Importance of Recommendation System in Modern Forms of Learning

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Abstract—**In this paper a new platform for distance learning based on student centric model with a focus on a role of Recommendation System in the whole project is described. Fields like learning management system, virtual laboratories, augmented reality, assessment method and multimodal system are included in this paper. Second part is devoted to recommendation engine. Two main recommendation methods, content-based and collaborative filtering, are described. Last section describes the integration of recommendation engine to the e-learning process and a potential usage of the engine in education.**

Keywords—**NEWTON, recommendation engine, e-learning**

I. INTRODUCTION AND MOTIVATION

Commonly used education system in Europe uses traditional methods to learn new knowledge. These methods have not changed much over decades. Indeed, the technologies of 21th century allow trying innovative ways of a learning process. However, the system recognizes proved methods focused on teacher-students relation and uses these technologies like an experimental option or exhibition. E-learning brings new aspects in education, like the student-centric learning. A learning outcome of the e-learning could be empowered by recommendation system. An adequate hint of the system, such as an offer of a textbook, a contact or an area of interest, opens a new dimension in learning. A student is not only led by the system, but the system knows what the student's need is without any additional inputs. It makes the system more sense-oriented and user-friendly. There is a space to create a new platform for e-learning and innovative teaching with the up-to-date technologies for more students beyond the country borders. A project called NEWTON involves development tools for learning, creating new teaching labs and building pan-European learning network to increase learning outcome [1].
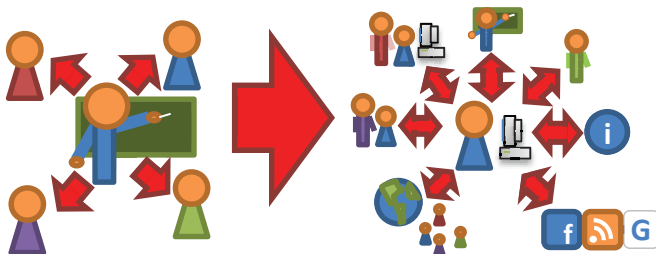

Figure 1. NEWTON's paradigm of student-centric enviroment

It accentuates the student-centric model where an active learner has many quick and accessible options to get more information.

II. BACKGROUND

A. European education issues

1) Decreasing of young scientist rate

In Europe arises a crisis of decreasing of young scientist rate in computer and mathematical sciences. A rate of graduate scientists in technical branch decreases. Nowadays, the rate is 9% while in 2000 it was 12%. There are two main reasons. The first is that the younger generation has a respect of a subject difficulty in that area. Many of them have started to feel an aversion of those subjects during the secondary education level. The second reason is the profitability. The commercial sector is more preferred than science-based one. The students with computer knowledge are motivated to work in commerce because it offers higher payment level and quality.

2) Early school leavers

Education departments in the European Union (EU) are worried by the term of early leavers. The early leavers are students, which leave school earlier without a graduation. According to research in 2014 in the EU an early leavers' rate is about 12%.[1] However, this global rate hides the real situation. In Spain or in Malta the rate is above 20% and in Romania, Italy and Portugal the rate is above 15%. Students leave school early because they have not enough motivation. The second aspect which impacts school leaving is a gender of the student. More boys leave the school earlier than girls. Boys perceive learning as more difficult than girls. The cancellation of school without graduating leads to increasing unemployment rate in European countries. There is need to use non-conventional ways in the learning system.

3) Education for disable students

The study for students with disabilities is more complicated. Not every student with special education needs is in special schools. Every country of the EU had different arrangements. Among countries is a wide variety of students with special needs. Those students that are in mainstream educational settings do not get adequate support. According to research, the majority of people with special education needs are early leavers. In some countries the rate can be higher than 70% for people with serious disability. [1]

B. Project NEWTON

The mentioned project Networked Labs for Training in Sciences and Technologies for Information and Communication (NEWTON) is a Horizon2020 project and covers a wide spectrum of options how to enhance education system. It ranges from an adaptation and personalisation of learning system to deep technical implementation and using modern innovations. It involves all the educational stakeholders (teachers, students, scientists, experts and others). Academies and industries from Ireland, Estonia, United Kingdom, Slovakia, Romania, Italy and Czech Republic participate in the project.

The motivation of the project is to use all types of education. The formal type is the most common type of education (school, university). The non-formal type can be presented by ICT technologies. It has the same importance as the formal one, but it is not recognized by every country and state. The last type is the informal education. It can be provided by the augmented reality, gamification or other enjoying ways of unconscious learning. The priority of NEWTON learning process is to spread the skills of 21th century. Nowadays, the most useful and relevant abilities are communication, creativity, problem-solving and team-building. These abilities are essential for employees or for everyone who works in team with new ideas to figure out the issues and get the most effective solution. This project point out this fact and aims to afforce these skills among students and in education.

