2. LITERATURE SURVEY

2.1 INTRODUCTION

The institutes of higher education shall not be exempted to fall back by the rapid advancements in technology and the development at higher education level is credited to the fact that learning technologies can refurbish it. E-learning is one of the growing research areas recognized by the educational community in particular. This e-learning system is newly sculpted for teaching and learning process in a flexible manner irrespective of pace, place and time. However, these systems are least adaptive and follow a particular strategy once the system is developed and implemented. The e-learning environment is considered as static because it treats all learners in similar approach and thus it is unable to respond individual learner’s needs. Current e-learning platforms in common do not consist of personalization features and are less likely to change as per the learner’s interaction and their preferences. Even though the content lying within the system is easily accessible without the constraints of time and place and the courses, activities and materials are visible to all students. But the access only doesn’t ensure better learning experience and results. But there is an affinity to assert that personalization is an inherited character of e-learning. Henceforth, current e-learning systems should be enhanced to ensure personalization of learning through recommender system for courses, content, and other objects.

The process of personalization is usually realized employing learners choice or by using the learner profile. The learner is suggested with the relevant information to match their requirement from a large number of choices and recommendations are based on opinions and behaviours of similar feature group. It is also becoming difficult to comprehend the volume of educational data and other learning resources, which is growing faster. In such a case one of the involuntary solutions to help a learner with the finest choices is to use a recommender system. RS’s employs algorithms aiming to provide personalized information to the users concerning respective domains, and the decision is taken on different criterion like interests and requirement of the learners [22].
This study aims to develop a personalization approach using recommender systems to provide course personalization as per learner’s interest, background and preference. A novel recommendation approach based on hybrid methodology is presented in the form of a Personalized Course Recommender System (PCRS). This system can be incorporated with any learning environment to personalize courses for an individual learner. The existing methodology for a recommendation in e-learning system is detailed in this chapter.

2.2 E-LEARNING SYSTEM

E-learning being a versatile and a new tool with the potential to drastically improve achievements and participation access in education let many discussions about its definition. E-learning is coupled with the actions that involve computer and interactive networks simultaneously. This new teaching method is based on the flexible learning irrespective of time pace and place and do not require computers to be the facet of central activity or to provide learning content, instead both computers and networks hold a noteworthy contribution in learning activity [23]. E-learning is the use of various Electronic Medias (EM), Educational Technology (ET) and Information and Communication Technologies (ICT) in education which can take place in or out of the classroom. E-Learning enables you to use tools and devices, technology like internet, learning management system (LMS) and CD’s to create an interactive learning environment and materials that increase process of information sharing, increased productivity through increased knowledge retention [24]. E-learning integrates flexibility in terms of learning pace, time frame and from physical locations which suits a learner. So commonly e-learning is referred as intended use of network and information communication technology in the process teaching and learning.

There are various terms used to portray this modern means of teaching and learning which includes web-based learning, online learning, virtual learning, and distributed learning. Basically, they all refer to the educational processes that employ information and communications technology to arbitrate synchronous as well as asynchronous teaching and learning activities. The term e-learning also constitutes more than the letter ‘E’in e-learning stand for the phrase “electronic”.
The e-learning would consist of all the learning activities that are conceded by groups or an individual’s synchronously or asynchronously, working offline or online, and by the use of standalone computers or networked and other electronic devices [25].

2.2.1 Trends in E-Learning

E-learning concerns the implementation of computer-based educational system without the limitations of space and time to provide a flexible education environment, and its increasing interest seems to be arriving from various directions. Institutions who offered traditional education in mixed mode, single or dual settings thought that incorporating e-learning in their context is the logical extension of distance education activities. On the other hand, the corporate sector has already implemented e-learning to rationalize the cost of the training conducted for their internal staff. For campus based educational organizations it is a way to improve to access to the programs they offered, and it is in their interest to tap into growing e-learning market. E-learning growth is directly related to access ICT, its decreasing cost, and resource based teaching and learning [26].

Due to multimedia and Internet evolution, the large number of faculties are using ICT to support their teaching and learning process. Even student of today have grown up using only technology gadgets and ICT around them, also expect to see technology being used in their education. But the main chore is to involve and determine how best to make optimal use of available resources of technology for enhancing student learning, and make possible to engage mass learners. E-learning is supported by Learning Management System and is gaining popularity across the globe but Universities in developing countries are opting for Open source LMS (e.g. Moodle) and that too for course material distribution mostly, but Universities or College authorities are not taking the actual benefits. The e-learning system has some positive impact on the students, which will prove very useful when e-learning will be implemented on a large scale. The Universities are eager to acclimatize LMS in teaching & learning process, but the lack of functionalities from faculty point of view and fewer resources hinder such process.
The authorities in institutes must aim to ensure availability, accessibility, and reliability of all Facilities in their higher education system.

