standing in society, available resources, affordability, and prospects for employment.

As discussed in the above paper [16] career expectations are a major factor influencing career choice, In the paper [17], to identify characteristics influencing South African students' career choices and goals, this

investigation was led by a quantitative paradigm. In this study, a structured questionnaire survey methodology was utilized to investigate the characteristics that influence the choice of and aspirations among South African undergraduates. This study made use of the Career Aspirations Questionnaire A total of 133 first and second-year university students enrolled (aged 15 to 30; 77 females and 56 males). With the help of a questionnaire, researchers looked at what influences medical students' career decisions and objectives. Percentages and tables used to analyze the data. According to the results, the family, the ability of the learner to identify his or her preferred career, and teachers are all key factors that influence students' career choices and aspirations.

This research [18] looks into the elements that influence students' choices when it comes to scientific courses at the American University of Sharjah. A survey with open-ended questions, as well as quantitative inquiries, was distributed to environmental science students to determine the primary reason for their choice. It reveals how students are significantly influenced by prior learning, educator's popularity, peer endorsement, memorization skills, and math capability. The survey found that students' primary concern is the volume of data and details given in the course curriculum.

This exploratory study [19], is designed to investigate, "why" and "how" students choose specific university courses. To put it another way, what types of sources of information do students utilize to select courses? A sample of 100 general business undergraduate students was chosen at random from a pool of roughly 900 students. During the pre-registration period, a graduate student in the Business School delivered a questionnaire to each student which was divided into three sections to ensure students were familiar with course offers and had recently undergone the course selection process. Each student's questionnaire was collected personally, t-test and Kendall's Coefficient of Concordance were applied for the analysis of the data. According to the study's findings personal preference in the region, content of the course, compatibility with the main field, and instructor were the most important factors in students' course decisions. Students' primary information sources included peers, catalog descriptions, and faculty members (other than advisors). As a result, students investigated both informal and official information sources.

This study [20] focuses on identifying the elements that influence students' job choices. This study looked at how parents' education, job status, and income influenced the career decision of 432 students from two public section institutions in Lahore. Peers' influence on respondents' subject-specialized choices was also explored. A questionnaire and in-depth interviews were used to collect data. The data suggest that parental influence is the most powerful, followed by peer influence, gender, print media, financial reasons, interest, and others.

This paper [21] explores the characteristics that impact career choice among BSc in Agriculture students; determines students' perceptions of farming as a vocation after university; and explains support services provided by the institution. Using a standardized questionnaire, From 116 students' data were collected in the School of Agricultural Sciences and analyzed for descriptive statistics such as frequencies and percentages using SPSS software. The findings revealed that based on personal experiences and interests about 30.2% of students made decisions and about 15.5% due to parental pressure. To assist students in making educated career choices it is recommended to the university provide career advising services.

Parents' Desire/Parental Force, Peer Persuasion, Past Performance, Potential, Placements, and Personality Driven are the seven most common factors that influence students' career decisions [22].

According to the discussion above, several factors may influence how students choose their courses, and these aspects can be utilized to guide the development of recommendation

systems. Some of the major influences of course choice in higher education include:

**a. Interests and career aims:** Students may choose courses that are compatible with their areas of interest or that can support them in achieving their desired job objectives depending on their interests and career aspirations, which are important elements that impact course selection.

**b. Previous academic performance:** The academic background of a student may influence the courses individuals take, allowing them to build on their skills or address their shortcomings.

**c. Availability of courses:** Due to time constraints or other restrictions, students might only be able to pick from a small number of courses, availability of courses can play a big role in course selection.

**d. Course prerequisites:** Prerequisites for some courses must be fulfilled before enrolment, which may restrict the range of courses available to a student.

**Difficulties Faced by Students**

The challenge of choosing a course can be difficult for students, especially in higher education where the possibilities are often overwhelming. Lack of knowledge regarding the course, the possibility of limited enrollment in some courses, finding courses that fit their requirements, failure-related anxiety, and other issues are some of the challenges students experience while choosing a course.