NEWTON has set the target to solve main educational issues. It has designed a solution for each to the main problems and certain learning area. NEWTON's response to mentioned issues like decreasing of young scientist rate is to use diverse form of learning and thus support different levels of education, put into practice augmented reality, gaming and multi-modal and multi-sensorial interaction. These accomplishments present the science and mathematics, informatics and physics from the other point of view. Students get more information in different way and the impression can create a spark of the motivation in some students. This can be an answer to the issue of decreasing. Also, these innovations can support the education in all directions in general like problem of early school leavers too. For this issue NEWTON offers to develop a new school-wide strategy and student-focused strategy. These strategies are focused on the network outside school, education of teachers, tutoring and individual learning by usage of new technologies. The new strategy is welcomed for study of students with disabilities, but it is not easy to figure out the compatibility between a level of befalling and handling form of learning. The project generates a space to develop appropriate tools for each level of the disability and to bridge amount of information and ability of student's perception. [1]

C. Virtual Learning Systems

Virtual Learning Systems or Learning Management Systems (LMS) have been used for the last 15 years. The first purpose was an online storing of educational resources, managing them, tracking the content delivery and testing the students. Step by step, LMS functionalization has been extended and current generation contains core services. The main purpose of LMS is to enhance learning outcome. These systems enable to accomplish the administrative tasks related to education and learning process, to diversify the learning process by multimedia, animated content, hypertext and the other options offered by them. However, LMS is provided for a higher level of education. For primary or secondary schools do not exist relevant LMS. Moreover, for learning system for disable people, there is a lack of the Virtual Learning System. LMS can contain many features and amounts of knowledge but when the learner is addled, feels uncomfortable of user interface or he or she does not find wanted data or output, the learning outcome rapidly decreases. So the learner experience is essential in education. The next generation of LMS should track learner's behavior, detect learner context and so bring in more intelligence. There can be used new education concept of student-centric environment. It should facilitate to get in the subject as deeply as the active student wants. If the student was impressed by some information, he or she would study more in that area. This should be a huge advantage of the system that LMS would offer recommended source to the learner, because the internet has also much knowledge, but not everyone is correct. Due to a recommendation of the source is essential in learning. So in this area the recommendation engine brings a new point of view in education. It is necessary to join quality of the textbook and neediness or preference of the student. The well-designed recommendation engine offers a solution to find a right conjunction of many requirements. [1]

D. Virtual Remote Laboratories

In the mathematics , physics or other subjects the students are taught in a theoretical way. They write a lot of formulas, but they cannot imagine how to use this knowledge in practice. In the school there is one or a couple of labs, but not every school has an opportunity to be fully-fitted with the newest accessories. When some school disposes of the hi-tech lab, it is shared among a close society of the students. Virtual remote laboratories enable to use one special lab for many schools which are connected online. Students are able to view and control an experiment remotely by PC. An appropriate remote control interface helps to show and describe an experiment. The whole action is captured by the interface and all values and measurements are displayed on the student's monitor. The process is streamed by the lab cam in realtime and can be replayed or in detail investigated. NEWTON supports a creation of a European lab platform that offers to each engaged student an access to the labs of the highest quality. There are lots of features that should be developed like digital repositaries, virtual tools, e-infrastucture, virtu-interface or an abstract layer and the many others.

The fabrication laboratories are another type of the learning facility. While the school labs incite students to prove the theoretical knowledge, the fab lab facilitates to enhance their creative abilities. The fab labs dispose of the computer-

controlled tools like 3D printers, 3D scanner, laser cutter or other tools to accomplish their ideas. This way of the education is called "learning by doing" and students can experience real issues during development of an invention and a prototype creation. [1]

E. Gamification and Augmented reality

This part of education complements learning system to get the best outcome. The young people or almost everyone likes to play games. There exist a lot of games that we can buy and play, without any or with minimal learning experience. However, the game based on the learning outcome and the educational field can teach a user in an informal way. Gamification includes reward system that keeps the user to be keen on to get higher and to reach an upper level. Around the game is commonly a huge virtual community, which can support the user in progress. Also in this way the community can help with learning issues. The game uses many kinds of an interaction to increase user's experience and this interaction is supposed to support a memorization of new information. The students can forget that they are taught and can enjoy the game with a learning background. NEWTON deals with adaptive and gamified contents. Also an augmented reality is interesting for the project from two points. The first point of view is a description of scientific content by the virtual environment. On the other hand it can be useful for people with hearing disabilities to get necessary information through sign language. [1]

F. Assessment methods

The evaluation process determines a learning outcome. A traditional approach like paper exam has one disadvantage. The questions are simply given and they could reach out of the bounds of student's knowledge. An electronic exam with a special assessment method enables to set the questions in the process of the examination to get closer to the student's knowledge and it gives a more accurate result about the student's state. The result of the test can be a good input to the recommendation engine in this area. The engine can select a correct textbook with higher precision to get student's learning to an advance level. It should be connected with an area of learner's interest and aim. [1]