2.2.2  Opportunities for E-learning

The aim behind e-learning implementation should be clear, and its nature should be transformative rather than just facilitating e-learning. It is believed that an e-learning tool like LMS is of no use unless appropriate implementation planning of its usage is provided, without which LMS is not going to serve up any purpose, even though being much effective[27]. Therefore, during e-learning implementation a learner can face various challenges, in terms of technology satisfaction, available infrastructure, faculty’s competence, workload, and motivation etc., [28]. Some of the opportunities for e-learning are as follows.

i. Use of educational data mining. In educational perspective the data that is being generated can be handled by creating some proficient information retrieval or data mining applications. One of the kinds of such application are EDM whose aim is to analyze educational data to resolve issues in e-learning or any educational field. Practising data mining techniques in educational field are emerging which gives basis to a new research field of Educational Data Mining and inherits the properties from different fields like Database Management (DM), Artificial Intelligence (AI), Information Retrieval (IR), Machine Learning (ML), Data Mining (DM), and Learning Analytics (LA) [29]. EDM has potential benefits in enhancing the e-learning environment, and there is a growing demand for EDM in a variety of educational contexts where EDM can act as a powerful analytical tool. The main objective is to get meaningful information about the learner through their learning process and from raw data, into in order to take better decisions with respect to learning environment trajectory [30].

The educational data set originated in the learning process system hide the information within itself which is extracted by using some data mining methods and techniques can serve a various purpose to administration. The considerable patterns of data obtained from a learning system could be used to formulate premeditated planning as well as for other learning benefits [31]. EDM
will help us to increase the functionality of e-learning systems by exploring appropriate information outcomes and can help to construct different perspectives for understanding more about the activities and needs of a learner’s during a learning process. The data can be connected to student courses, demography or other academic activities that will be helpful for instructors in the following ways.

- To track and understand the behaviour of learner or students
- To create a static and dynamic model of a learner
- To analyze learning trends for curriculum enhancement
- To track learner efforts and keep track of his learning progress
- To recommend learning courses based on learner requirements

ii. Flexible access to the system. It refers to access to the information and other resources, suitable and convenient with respect to learners pace, place and time rather than controlled by institute and faculty. Learner centred system should be flexible enough so that every learners should be able to access resources like courses, content, objects, the material at their will and of their interest. Resources should be provided dynamically rather than static as each learner has different requirements, learning styles not in one-size-fits-all way.

iii. Easy access to electronic resources. The growth of information network and communication technology enabled easy access to the courses and the content in a way which was impractical within temporal and spatial limitations of a traditional educational setting. The learners have access to a wide range of learning resources that are open to individual learning methods and with no difficulty should be accessible.

Thus, it is exceptionally important to uncover more effective ways to improve education and it is evident from the above-mentioned points that enhancing e-learning systems will not only make it popular but also help in improving the learning process to a great extent. The e-learning system also helps by tracking student’s academic progress and instructional practice to help the administration to set learning goals for a learner by identifying strong and weak spots of a learner [32]
2.2.3 Challenges in E-Learning

In spite of the level of interest, people are showing in e-learning, it is not free from limitations and constraints. The main complication towards the development of e-learning is insufficient access to prerequisite technology infrastructure without which e-learning can’t be started, its “one size fits all” approach of e-learning, and lack of advanced functionalities to entice faculty and students. The insufficient infrastructure in terms of technology is as bad that will lead to an unsavoury experience to students, teachers and the learning experience and is enough to cause more impairment than doing well.

Table 2.1 E-learning implementation challenges

<table>
<thead>
<tr>
<th>Adoption</th>
<th>Workload</th>
<th>Motivation</th>
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<tbody>
<tr>
<td>Academic Level</td>
<td>Pedagogy Shift</td>
<td>Nonfinancial support</td>
</tr>
<tr>
<td>Technical Level</td>
<td>Poor Skills</td>
<td>Technical support</td>
</tr>
<tr>
<td>Time Constraint</td>
<td>Content Creation</td>
<td>Software Support</td>
</tr>
</tbody>
</table>

Although the cost of software and hardware have fallen due to their explosive growth which no longer remains a barrier but the cost of infrastructure, its maintenance, training and motivation to staff are some factor which are major barrier factors that play a critical role in accepting e-learning and its implementation. Some other implementation challenges in developing countries are categorized in Table 2.1. [33].

With growing e-learning trends its focus has been shifting from infrastructure development and information delivery to improving learning experience and performance. Today the internet is full of e-learning examples; however, its true power came with the exploitation of a broad range of capabilities that ICT can afford. The most obvious and important is to provide instructional content regarding the learner’s domain of interest. Almost all e-learning systems provide the same course, content and material to students despite their diverse interests and even though the material orientation is homogeneous [34]. These
traditional e-learning systems could not help students in achieving their learning goals because of the heterogeneous character of the students with different learning interest, knowledge level, background and different goals as well. The main task of any institution at the first attempt is to make strategies to deal with new challenges brought forth by these e-learning systems and to support faculty to modify their traditional teaching methods and techniques to accommodate these new situations. [35].

**Figure 2.1 Important Characteristics of E-learning**

The faculty is the leader of the learning process, and e-learning, if implemented, in terms needs time and efforts and the majority of faculty are in no way interested in giving their extra hours of time, being in the university or at home. The faculty is bound to do so, according to Roger’s innovation adoption curve, which highlights the fact that there is an asymmetric distribution of technologies in any developing country with developing economies. Faculty takes multiple roles while directing and running a course, as a content developer and
who steers the various activities in the development of curricula, student interaction, forum experts, design, develops and conduct the quizzes, assignments. Faculties in higher education institutes find themselves in a position, where they want to avoid future workload and pressure incorporated with their transition from traditional learning towards e-learning [36]. The Figure 2.1 summarizes the essential characteristics of e-learning and the resources that come under the dotted circle need to be improved.