The incorrect career path can directly result in mental health problems. Anxieties, rage issues, and depression are a few. Some students depend on their families to make the proper decision; others simply follow the crowd. There is no sense of self-interest. This is the first mistake that could lead them misguided [22]. After completing the class 12 exam, students must decide what career to follow and what course to take for graduation. Some students are influenced by their friends, while others are influenced by their parents or the course that appears to be the most glamorous. The wrong choice, of course, causes youngsters to feel panicked, anxious, stressed, and unpleasant practically all of the time. They may have a significant lack of self-esteem and self-confidence [23].

About half of all learners in college who quit their education do so because they chose poorly. Lack of career counseling in the educational environment and overall pressures on students in the sixth year are highlighted as two of the primary factors as to why people choose the wrong degree[24]. This study focuses on the decisions of CS minor students to drop out of the CS1 course. About 500-600 students yearly enrolled in this program, its dropout rates ranging from 30 to 50%. A qualitative interview study they conducted in which 18-course dropouts were interviewed. The findings reveal that a variety of factors influence students' decision to drop out of the course. The reasons were influenced by factors, such as the perceived level of the course difficulty and a preference for something else [25].

**Need for Recommendation Systems**

By giving students information about courses and generating tailored suggestions based on their interests, prior academic achievement, and other variables, course recommendation systems can assist students to overcome the challenges they confront. Recommendation systems can assist students in selecting courses that support their objectives by considering these characteristics, eventually improving their academic achievement and personal development.

The recommendation systems play a significant part in decision-making, assisting users in many different areas to optimize revenues or reduce risks [26]**.** Students may struggle to choose the right course for their higher education and require assistance in identifying the academic program that will best advance their careers and help them reach their objectives. The optimal course of study for each student's higher education can be provided via a recommendation system, which can assist students [27]**.** This will help students to build skills and get more knowledge. Most of the time

when enrolling in higher education institutions, students are not able to choose the best course selections on their own. Pupils still have their areas of interest, but they are unable to pursue them because of their lack of knowledge about the courses. As a result, recommendation systems may be a better advisory system for assisting students in making educated course choices [5]. Additionally, a recommendation system will be beneficial for learners to establish a college student relationship management strategy as well [3]**.** Making the appropriate academic choices is crucial for a student's future job, education, and other pursuits. The course recommender is a useful advancement to assisting pupils in making better academic choices [28].

**Several Systems of Recommendation**

The amount of digital information that is now readily available has increased dramatically, and the amount of people using the internet has led to a possible challenge for information worldwide that prevents fast access to the internet online. Recommender Systems are tools to search for information that are developed to address issues with data overload and assist people in making decisions or staying educated about a certain topic. There are numerous recommendation systems available. Applications like Netflix, YouTube, Instagram, Facebook, Twitter, Amazon, Spotify, and others suggest specific items that users are likely to find appealing.

Higher education institutions encounter several challenges, including a competitive educational market, decreased government financing, rising enrollment of students, and a variety of academic majors. Education leaders must continue to provide necessary and effective student support services, such as curriculum assistance, learning support, and advice about careers, despite all of these problems [5]. Making decisions is crucial to students' academic success. The choice a student makes about their major during their undergraduate studies could have an impact on their future. As we know popular recommendation systems, a course recommendation system is important for students to guide them in choosing a particular course for higher education.

Recommendation systems make use of special algorithms and machine-learning solutions. As shown in Figure 1, there are main three kinds of recommendation systems [29] :

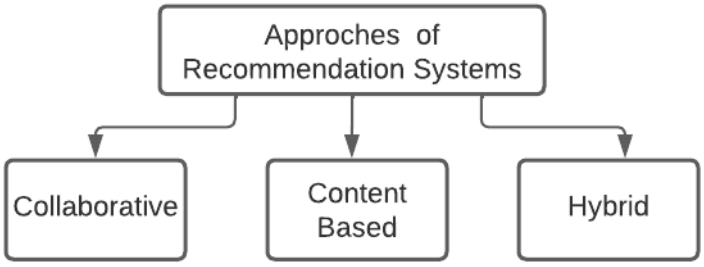


**Figure 1: Fundamental Recommendation Systems Approaches**

**a. Collaborative Filtering**

Concerned with making suggestions for items to specific users by identifying users who share the same interests. This technique seeks to assist users in obtaining relevant recommendations from individuals or groups who share similar tastes or activities [5].

