

A Survey of Course Advisory Systems and its Design Methodology

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Abstract—“As many courses are introduced in an educational system, the technology based course advisory systems are needed to help the students to select the appropriate courses. This paper is based on the survey of course advisory systems in different dimensions like advising models, advisory systems, learning analytics and the associated algorithms. Various advising models involved in advising process is elaborated in this paper. Various advisory systems and its design methodologies are also discussed in this paper. This current research work aims to list the drawbacks of the existing advisory systems. This paper also highlights the challenges involved in the design and implementation of course advisory systems.

Keywords—*Course advisory systems, advising models, learning analytics, algorithms, design methodology*

I. INTRODUCTION

Advising is a complex task. It is nothing but marking appropriate recommendations that suits the person. Recommendations can be made by the advisor using his expertise (knowledge level) and experience. Choosing appropriate course in the higher education institutions is a tedious task. As the courses change from time to time, an expertise is needed to help the students for their course selection.

Advising model play a vital role during the process of advising. Also, the technology based course advisory systems assist the human advisor to enhance the performance of the students. Such systems could be constructed by using different design approaches. Also various algorithms are involved in analyzing the different parameters of student data.

This paper is based on an extensive literature review in different domains of student data like Academic advising, Course advisory systems, Learning analytics and Machine Learning Algorithms. This paper is organized as different sections. Section 2 explains the related research work in academic advising. Section 3 explains the related research work in advisory systems. Section 4 explains the related research work in learning analytics. Section 5 briefs the research work in machine learning algorithms used in course advisory systems. Section 6 briefs the drawbacks identified in the existing course advisory systems. Section 7 highlights the challenges in the design and implementation of the course advisory systems.

II. ACADEMIC ADVISING

The comparative study of prescriptive and developmental model of academic advising is discussed in [1]. Crookston[1]

studied the academic advising models and compared the models on different parameters like motivation, initiative, evaluation, responsibility, control system and so on. Crookston [1] concluded that developmental model of academic advising is better than prescriptive model. In [2] David Yarbrough, proposes Engagement model for academic advising. Also Yarbrough [2] specifies that usage of technology in the academic advisory process is aimed to facilitate the advisor and the student and not to replace the advisor with the technology. In [3] Schein and Laff suggest that academic advising should include students self descriptors like goals and objectives. This approach with result in an effective academic advising process. In [4], systematic approach of academic advising to students in higher education institutions is discussed. Systematic approach like Preplanning for academics, extracurricular and financial success, Exploring options in higher education, Exploring the needs of specific populations are suggested by Matthey [4]. In [5] Heisserer proposes a academic advising model called as integrated model for effective student advising. Also Heisserer[5] says that academic advisors should be equipped with various skills and in fact the interviewing questions play a vital role in the advising process. In [6] Murray recommends the usage of technology in the academic advising process to enhance the decisions and improve the services in an effective way.

A. Models on academic advising

From the literature, academic advising models are categorized as follows.

Prescriptive model

Developmental model

Engagement model

Integrated model

Prescriptive Model

In this model, advisers prescribe the things to be followed by the students. If the student follows, then he succeeds; otherwise the student fails. The primary objective of this model is to focus on the limitations of the students and to provide appropriate strategies to overcome from the limitations. Therefore, this model is controlled by the advisor. Both the advisor and the students are equally responsible to get the desired output. It functions in such a way that advisor initiates the process by prescribing the appropriate strategies and given to the students to follow. Afterwards the students are evaluated by the advisor. Generally the output of the model is measured in terms of the grades of the student.

Developmental Model

In this model, both the advisors and the students are working together to strengthen the relationships and to help each other. The primary objective of this model is to look into the strength of the students and to enhance it. This model can be initiated by the students or the advisor or by both. Therefore, the control mechanisms and responsibilities are shared by students and advisors. The evaluation of this model is done in a collaborative way by student as well as the advisor. Generally the output of the model is measured in terms of the achievement and fulfillment of the student.

Engagement Model

In this model, students, teachers and administrators are involved. It functions in such a way that all are supportive to each other in the teaching learning process. The primary objective of this model is to help the students to identify and clarify the personal academic goals and objectives. This model has some predefined assumptions like student was admitted to college/university; student had identified academic strength and weaknesses. This model works based on the experience of the advisor towards various attributes like interviewing questions and style, information about changing courses in colleges / universities. The output of the model is to identify the learning style and competencies of the students.