2.3 Recommendation System

The resources of learning in the educational scenario are heterogeneous in nature and are available in different formats. The possibility of a learner to access the most relevant items is intensively researched as it is of great concern. So, in the context of e-learning, the recommendation system is an application software agent who recommends interesting and useful resources to a learner using expertise, preferences, and ratings of other learners. Recommendation Systems work on the specific types of information filtering and data mining techniques to recommend information items like courses, images, web pages, books, videos, news which is expected to be in the preference list of the user. Recommender Systems are basically techniques and tools that offer suggestions to its user and thus help in a variety of decision making process [37].

The most basic element which constitutes a recommendation system is the event, the session and the recommendation process. An event is an external action performed by the user and is a call to the system to perform some operations. Similarly, the process of recommendation is the actions which are executed in a particular sequence by the recommender system to produce a specific set of recommendations. An event in a recommendation can have more than one session, and the basic unit in a recommendation event is the items available need to be recommended. The item represents an object that a Recommender System suggests to its users like course, material, image, video, books etc. For each event, a recommendation window is created with a filter to create and filling the window to finally wrap and display the recommended items.
2.3.1 Recommender System in E-learning

The basic use-case for Recommender Systems to personalize items has been mentioned, in the filtering of the e-commerce items, and entertainment options. As far as this study was able to find their usage in e-learning system or Learning Management System for course selection have been minimum. The personalization of content, courses and other educational objects became an important feature of e-learning systems. A large number of learners with almost different background, style of learning, personality, interests and capabilities are the primary users of the system. Personalization occurs when e-learning system is designed as per the requirements of the learner.

Elearning repository contains a huge number of objects and the object chosen by any learner may not be fit for them according to the pedagogy. For example, the resources recommended to a learner who is searching for “Data Mining” for writing an assignment is different than those learners writing a research article on the same topic, because the requirements and the mode of education differs. The graduate student is doing formal learning while as research is an informal mode of learning which may combine different domains also. Hence, the learners are treated contextually and, thus contextual information will be measured as a key source of suitable recommendations. However, in other domains, the recommendations are solely done on the basis of the user’s interest.

In the e-learning context, the recommender system should be able to recommend the items to the learner based on the requirement or the previous action of the learner. The most critical issue in e-learning systems for a learner is that they need tailored access to information based on the preferences and requirement, and this issue can be mitigated using the Recommendation System approach. Recommender Systems will analyze the information automatically according to the user preferences, and the most interesting one is presented to him in a large space of possible choices [38]. The recommendations could be related to objects like courses, tasks, books, pictures, similar learners or any other educational resource. Earlier due to the availability of substantial
commercial databases recommender systems have been tried by e-commerce for purchasing goods but little attention has been paid off using recommendation system in e-learning systems, and certain essential things make recommendation system diverse in e-learning systems from the rest of the domains.

2.4. Recommender System Approaches

Recommendation Systems (RSs) are extremely handy in non-formal learning environment because learners need diverse courses to learn according to the domain of interest in order to improve learning effects, reducing learning difficulties, and especially to trial-error method. Recommender system supports a user by providing some potential choices from a set of alternatives which are of user’s interest. Recommendation system can be built with a variety of approaches, but according to Literature the categorization of a recommender system is usually done [39] on the following bases.

- The methodology or the approach used to recommend items
- The application area of recommendation
- The Information retrieval technique applied

On the above mentioned criterion, the recommendations systems are traditionally classified [40, 41] into different categories as shown in Figure 2.2, depending on the information they use to suggest an item. The Collaborative Filtering (CF), Content Based Filtering (CBF), Knowledge Based Systems (KBS) and Hybrid Systems (HS) are the main categories and are described below.

![Figure 2.2 Categorization of Recommendation Systems](image-url)
2.4.1 Content and Collaborative Filtering Based Recommender Systems

Collaborative Filtering is extensively used technique for personalizing the items using recommender systems. Collaborative Filtering works by evaluating the relationship between the users and interdependencies among items, to build a database of connections between them. So CF can be either based on items or user based and the algorithms which are mainly used for this filtering are Cosine based Correlation and Pearson Correlation. For user based CF, the system uses ratings provided by the users or a group for generating recommendations and for Item based CF recommendations are generated by accessing collaborative behaviour of similar users in the past as of the targeted users [42].

In order to recommend learning courses that are suitable to the students as per the learning level a collaborative systems were developed. Keeping in view complications that students are facing CF helps to improve the learning performance by recommending the courses that are more suitable to a respective students level of learning. To make the correlation between student skills and their profiles, the curriculum development, student skill model, Delphi analysis were utilized. The result analysis made it clear that the students obtained better result and with more contentment with CF methods rather than facing difficult time with time trial and error methodology [43].

A two-stage recommender system was proposed by [44] based on collaborative filtering to predict student grading in combination with faculty ratings to recommend courses for graduate students. Karl Pearson correlation and cosine similarity were used to calculate the affinity whereas collaborative filtering in the form of cluster approach based on the Artificial Immune Network (AIN) theory is used to recognize the similar learner. The study involves a dataset of both faculties, as well as student but the ratings from faculty do not intervene with predictions.

To mitigate the problem of sparsity issue in Collaborative filters [45] came up with a novel method of Collaborative Deep Learning (CDL) which uses a hierarchical Bayesian model, where deep representation learning is jointly
performed for user content information, and CF is done for the feedback or rating matrix. The Collaborative Topic Regression (CTR) is an attractive methodology that firmly couples the two components which learn from two unique sources of information. The experimental results have shown the significant improvements in the results, but the hidden representation which CTR has learnt to be ineffective at the times when secondary information is sparse.