G. Multimodal system

Multimodal system is welcomed in NEWTON project. It is essential firstly for people with disabilities and impairments and also for new ways of education. The multimodal environment offers new types of interaction in e-learning. It allows to get personalized access for different levels of impairment. Nowadays there exist many useful solutions to stimulate each human sense. Thus, when we merge all stimulation modules together, we get empowered tool to control the system by every sense. This equipped interface helps to enhance a communication between a human and a computer, so it creates an environment called "human-machine interface". By using touches, gestures, movements, human speech, face recognition it is possible to ease human inputs and from the opposite side by wearing special clothes,

gloves, using speakers, 2D or 3D screens, olfaction or gustatory devices people can discover an impressive experience and get new knowledge. Everybody knows multimedia, which usually use video and audio. However, with new sense devices come new types of media like e-touch, e-smell and e-taste. Together with audio and video they create a group of media called multiple sensorial media – mulsemedia. The more one of the senses is stimulated, the better retention it is. The multimodal system in education can be smart accessory and facility. However, for students with disabilities it supposed to be a needfulness to get the best level of knowledge as well as possible. Obviously, it depends on the content of the mulsemedia. The good multimodal system is a tool, an appliance to offer quality information. On the other hand to develop a good multimodal system is a complex issue and every module of the system has an impact on the result.

H. Recommendation engine

Recommendation engine is a system to understand user needs. It saves user's time of a searching appropriate and interesting content, and it offers the favorite content of another user with a similar profile or similar content of user's favorite one. It helps to filtrate those items which are interesting for stakeholder's objectives. So an algorithm derives from the connections between contents or from the similarity of the other users. The overview of recommender engines is given in [2]. The most commonly used techniques are:

- Content-based filtering
- Collaborative filtering
Both needs to deal with so called cold start problem, which occurs when there is a new item or new user in the system.

The content-based recommendation finds and recommend items similar to those user rated in past. Then user profile is described by his/her preferences drawn from item content description. When a recommendation is made, the item with the content closest to user profile is chosen. Content based recommenders are not able to predict something unexpected or novel, because they are trained to suggest content, which was labelled as relevant in the past. In other words, only similar programs will be offered to user. On the other hand, this approach handles cold start problem. A new item can be recommended according to its content and a new user can be offered to fill a short questionnaire to initialize preferences.

For numerical variables, the most commonly used method is support vector machine (SVM) or k-nearest neighbour (kNN) approach, where features are represented in N-dimensional feature space [2]. There are very few CB designs handling categorical data. Most of them use text classification methods, like bag of words, to discover user preference [3]. .

Unlike the content-based approach the collaborative filtering is the active recommendation. The item content description is not necessary to make recommendations. This type compares a rating profile of a user to another one, who rated the same or similar set of items. This recommendation

method is user oriented and based on "*people-to-people correlation*". It has some important advantages. The most commonly used algorithms are k nearest neighbors (kNN), singular value decomposition (SVD), Pearson correlation and cosine similarity to find users with similar rating pattern [3].The explicit setting of the content is based on subjective rules. The users define the connections. A taste of the society is constantly changing. People naturally interact with the time and this interaction is captured by this On the other hand, it brings some drawbacks. A main issue of collaborative filtering is the cold start problem. New users have no rating history, therefore no items can be recommended to them. Similarly, new items cannot be recommended as no user has rate it before. The other drawback is that it works only for common users with a common taste. Content base methods, however, can make more personalized recommendations.

The properties of these two approaches are complementary to each other. Therefore, they are widely combined to create hybrid recommendation system to eliminate drawbacks specific for each of them.

Moreover, well designed hybrid recommendation system increases the system accuracy. .

III. RECOMMENDATION IN E-LEARNING

Every complex system which offers some content and includes groups of users should be supported by the recommendation system. Many successful e-shops, commercial databases or advertising companies track user behavior, process user data to understand customer needs. It eases user search of looking for a new content and enriches his or her selection.

E-learning system is also a system with users choosing from the rich content. It is a field where recommendation should be implemented as one of the most essential parts. Although recommendation systems are commonly implemented in various types of services, the recommendations designed for education have a wider impact. People are influenced by reviews, ideas and recommendations of other people. When the recommendation engine gains users' trust, it becomes a guide of the learning process.

Not even, a learner knows, where he or she should continue in study. However, the learning itinerary is set to some extend, knowledge requirements are continually changing because of the fast progress in science. Recommendation engine can keep abreast of the times, detect a potential of new topic and lead the student to study the hot science topics without an extra encroachment on the system. Therefore, in education the well-designed engine could not only fortify the learning outcome, but extend bounds of an acquaintance and interests of the student, as well.

This engine is not exclusively designed for LMS to recommend literature to study and can be used in a wider area. E-learning, as it was mentioned, includes many fields which support different aspects of learning and science. In NEWTON the aim is to create a network of learning units, like labs, experimental rooms, tools, observation points and others. Recommendation engine could offer one of them to a student or a scientist based on their doctoral thesis, a field of research or a progress of the research. A scientist which does a research in some field needs to search for other solutions or state of the art. Recommendation engine could lead the scientist to get the newest knowledge and to build a base of scientist's solution on reviewed and proved attainments.

IV. CONCLUSIONS

The recommendation engine is smart feature helping to obtain a desired content for user. In commerce, it is usually used to offer an appropriate product. However, when we use this feature in education, it opens new options and possibilities. Rather than being just an advisor, there is a potential to become a supervisor.

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