Integrated model

This model is a combination of prescriptive and developmental model for effective academic student advising.

III. ADVISORY SYSTEMS

Advisory systems are available to help the decision making process. Decision making is a complex real time problem which has numerous inputs and criteria. Advisory systems have a wide range of applications in various domains like finance, share markets, investment, business etc. The power of technology in the advisory systems is to help the decision making process. The right decisions taken at a right time has a greater impact in human life. Therefore the role of advisory systems is to guide a person to take effective decisions.

The design of a web based academic advisor is discussed in [8]. The design of intelligent advisory system for a specific department (Law) using expert system approach is discussed in [9]. The design of intelligent advisory system to authenticate the users of the computer system using neural networks is discussed in [10]. The various applications of machine learning is discussed in [11]. The adaptive advisory systems can be built by using machine learning algorithms [11]. Academic advising has taken a key place in higher education institutions. The role of academic advisor, characteristics of academic advisor and responsibilities of academic advisor is elaborately discussed in [12]. The design of advisory system using agent based expert system is discussed in [13]. The design of advisory system using neural networks is discussed in [14]. The implementation of web based Fuzzy expert system is discussed in [15]. The case based reasoning expert system for course advisor is discussed in [16]. In [17], Vahid and Mahdi propose a novel approach to design and implement the web based fuzzy expert system for student advising.

A. Academic advisory systems

Academic advisory systems exist in Higher education institutions to help the students in their academics. Generally such systems are operated by the counsellor / faculty member in the colleges / Universities / Institutions. The general characteristics of all academic advisory systems is that it could be used only after a student is admitted to a particular course in a college/university/institution. The academic advising is a process that functions in such a way that student and advisor will have a frequent one to one discussion on various academic parameters. These academic systems are used to improve the performance (grade) of the student, to help the student to identify or set the goals and objectives, to explore various career options, to improve the personal characteristics like learning style, learning skills, monitoring the attendance and discipline etc. This process involves a lot of paper work. The output of this process is highly dependent on the knowledge level of the advisor. To overcome these issues, the technology based advisory systems emerged. The use of technology in the academic advising process is to help the student and the advisor to enhance the academic performance.

B. Course Advisory systems

There are plenty of academic advisory systems designed for specific academic tasks. Academic Advisory systems that help the student to choose a particular course is generally referred as course advisory systems. Course advisory systems help the student to choose a particular course depending upon the potential of the student. From the literature of academic advising, technology based advisory systems are designed as Web based advisory systems, intelligent advisory systems, Expert advisory systems, neural network based advisory systems, Adaptive advisory systems and fuzzy advisory systems.

Web based advisory systems

These systems are designed in such a way to satisfy the needs of the Colleges / universities / institution in a customized way. The catalogue of courses and the parameters pertaining to the students will be designed depending upon the requirements. These systems are designed using traditional database oriented approach. The drawback of these system is that always the rules will be static.

Intelligent advisory systems

These systems are designed using AI principles. These systems are designed using learning analytics, data mining algorithms, neuro systems and fuzzy systems. These systems are capable of adapting to new situations based on training and testing strategies.

Expert advisory Systems

These systems are designed based on cases and rules. Also, the expertise knowledge is stored as knowledge rules. The drawback of these systems is that it fails to adapt to new rules and new courses.

Neuro advisory systems

These systems are constructed using artificial neural networks. These systems are designed by using learning algorithms. These algorithms are used to train the artificial neurons in the systems. After training and testing phase, the system will behave similar to human expert in that field.

Adaptive Systems

These systems are designed using AI principles. These systems are designed using learning analytics, data mining algorithms and fuzzy systems. These systems are capable of adapting to new inputs.

Fuzzy advisory systems

These systems are constructed using Fuzzy rules. These systems are designed by using learning algorithms similar to neural networks. The design of the system is based on fuzzy rules which solves the problem of uncertainty. For any real world problem with fuzzy values, these systems are capable of having better performance.