Similarly [46] was determined to improve Latent Dirichlet Allocation (LDA) based CF by introducing a Collaborative Filtering based Recommender System. The system works by integrating reviews in the form of side information as a way of representing the resultant product regularization. They were moved by the success of the LDA based CF approach and proposed two review models based on Neural Network (NN) and Recurrent Neural Network (RNN) to study their effect on CF. NN has the capacity to perform resultant product regularization but interestingly the RNN seems to weaken the models ability to act regularize the resultant product.

Unlike Content Based Recommender System, Collaborative Recommender System captures the user behaviour easily and effectively, even where user historical consumption overlies and is relatively high, but the range of the content remains static. On the other hand the content may undergo frequent changes in much web application and there are users whose historical records are either not available or not enough for generating recommendations and thus ended up in cold start problem leaving this collaborative recommendation technique unproductive.

Content Based Recommender System (CBRS) attempt to solve recommendation problem by searching the items for a new user that are similar to the liking of the past users considering the item content. This means that the item preferences of one user should correlate with the same item of another user. The recommendation framework for e-learning systems was proposed by [47] which based on excellent learners' ratings that indicate the quality of learning materials while recommending the learning materials of similar content. The authors tried to address the problem of growing e-learning material and recommend the material
for a specific topic. The system was based on the concepts of Social Learning (SL) and Peer Learning (PL) theories which encourage persuade learners to learn among themselves. This content based recommendation system has shown noteworthy progress in test results in e-learning as compared to the e-learning systems without recommendation feature. But again learner rating deviations will affect the result which results in a lower accuracy rate.

A novel Content Based recommendation approach was suggested by [48] which use a network of multiple attribute system for reflecting several other attributes much effectively during the calculation of correlations among the items while recommending them. To ensure that various items should be recommended to the users, they employ clustering with the mechanism of centrality, to check interdependence between items and determine their interaction pattern structure. The method mitigates the problems of overspecialization and sparsity and even claims to overcome the cold start problem by using the past data of the users.

The overall scenario related to content based RS’s is that they are simple to implement but, in some situations, it is not sufficient to seize the exact user preferences using information stored in the user profile. First, the metadata has not be specified entirely in the e-learning systems where there is no service for recommendation feature which leads to the incorrect user profile. Second, the representation of user profiling cannot efficiently capture the relationship among the user items that have been accessed before. In addition to that, CBRS are not readily susceptible to the changes adopted by the user, and thus the content filtering system will undergo new user and new item problem.

### 2.4.2 Knowledge based Recommender Systems

Recommender System has a key role to play in e-learning while addressing the problem of information overload and help the learner to get relevant e-learning resources from a considerable collection both online as well as offline. In e-learning systems, Ontology Based Recommender Systems (OBRS) added a new facet of ontology domain knowledge about e-learning resources in the process of recommendation while as conventional recommender
systems still, suggest items based on user ratings. By combining ontology with other recommendation methods will be helpful for recommending the resources in an e-learning system. Such hybridization overcomes the drawbacks associated with individual recommenders like sparsity, cold start, new item problems, and can improve the overall quality and accuracy of the recommendations [49].

Ontology based recommender systems come under the category of knowledge-based recommenders which utilize ontology for the representation of domain knowledge. In e-learning context domain ontology will helpful to model the knowledge about each learner and the resources about learning. Ontology based recommendation Systems unlike, knowledge-based recommender systems do not experience the problems coupled with traditional recommender systems such as overspecialization, rating sparsity and cold-start problem, because ontology based recommender systems rely mostly on domain knowledge rather than ratings given by the users [50].

The ranking technique was brought in to limelight by [51] which was capable of delivering specific appraisal for the document relevance with respect to a specific query. The method employed was domain ontology to evaluate the linkage between the terms in the document. The Document semantics were exemplified in specified domain ontology with the help of Document Semantic Network (DSN) graph, and weighing approach based on the relationship was used to estimate the score of relevance in the document. Importance was given to the user interests and preferences for types of data to utilize the concept of personalization. Furthermore, the document semantics were depicted nicely in the form of a graph has emerged as the noteworthy aspect for the implausible improvement.

Personalized learning system invariably based on domain specific ontology was developed that could be incorporated with e-learning system. The semantic compatibility was difficult to comprehend with respect to educational scenario and it needs a general ontology based on the understanding of the teaching and learning realm. The developed ontology was institution-specific and could be incorporated into a learning system where data is retrieved automatically from the
database. Furthermore, the system needs to be more flexible by adding the ontology the user queries were restricted with respect to the ontology vocabulary [52]. A novel open source e-learning system called Modular Object Oriented Dynamic Learning Environment (MOODLE) was developed that introduced domain ontology on learning network. The ontology was arranged to capture the communication among students under Moodle environment. Additionally, Moodle introduced log based learner activities to understand the behaviour of the learner and organize them under certain groups knows as clusters [53]. Major portion of students belong to the premeditated cluster, while others allege to other assiduous and proactive groups. All was accomplished under Moodle system according to the execution during the courses of the learning process.