**b. Content-Based Filtering**

In this strategy, the system suggests stuff comparable to those that the user has previously selected. The similarity calculation is based on the attributes of the matched elements.

**c. Hybrid recommendation**

These solutions combine the strengths of various types of recommender systems. Items in these systems are recommended using both content-

based and collaborative filtering at the same time, resulting in more accurate recommendations than typical recommender systems.

For course recommendations, the content-based filtering technique is based on the notion that if a user likes one type of course, they are likely to be interested in other courses that cover related topics. The system analyses user behavior in the past and suggests courses that have similar profiles to the courses that the user has shown interest in. On the other side, collaborative filtering analyses the behavior of many users, searches for people who exhibit similar behavior and suggests courses that those users find interesting.

Today, the quantity of courses available in the scope of smart education has skyrocketed, and the associated course decision issue is playing a big part in the modern learning procedure. According to several researchers, thousands of students around the world face difficulty in selecting the best university/college courses [5]. The Recommender Systems can be utilized to help students decide on courses that are suitable for their interests as well as abilities.

The purpose of this work [30] is to build a trusted recommender system relying on data mining techniques and acquisition of information, the suggested system comprises two cascaded hybrid recommenders operating together with the assistance of a college predictor. For preparatory year students, the first recommender assigns student tracks. While the specialized college to pupils who have completed the preparation year tests assigned by the second recommender. The college predictor algorithm predicts the most likely colleges based on historical college GPA student admission data. The system examines students' academic achievements, backgrounds, records, and college admission criteria. Then it predicts the possibility of a student enrolling in a university or college. At King Abdulaziz University, a prototype system design is constructed and tested using live data from the On Demand University Services (ODUS-Plus) database resources (KAU). Aside from the excellent prediction accuracy rate.

This paper [5] is a study on establishing and constructing a recommender system for graduate admission applicants to assist them in selecting a graduate institution, matching their complete academic profile, and an algorithm that can calculate the similarity between training and test data sets using mean squared deviation similarity metrics based on weighted scores, to determine the top comparable users for the test users and to recommend the top universities to users using the K-nearest Neighbor technique.

The recommendation systems can be built using a wide variety of algorithms. The systems utilized to create course suggestions for students are shown in Table 1.

| **Paper** | **Technique Used** | **Description** | **Dataset Used** | **Results** | **Year of Publicat-ion** | **References** |
|---|---|---|---|---|---|---|
| An Autonomous Courses Recommendation System For Undergraduate Using Machine Learning Techniques. | Linear Regression Model, Naïve Bayes, SVM (Support Vector Machine), K-nearest neighbor, and | The system's inputs are the average scores of exams named UTME, Post-UTME, and Secondary School | Academic session data from two universities. There were 8700 data instances in all, with four variables: UTME | The Naive Bayes and SVM models were discovered to have the highest recommendation accuracy: 99.94%. | 2020 | [31] |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Decision Tree. | subject combinations, as well as their grades. These inputs are obtained via an API from the university's data repository. | number, UTME score, Post-UTME score, and Secondary School outcomes. | | | |
| An Effective Recommendation System to Forecast the Best Educational Program Using Machine Learning Classification Algorithms | Forecast accurate results using various ensemble-based machine learning classification models such as Random Forest (RF), XGBoost (XGB), Gradient Boosting (GB), the Gaussian Naive Bayes (GNB), Logistic Regression (LR), CatBoost (CATB), DecisionTree (DT), LightGBM (LGBM), and K-Nearest Neighbor (KNN). | The proposed system receives data from 10th-grade pass-out students. The system forecasts student academic achievement and recommends the most appropriate academic path. Past performance of class 12th pupils, such as class 10th results, is submitted as input to this suggested system. | Collected data of passing students from Hatgobinda-pur M.C. High School in West Bengal, India. There are 2996 samples accessible for this proposed research, of which 2404 were legitimate samples of students' data who took the class 10th exam between 2010 and 2018, as well as the final year's academic status and earned marks by students who are still enrolled in | The LightGBM method best classification model for intermediate science and arts/humanities programs, whereas the CatBoost algorithm was the ideal classification model for intermediate commerce and diploma engineering programs. As the best classification model for the ITI-based application, the Random Forest method is rewarded. | 2020 | [32] |