IV. LEARNING ANALYTICS

Analysis on learners' data is learning analytics. In [18], the ethics and policy of learners data is discussed elaborately. Also the design of smart learning environment to improve the learners ability is discussed in [18]. In [19], the design and implementation of teachers tool kit using learning analytics is discussed. Also the indicators used to analyze an individual is also specified in [19]. In [20], the prediction system using learning analytics is studied. Baker and Siemens[21] discuss the various methodologies used in educational data mining and learning analytics. Also the classifiers used in EDM and LA are discussed in [21]. The issues related with educational data and methods to overcome it is also discussed in [21]. In [22], the usage of learning analytics in recommendation and adaptive systems in student /educational domain is discussed. In [23] a complete research in education using technology is carried out and the results of various research activities related to education domain was summarized. It is important to note that data collection method is done through questionnaire and population used for the study is mostly undergraduate students [23]. The various data models used in Learning Analytics is discussed in [24]. Also the comparison between the data models is specified in [24]. Learning style defines the learning pattern of the student. Learning styles defines the characteristics of the student. Therefore the role of learning style in the quality of learning is discussed in [25]. In [26], the relationship between the learning style and the courses available in the education domain is discussed. Thus the literature provides the following analysis from the student data.

- Improving / Predicting /monitoring the student performance
- Recommendations (Personalized) as feedback systems
- Pedagogy for teachers
- Participation of students in class room activities

V. MACHINE LEARNING ALGORITHMS

The machine learning algorithms help any system to automatically learn from the data. As many algorithms are available, [27] lists the top 10 algorithms in this domain. Various classification algorithms related to text mining is discussed in [28]. The decision tree and Naïve Bayes classification is discussed in [29] with respect to marketing domain. The various classification algorithms used in text mining domain is discussed in [30]. The various machine learning algorithms used to evaluate the performance of students are discussed in [31 – 37]. The algorithms involved are listed as follows

- Induction rules based classification
- Decision tree classification algorithms(J48)
- Agent based classification algorithms
- Regression models and trees
- Support vector machine
- Neural network based classification

VI. DRAWBACKS

From the literature, it is evident that the existing course advisory systems are not capable of handling the dynamic changes being introduced in the Indian education system. It is also noted that the advisory systems are available to the students only after joining a particular course. Generally, the current advisory systems are functioning as feedback based systems regarding the overall performance (Pass/Fail) or the performance in a specific subject. Even, some advisory systems are designed as Recommendation systems based on the earlier performance. Parameters pertaining to the individual learning skills or abilities are not considered in the design of the course advisory systems. The existing systems are designed as predictor systems to predict the performance of the students. Most of the advisory systems are targeted for online students undergoing online courses (virtual learning environment). The existing advisory systems also help the teachers to plan the pedagogy that satisfies the students' need.

VII. CHALLENGES

This research work has helped to identify the challenges in the design and implementation of course advisory systems. It's a complex task for researchers to design a course advisory system to satisfy multiple users. Also, there is a rapid change in the courses being introduced in each academic year. Therefore, the course advisory systems should be designed as intelligent and adaptive systems to incorporate the dynamic changes in the education system. Also, as a design methodology, it is very difficult to identify the appropriate machine learning algorithms that suit the current situation. The course advisory systems should be used in such a way that the students are benefitted before they join any course in any institution. Because of the internet era, the issues related with the compatibility of the web based course advisory systems using machine learning algorithms are to be considered during the implementation stage of the system. This current research work provides a lot of challenging task in identifying the various parameters associated with the course selection and also to identify the most relevant parameter involved in the course selection process. The future research work is to focus on the courses available in Indian Education system. The recommendations from the system should be designed as a complete personalized system for the students in a customized way.

VIII. CONCLUSION

This paper identifies the limitations of the existing course advisory systems. Also, this research lists the challenges the design of the course advisory systems. Course advisory systems can be used before a student joins a particular course in any college/university/institution. The main objective of this system is to suggest a particular course depending upon the

skillset of the student. This paper provides a complete survey on the advising models. Also different advisory systems and its usage is elaborated in this paper. Also the learning analytics and its role in the advisory system is discussed. The various algorithms used in analyzing the student data is explored effectively. Thus, this paper provides various research openings in the design of the course advisory system.

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