Another splendid visual mechanism and ontology based approach for computer based collaborative learning set-up that includes the domain of big-data was stage-managed by [54]. Ontology tool was efficiently used as a platform to bring together business enterprise and the students from university. Furthermore, the big issues of designing ontology to configure the IT projects and domain of big data were achieved with the involvement of students.

A wonderful innovative idea by [55] with the help of Case Based Reasoning (CBR) device launched for the personalization model for information retrieval based on ontology. The technique was committed to be user-friendly and scalable to understand the performance of information retrieval mechanism where results are ranked according to user’s interest. Two techniques were integrated together, CBR to customize the searching procedure and the ontology based approach to exemplify the data to deliver users with alternate document recommendation. Recall and precision measure were carried out with the intent to assess and appraise the execution efficacy of hybrid technique. Additionally, it was found that technique will improve with time in itinerary domain for the transportation of metropolitan cargo.

Knowledge based recommendation system using semantic web was advocated by [56] to illustrate the current status of the learner and the learning objects and learning material using knowledge pattern. The objective is to
generate a student model and to track the progress of the student. For a specific student, the recommender was able to make the speculations regarding the objects that exist in a personalized learning path of the concerned learner. Furthermore, the main functions were also successfully implemented to assess the score for the best possible relevant learning object.

An extension to Moodle in the form of ontology based skill management was developed by [57] to check the growth, and assess the competency in student within a registered course. The ontology based management of student competency design was developed in a course structure and certain attributes were integrated into Moodle. After integrated the attributes Moodle was competent enough to tackle the competencies along with some proof of instance. Also they have created assorted categories of reports on competency according to profile such as faculty, administration and students.

Vladimír Luna et al; [58] excellently developed an ontology based technique to demonstrate the swapping of tasks between the user’s background and profiles for common learning purpose. The system efficiently estimates the constraints and rules with respect to learners especially in common learning scenario. They also discuss school background of the students as a case study, and the relevancy of the novel techniques with respect to the learning scenario to predict learners and their background model to establish the link in a predefined scenario.

2.4.3 Hybrid Recommender Systems

The Hybrid Recommender System is a multi objective recommender system, which is a combination of subcomponents of single Recommender Systems like a combination of Collaborative, Content based approach, Knowledge based, and Demography based approach. The Hybrid approach of recommendation was introduced to overcome the problems and the limitations of conventional Recommender systems. In a hybrid approach, different methods are combined in together to optimize the prediction quality of recommendations and resolve the bottlenecks of conventional individual techniques. Combination of
these recommendation approaches is done in different ways and can be classified as follows.

- Content-based and Collaborative methods are implemented separately and later their predictions are combined
- To incorporate a collaborative approach with some content-based characteristics
- Content-based approach is incorporated with some collaborative characteristics
- Construct a unified model that incorporates all approaches
- Incorporating keyword based on ontology of the knowledge based approach
- Incorporating knowledge based approach with information retrieval techniques

The Hybrid techniques integrate multiple individual recommendation approaches to show better results and to mitigate the problems faced by individual systems. Hybrid approach can overcome the problems of scalability, sparsity, cold start, and overspecialization. A hybrid Recommendation system was proposed by [59] that were based on the interactive scenarios for user recommendations. The user recommender interaction is defined first and then N different Items are recommends to the user. The proposed system save the feedback or choices opted by the user them and if the recommended items are in favour, the user will allowed browsing for further search for recommendations till items do not favour her preferences. In addition to that K-Nearest Neighbourhood (KNN) algorithm was also combined with the proposed to generate the nearest neighbourhood. Finally, the scenario based metrics was used to evaluate the system using diversity and recall feature.
Jose Aguilar et al [60] marvellously brought a novel Intelligent Recommender System into light by extending the knowledge based concept of recommender systems. The system has used fuzzy logic in combination with the cognitive maps and created five knowledge models about various facets that need to be considered during recommendations. The system uncovers new information, the preferences of the user, different learning methods and even criticism for exploiting the knowledge. The proposed system do not require knowledge engineering, user ratings and user information as its decisions are not dependent on individual preferences and are invulnerable to statistical errors. The aspects that guaranteed that the system is behaving intelligently are the reasoning capability and different representation of knowledge and learning. Recommender system exploits the extracted knowledge with the help of a learning mechanism which allows the system to update knowledge that was initially gathered in the form of domain and context information in initial inferences. The Proposed recommender system improved the recommendation quality because of knowledge representation and a different mechanism for reasoning and learning which traditional recommender systems do not possess simultaneously.

Another unique Recommender System approach which was systematically designed by [61] using the combination of different attributes like ratings, demographic information related to the items and features correlation. The system was based on cascading hybrid technique and it claims to outperform the traditional recommender systems and also overcome the recorded problem associated with RS. In order to allow the learner to have the utmost information for the purpose of learning, a splendid Hybrid Recommender System was formed by [62] to suggest the content to the users on e-learning platforms for distance education. They have used the data mining techniques have divided the system into four parts to collect the information. The system assists to build the main centre of user’s interest for accessing the material. The user information about their interest is collected in two modes explicit (collected from profile) and implicit (collected from the survey) mode. After a successful collection of information, they create a learner model and classify the content and the users also. Before recommending the new content and the content that has been already
recommended, the system makes a similarity check between the content and the learners and later create a log file of recommendations for learners.

