Learning Resources Recommendations Taking into Account the Individual's Preferences in Learning Style

Yevheniya Savchenko-Syniakova[1,*,†], Kateryna Synytsya[1,†], Mykhailo Savchenko[2,†], Volodymyr Otenko[1,†] and Svitlana Zaritskaya[1,†]

1 Institute for Information Technologies and Systems of the NAS of Ukraine,
2 Aurora Geosciences Ltd., YN, Canada

Abstract

An approach to providing recommendations for the selection of learning resources for various learning purposes is proposed, taking into account preferences for learning styles, such as audio, text, etc. A framework for constructing a recommendation system is presented, which enables generating personalized recommendations for students, considering their accumulated learning experience. Incorporating such recommendations when choosing resources can make learning more comfortable, as it allows the selection of materials aligned with individual preferences in presentation.

Keywords

e-learning, lifelong learning, continuous learning, recommendation system, learning styles, recommendations.

1. Introduction

In modern society, lifelong learning has become a necessity for several reasons: globalization creates new opportunities to change workplaces; professional requirements increasingly demand fluency in information and communication technologies; and individuals need skills to learn from diverse sources. Digital resources are used for both professional and personal growth.

E-learning technologies support traditional education and also facilitate independent study for people of all ages, providing flexible access to learning content in various formats. They enable the selection of individual learning paths and schedules, as well as content that best matches learners' needs and expectations, which is especially important for adult learners. The promise of e-learning – to ensure just-in-time and just for you learning – has become a reality.

Lifelong learning is a crucial component of personal and professional growth today, as the Internet offers a wide range of content for e-learning. However, individuals who wish to learn often need advice or guidance in finding suitable resources, particularly by drawing on the experience of learners who have already completed these courses or used such materials. This kind of support can be provided by a recommendation system, which offers intelligent assistance for lifelong e-learning. The development of such a system is of scientific interest to the authors.

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* Corresponding author.
† These authors contributed equally.
savchenko_e@meta.ua (Ye. Savchenko-Syniakova); ksynytsya@irtc.org.ua (K. Synytsya); m_savchenko@meta.ua (M. Savchenko); auten@ukr.net (V. Otenko); lana_zar@i.ua (S. Zaritskaya)
0000-0003-4851-9664 (Ye. Savchenko-Syniakova); 0000-0002-7417-1748 (K. Synytsya); 0009-0009-1749-9550 (M. Savchenko); 0009-0002-6429-7715 (V. Otenko); 0009-0009-5014-5631 (S. Zaritskaya)

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The task of preparing learning recommendations is aimed at improving the process of acquiring knowledge and skills. It can help learners select resources that match both their learning style and their goals.

Therefore, the development of a recommendation system capable of automatically generating suggestions for choosing learning resources, while considering the preferred style of content presentation, is an urgent and relevant task.

The purpose of this paper is to propose a methodology for generating recommendations for selecting learning resources based on learning styles, with the aim of improving the overall comfort and effectiveness of learning.

The paper is structured as follows. The first section describes the task of digital learning and the problems that arise there. The second section describes the task of preparing recommendations for selecting educational resources. The third section outlines the methodology for generating such recommendations.

2. Modern Information Technologies in Education

The movement for open educational resources [1] facilitates the availability of electronic content, as well as its correction and adaptation in accordance with the CreativeCommon license [2]. Adaptation of educational resources to new conditions. The growing number of educational resources, especially those, and open educational resources, is a main factor in accounting for individual preferences.

The emergence of new technologies has led to the need for continuous updating of knowledge, acquisition of new skills, and improvement of qualifications [3]. Technologies have provided mass access to educational materials and content, making them convenient to use. The presentation of educational information in electronic form (text, audio, and video) has ensured its mass use. The development of computer-based learning technologies allows the replication of the educational process through access to educational courses for learning

Modern technologies allow the creation of multimedia and interactive content even by individuals without extensive training in this field. For example, teachers use YouTube to deliver lessons, while H5P enables the quick development of tests and other learning content [4]. Such content can be recombined and shared with others.

The application of recommender systems in education requires considering a wide range of variables, including students' knowledge levels, competencies, and learning styles. Most existing approaches in recommender systems rely on user-generated data, such as ratings, reviews, and feedback.

In [5], the deployment and experimental evaluation of collaborative filtering algorithms was carried out using three datasets of performance history collected from first-year students at a Chilean university. The experiments demonstrated that recommender systems can be a promising tool not only for predicting student performance but also for assisting learners in the educational process by recommending meaningful resources.

Study [6] introduces a teacher recommendation system that provides educators with the most relevant open educational resources, extracted from collections aligned with the UNESCO Information and Communication Technology – Teacher Competency Framework.

The authors of [7] argue that recommender systems are especially valuable in online and blended courses that employ competency-based assessment. These systems can leverage social knowledge about competency development and student performance. The recommender system developed by the authors considers experiences accumulated and ranked by former students. To generate recommendations that support successful learning, it compares the current level of a student's competencies with the past results of similar learners.

Finally, [8] describes the use of machine learning methods to assess the development of students' cognitive abilities.

So, today, when a large number of various courses for learning in various fields have been developed, which can be used both for independent learning and for specialized training, it is very difficult for a student to navigate in choosing an educational resource, even taking into account the purpose of his learning. Therefore, building technologies that could help him in this choice is an important and urgent task today. This study aims to develop a methodology for preparing recommendations for a student, taking into account a comfortable learning style.

Let's take a closer look at what educational resources exist today.