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| | | | the class 12th standard program. | | | |
| Machine Learning-Based Support System for Students to Select Stream (Subject) | SVM (Support Vector Machine), ANN (Artificial Neural Networks), and NN (Neural Networks) were the three algorithms employed. | The purpose of this project is to collect data from students studying in several respected educational institutions in India and use it to construct a model for predicting the students' stream at the higher secondary education level. | The data was gathered from 550 medical and engineering students through a questionnaire at various educational institutions including IITs, NITs, IGMCs, and Dr. RPGMCs. | When compared to the other two methods, neural networks have proven to be more effective. This approach has given a classification accuracy of 86.72%. | 2018 | [2] |
| Developing an intelligent system for course selection by students for Graduate Courses | This framework employed the following techniques: clustering, feed forward back propagation probabilistic neural network, fuzzy logic, and rough set classification. To build the system PHP and MySQL are the languages used. | A sample data set that includes student preferences, previous outcomes, topic scores, and the overall percentage of the database trained and evaluated using a feed-forward back-propagation probabilistic neural network. The result is then | A sample of data from the complete database is obtained, which includes student preferences, previous outcomes, topic scores, and the overall percentage. Data from 1500 students from the engineering stream and various academic | The recommendation algorithm recommends the most suited courses and subjects to 10+2 students from all streams. | 2016 | [3] |

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|---|---|---|---|---|---|---|
| | | compared to the bio-data of the prospective student. | years were acquired. | | | |

**Table 1: Recommendation systems used for recommending courses/subjects to students.**

## 2. KNOWLEDGE GAP

Following the examination of the above-mentioned techniques in Table 1, it can be concluded that each method has advantages over the others. Other techniques are more effective and some are more accurate. Many researchers used data mining and machine learning techniques to build course recommendation systems. Comparatively little study has been done on the analysis of students' preferences to create decision making systems, even though there has been a lot of education research devoted to creating course recommender systems [33]. According to [16] there is a requirement to provide career counseling to students during the high school studies. Before enrolling in university, career advisory programs assist students in developing career decisions and objectives.

As discussed earlier according to paper, [31] In contrast to K-nearest neighbor and Decision Tree algorithms, Naive Bayes and Support Vector Machine methods were discovered to have the maximum accuracy, and it was suggested that we might create more systems by using more features and data.

As per knowledge [11], not many researchers have researched the many elements impacting students' choice of education except for a few factors such as society, technology, and individual plans.

It could be better if the data was collected during the admission process to make the dataset large. It could help find out interesting patterns in the data and the performance can be improved. The student career guidance system can help students choose the ideal career option for them based on their unique skills, strengths, and shortcomings [34].

## 3. CONCLUSION

These expert systems analyze student data using machine learning techniques to identify the connections between the courses students' chosen. Graduates' experiences can be used to discover fascinating results that recommender system can then use to suggest the best suitable courses to new students. Student desire in a career choice should never be underestimated. Not all students will be able to receive the necessary counseling and career guidance. This can make it difficult for them to find a career that will help them develop in life. As per this survey, there is less study in producing proper course recommendations for students following the 10+2 grade students; there is a need to develop system that could suggest a course to take after the 10+2 grade and that include more parameters relating to the students such as psychological factors. More data and features will aid in accurately recommending a certain course to a student.

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