As the growth of e-learning material was mounted [63] developed a Hybrid Recommendation system to recommend potential useful learning items to the users during their current learning process. The system was developed because the material was heterogeneous in nature and is available in different formats. So, the user with little knowledge about the domain and with growing number of learning resources finds it difficult to choose courses for learning. The two methods were combined where CF was chosen to discover the items based on their content relationship and also Sequential Pattern Mining algorithm to filter the learning resources as per the common sequence of learning. The system was tested in peer-to-peer online learning environment and in a centralized learning system where it has shown good performance.

2.4.4 E-learning Recommender Systems using other methods

Another important point is not to take care of the customization only, but also the delivery of the learning objects. Customization should not only be made about the choice of learning items, but also about their delivery. For example, sometimes a learner is recommended to go through certain survey papers before being recommended to go through some technical articles. It is because of the fact they these instructors believe that with this pattern learner will feel less intimidated and may prove effective for a learner to understand the papers. Conversely, in e-commerce, this pattern will not be taken care of and instead a list of unordered items is recommended to leave an impression of not being specific to any recommended item.

Farzan et al [64] developed a recommender system namely course agent that focused on finding courses to match user’s career goals. The novel approach of this system was “do-it-your-self” that is to get feedback from the users and later providing the same to the system. So this system is mostly dependent on the student feedback rather than the system is choosing what can be the best for that particular student. Similarly [65] with the help of data mining techniques
constructed a recommendation system by classifying the courses "likely to succeed" and "not likely to succeed". These categories denote whether or not a student is going to score well or will achieve good grades, based on the history of his similar courses. This system also suffers from weakness, as they do not consider whether or not the course will be useful for the student, whether a student is likely to enjoy the course and classification of the courses are based on only yes or no scale without any course relation or course ranking. Chen W. et al [66] came up with recommender systems which crunch the student’s post-academic performance, the planned major courses and the data of similar fared students to arrive at a recommendation. The system is mostly used to arrive at grading students rather than what can best for him to study to affect his performance.

Another hybrid recommendation system with two-stage processing was proposed by [67] for an e-learning system to recommend items during the process of learning. First, in order to find out a related set of items item based CF is used, and second to filter the items as per frequent learning patterns a sequential mining algorithm is used. There are situations in e-learning scenario where predictable patterns can be found in learner actions and the item a learner is interested in entirely depends on the learning path of the learner in a course or a subject.

Tai D.W.S et al [68] provide recommendations by searching learners based on some attributes of a targeted learner. CF based recommender system was developed to collect ratings from learners and create Vector Space Model (VSM). The rating of those learners will be considered whose marks are above 80% of the total marks, which means that they might have studied the subject well. Learner with even 79.5% won’t be considered for generating similar learner and in this way the system will be induced with a bias among the learners who are genuinely well but didn’t score 80% or above. Vinaya et al [69] introduced the recommender system based on keyword to overcome the issues of ratings, scalability, and inadequacy during information overload and diverse user interest problems. They use specific keywords in order to signify items of user preference and CF method to personalize the recommendations. The keywords extracted
from the review are converted into negative keywords and positive keywords. The keywords are counted and the total number of keywords represents the weight of a particular keyword category. Then both the review weights are subjected to subtraction and if the result is positive the item will be recommended to the user and if result is negative the item is not recommended. The system has shown improved accuracy over existing methods but it suffers heavy drawbacks in terms of negative keywords. There should be some algorithm that will create effective keyword categories otherwise the chances are that system will put positive keywords in to negative category.

Wang et al [70] put forward a RS which was based on similarity categorization for detecting the query similarities to plan the execution of queries using machine languages. They employ association mining rule to ensure the similarities between the queries to be executed and also recommended appropriate execution plan for newly formed queries. Zahir J and Qadi [71] justified that classification techniques has been commonly used on queries in order to classify them into a set of particular category. During information retrieval process user queries will create difficulties to fetch relevant information as it is difficult to interpret the queries that are ambiguous, having lesser number of relevant query words, and are noisy. The research practices have shown that evaluation of information retrieval is a big hitch and the challenging task is planning a dependable method which can measure the effectiveness of satisfying the information need of a learner.

It is difficult to take recommendations from one system and transfer to another due to lack of interoperability or domain dependency. The main challenge for RS is to recognise the purpose of a domain and to understand the interests of a learner in a much better way [72]. Recommender system totally depends on ratings and interests of other users in the past, and then left it for a new user to respond to the choices that best matches their requirements with respect to previous users. Instead of recommending courses at initial stage most of the recommender system focuses only on recommending the learning material at later stage. If a learner, at the beginning is suggested with the right courses to study the learning material will logically become more productive
Pedagogically items liked by the learners may not be appropriate for them. Then it should be handled by the recommender system to help in customizing the learning items. The learners at the college or university level may not be satisfied with the course advisers, and it is also possible that advisers could not devote enough time to students or may not have sufficient knowledge about all the courses offered in an institute. It has also been seen that while handling complex tasks humans tend to have a blind spot, and they try to give advice based on personal preferences. The basic aim of Recommendations is to open student’s vision towards courses they are not aware of or might have skipped due to lack of knowledge.

2.5 Models of Similarity

The similarity is the assessment of how many similar two data points or objects are in certain characteristics. In the context of data mining similarity is generally described the distance between points within the dimensions representing the characteristics of the objects, in which minimum distance is the indication of similarity of high degree between objects and a larger distance is the indication of the similarity of low degree. To search a similar learner for a targeted learner who is new to the system, it is important to calculate the various similarities attributes between their interests, domain, background etc. The information retrieval system uses different similarity models to find the relevancy between the objects or items. The recommender system will carry similar actions with similarity models with some variations.

Let us consider L the set of learners where \( l \in L \) and D is the set of the domain where \( d \in D \). The similarities of interest may be similar \( \text{Sim} (l, d) \), \( \text{Sim} (l_i, l_j) \), \( \text{Sim} (d_i, d_j) \). There are different ways to compute the similarity between the user’s some of the popular methods are cosine similarity Pearson correlation, Squared Euclidean distance, Bray Curtis Distance, and Manhattan distance [73]

**Squared Euclidean distance:** The simplest method to measure the similarity between two elements is Euclidean method, and the measurement is given by the
sum of the square of the distance between the data points \( X \) and \( Y \). The formula of Euclidian distance is given in equation 2.1 where \( n \) is the dimensionality of the data points [74].

The Squared Euclidean is often the default distance measure used in classification like K-nearest neighbourhood or in K-means clustering to find the \( k \) closest neighbour or point.

\[
\text{Euclidean Distance} = d = \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \quad \text{Eq. (2.1)}
\]

**Manhattan Distance**: is another similarity measure, it computes the summation of the absolute differences in the distance between the data points \( X \) and \( Y \) as compared with Euclidean distance, The Mathematical expression of the Manhattan distance is given in equation 2.2.

\[
\text{Dist} (X, Y) = |x_2 - x_1| + |y_2 - y_1| + \ldots \ldots \quad \text{Eq. (2.2)}
\]

Both Manhattan and Euclidean distance equations measures the shortest path, but the Manhattan distance metric allows only the path that is constant in all but one dimension only while as there is no dimension restriction on Euclidean metric.

**Pearson correlation**: The Pearson Correlation is computed as the summation \( \langle \Sigma(x, y) \rangle \) of the co-variance of data points \( X \) and \( Y \), and their standard deviations \( \sigma_x \) and \( \sigma_y \). This correlation is used to measure the linear correlation between two elements as in Equation 2.3:

\[
\text{Sim} (x, y) = \frac{\Sigma(x, y)}{\sigma_x \times \sigma_y} \quad \text{Eq. (2.3)}
\]

**Cosine similarity**: It is the similarity measure between items \( x \) and \( y \) which are two non-zero items and in \( n \)-dimensional space \( x \) and \( y \) are treated as vectors.
The cosine angles is used to measure the similarity between \( x \) and \( y \). The cosine similarity can be used in the same way as the Pearson correlation in equation 2.4

\[
\text{Sim} (x, y) = \frac{x \cdot y}{|x| |y|} 
\]

Eq. (2.4)

### 2.5.1 Classification Techniques

The Classification is the process of mapping objects or data points in one of the various predefined classes which require extraction and selection of characteristics that illustrate the properties of a particular class. There are different machine learning techniques available to predict the membership group for a new user, and the classification technique is one among them. Classification is a mapping technique between the label and the feature space of the item. Classification algorithms form a strong base, and key component for recommender engines and without these algorithms, it is difficult to predict which item a user will like or not. Classification can be supervised where an algorithm is used to assess the probability for an object or item by the user, or it can be unsupervised which is used to form the user groups based on some similarity measure [75]. Some of the popular classification algorithms will be discussed in the following section.

- **K-Means**

  K-mean belongs to one of the unsupervised classification algorithms which try to group the objects or items that are more similar than the rest of the items in the group. The aim of K-mean algorithm is to partition the observations into \( K \) number of clusters where each item belongs to a particular cluster using nearest mean. K-mean is an iterative technique and starts by choosing a random cluster Centroid \( k \) which serves as a mean of the cluster. Then it assigns every object or item to the Centroid which is close to it, and in each step, clustering tries to decrease the distance of every item from its equivalent Centroid whose formula is
The process of clustering continues until a condition of convergence is not met [76].

\[
\text{Sim} (x, y) = \sum \sum d(n, k) \quad \text{Eq. (2.5)}
\]

The clustering algorithm will increase the efficacy of the recommender systems but is unlikely to improve the accuracy of recommendations. Clustering possesses some limitations also regarding the selection of K which indicates the number of clusters which are to be formed and the initial position of the Centroid. It also clusters the items which are far away from the cluster which can induce noise in the cluster.

- K-Nearest Neighbour

This approach is one of the oldest and simplest and method to be used for classification. To predict the label of the unseen items or cases, k-NN categorizes the unlabelled tests using the label of the majority among the neighbors by memorizing the training data set [77]. The closeness of the items is calculated by using one of the similarity model discussed in above section 2.5, and the similarity relies on a particular distance measure. Hence, the distance metrics significantly determines the performance of the classifier. In simple terms, the main function of the KNN is to relate the unknown record to the known according to some distance measure function.

The KNN in the entire available machine learning algorithms is one of the most accepted classifiers to recognize patterns because the algorithm is simple and easy to use. In the field of machine learning, pattern recognition, object recognition, data mining and text categorization, it yields effective performance, and its accuracy is better than state-of-art classification algorithms [78]. However, there are certain limitations for KNN classifier in the form of time complexity to compute the minimum distance to search for the similar neighbouring record and memory requirement to store the records of the training data set. KNN is usually called a lazy algorithm because it doesn’t construct a model in advance to base future classification. The key issue in KNN is to agree
on the value of k because if it is too small, the classification will be susceptible to noise points and if the value of k is high neighbourhood may comprise of data points from other classes. This method is frequently used in collaborative filtering because of simplicity.

- **Support Vector Machines (SVM)**

  The SVM is a non-probabilistic classification unlike Naive Bayes and supervised learning model that is used for pattern recognition and their analysis [79, 80]. If a training data set is given to the SVM it develops a model and assigns a new input data to one of the categories. The SVM develops a model which assigns a new input to one category or the other, if a training data set that is given belonging to one of two categories. The SVM is a hyper plane which segregates an item of positive group from a set of negative items with highest margin. In other words it can be said that SVM is a binary classifier in its easiest and linear form. SVM has gained popularity in recent years because it has performed well on handwritten character recognition, text categorization and face detection, and the formula for the output is given in equation 2.6.

\[
U = \~w \cdot \~x - B \quad \text{Eq. (2.6)}
\]

Where \~w is a vector to the hyper plane, \~x is input features vector.

**Naive Bayes**: It is one of the supervised classification techniques that are based on the Bayes theorem and the conditionality probability. A record R with an F-number of characters aims to predict class C by searching the value of C which can maximize the probability of the data for a given class [81]. On applying the Bayes theorem we get the following probability in equation 2.7.

\[
P(C|R1, R2... RF) = \frac{P(R1, R2... RF|C) \cdot P(C)}{P(R1, R2... RF)} \quad \text{Eq. (2.7)}
\]

This classification can make strong assumption between the data points and consider each feature independently of the fact to classify the object in spite
of any correlations between features of the objects or data points. It is regularly being used in classification because it is fast and simple to execute. The shortcoming of this classification algorithm is that it treats features independently, but in text classification two words in a sentence is not independent.

2.6 PROBLEM DESCRIPTION

The accomplishment of the effective eLearning approach invariably depends on a multitude of essential features like creating the learner’s profile, study program, and the challenges of personalization of items in formal and informal learning. The outcome of the previous researches on personalization issues encourages researchers to offer personalized information related to learning using recommender systems. Earlier, a learner used to consult faculty or peers about the courses that would be appropriate for them, but these findings are not comprehensive, thus automating the process of finding the courses which are in the interest of the learner’s domain would be beneficial. In this regard, various techniques and algorithms were elegantly applied to act as a catalyst towards the advancement of the e-learning systems.

Primarily the methods mentioned in the survey have been efficiently exploited to promote the performance of extremely convoluted knowledge model framework with the intention to facilitate the effective and smooth transmission of knowledge. The semantic essence in the form of course ontology is intended to provide the compatibility among the domains. However, to attain the allied objective, the design and the other logic approaches have to be specifically defined. First, a different type of approach is needed other than traditional patterns to develop the system that can recommend the objects. Secondly, the system should be able to handle the critical issue concerning the ambiguity and the imperfection of the query words, and then appropriate query transformation is needed to retrieve more valid information. A thorough analysis has been carried out by the passionate researchers by employing recommendation technology to the e-learning system with the aim of adding the flexibility, effectiveness and being more personalized.
Recommendation Systems have been the topic of research for about a decade. Many RS's with different techniques have been proposed in the past, and mostly they are used for commercial purposes such as content based, collaborative systems and knowledge based systems. Recommender systems helped in filtering the course data effortlessly for its users. The pre-eminent approach involving the deployment of recommender systems is ontology along with rules and techniques to facilitate recommendations to learners. E-learning systems also require ontology expert to develop course ontology for a specific realm to provide domain acumen to the learners to select the courses that are more suitable for them as per the area of interest. The ontology could act as a controlled dictionary to find the related courses.

With the help of RS approach appropriate courses can be suggested to the learner as every learner has diverse abilities and interests. Thus, the learning quality need to be enhanced using recommendations is the need of the hour to make learning effective. Most of the researcher provide personalized recommendations in e-learning systems and invariably utilize different supervised and unsupervised machine learning techniques. Some of them use keyword based approach due to ease of execution. The keyword based recommendation systems are well-appointed with some essential skills of retrieving the objects or documents by matching the keyword terms precisely. However, it beleaguered with several weaknesses in effectively retrieving the documents with regard to the fluctuation in query words and their meaning. E-learning systems are envisaged with the intention of providing a helping hand to both learners and the faculty to utilize the mechanism of personalization effectively, and the intention is to efficiently tackle the barbed issue discussed above. A Recommender System impels the e-learning systems to be more efficient by personalizing the courses to an individual learner according to the domain of interest and stipulations.

2.7 CONCLUSION

Personalization is being acknowledged as the most challenging and important issue in current e-learning systems. Various methods that were proposed to enhance the learning environment by taking learner characteristics or
factors into account. This chapter offered a diligent survey on the Recommender Systems and their importance in e-learning systems to provide personalization. The modern learning systems should take into account the requirements and needs of an individual learner. There were different approaches to personalize the things, and one of the approaches is a Recommendation approach to personalize the learner requirement in existing systems. Some of the studies adopted learning style as a reference for personalizing the learning content. This research study focused on hybrid recommendation approach to suggest learning courses for individual learners. The experiments show that the proposed system would improve the learning outcomes of the learners. The chapters 3, 4 support personalization to overcome the limitations in existing e-learning systems.