3. Learning Resources for the Learning

Educational resources can be presented in digital (electronic) and traditional formats, including electronic textbooks, interactive assignments, educational videos, and audio, presentations, educational and supportive software, including games and as well as books, reference books, and other materials used in the educational process.

The creation of standardized content for use in a variety of learning environments: face-to-face, blended, and/or virtual, is critical in today's education.

The learning object approach aims to facilitate the development of small units of content that can be combined and reused across courses, thereby taking advantage of the development of educational programs and materials.

According to the IEEE Educational Technology Standards Committee [9], the term "learning object" is defined as any entity, digital or non-digital, that can be used for teaching, learning, or training and that can be reused or reused in a technology-supported learning context.

A handy tool for creating learning resources is H5P [10]. It is an open-source content creation tool. This tool allows anyone to easily create, distribute, and reuse rich, interactive HTML5 content such as interactive videos, interactive presentations, quizzes, interactive timelines, and more.

Educational resources are a set of materials, tools, platforms, and services aimed at supporting and optimizing the learning process. This concept covers both traditional educational and methodological complexes and innovative digital solutions: from electronic textbooks to adaptive learning systems and virtual reality. The following gives a summary of all heading levels.

Choosing the optimal educational resource is a task that requires a systematic approach. With a huge variety of available platforms, it is easy to get lost or make a choice that does not correspond to real needs. The key to success is a clear formulation of educational goals and a critical analysis of the options offered.

4. Recommendation for Learning Resource Search

To select the appropriate educational resources from a large volume of offered ones, a recommendation that could guide the student in choosing educational resources would be very useful for the student.

Such a recommendation could be obtained using a recommendation system that, based on the collected information about the courses and the students who have completed them, would prepare recommendations for new students, taking into account the situation in which the student selects a resource for learning. This would allow the student's time to be used more efficiently in choosing a resource and selecting a resource that best suits the student's needs, which would improve the quality of the acquired skills or knowledge.

Such a recommendation system can be considered as an advisor that supports decision-making based on information about the student and their experience in a particular field of knowledge. Most educational recommendation systems use available information, such as descriptions of educational resources, student characteristics (age, gender, group, learning style, grades, etc.). Recommendations from such systems often assume similarities between students within a group, or similarities in the discipline being studied [11].

The quality of the recommendations that the recommendation system produces may depend on the information available about the students and their resources for learning. The more complete the information is, the more likely it is that the result will be most suitable for the student.

The situations in which a person who chooses a course for learning may find himself may be different. The authors conducted a study that showed that four types of situations can be distinguished in lifelong learning. For each of the situations, different methods and recommendations can be applied. Let us consider such situations in more detail.

For example, let's consider situations in which the need to select an educational resource arises. Situations in which students may find themselves when choosing a learning resource for a lifelong learning case were investigated [12]. Several lifelong learning situations related to the selection of the most appropriate learning resource were identified. These situations are linked to the purpose of learning.

The authors identified situations based on achieving the following goals:

- *for professional development*: the learner needs a proven learning outcome in a certain area, for example, in programming. In this case, the resource represents a course or program, activities, assignments, and assessments leading to confirmation of the learner's competence (diploma or certificate);
- f*or personal development*: the person needs to learn how to perform a task or solve a problem. Resource recommendations may include various types of resources for acquiring knowledge or skills, including microlearning videos;
- *satisfying one's own curiosity*: this may be simply a hobby, a need to clarify details, improve understanding of something, or simply a desire to keep up with modern technological advances. Various resources can be recommended here, from educational and entertaining to scientific research, passive presentations, interactive videos, games, and quizzes;
- *to consolidate existing skills or refresh knowledge*: this is a specific situation that has not yet been sufficiently studied. This is explained by the fact that, regardless of the subject area, acquired knowledge degrades over time and requires updating. It may also be necessary to work on the acquired skills.

You can also divide the learning process into superficial, when it is enough to repeat an exercise once or twice, or in-depth, when you need to return to repeating individual fragments or repeating exercises.

In addition, each student has preferences for the style of presentation of learning materials. We will consider this in more detail in the next section.

5. Application of Different Styles in Learning

Learning style is usually understood as the preferred way of accepting and processing new information.

There are several approaches to describing learning styles. Learning style is understood as a set of parameters that characterize the method of presenting and perceiving information, the method of awareness, and cognitive characteristics. Using a preferred style promotes effective assimilation. There are several models that systematize the characteristics of the learner that determine his or her learning style.

For example, such as Learning Styles VARK [13], which focuses on the information presentation to be consumed as visual, aural, or via text reading.

Other learning styles are also known, such as Kolb learning [14], Herrmann's brain dominance model [15], and the Felder-Silverman model [16–19].

The Felder-Silverman (FS) model describes learning preferences as a set of parameters across four dimensions that characterize the best way the new information is both perceived and

processed. The drawback of the classical FS model comparing to VARK is in separation between verbal and visual information without further detailization to text or audio presentation.

Other dimensions feature the learner's involvement in the process (active or reflective), and information processing (sequential vs global).

The learning styles FS model describes four measurement scales that determine students' learning preferences: active/reflective, sensory/intuitive, visual/verbal, and sequential/global.

This model helps teachers adapt teaching methods to different student styles, making the learning process more comfortable.

FS model scales:

1 scale. The learning process can be active or reflective, i.e. it is an action, not a reflection.

Active learners prefer to learn by actively participating in the process, for example, discussing, working in groups, conducting experiments. Reflective learners prefer to think about information, analyze it and reflect on it.

2 scale. Perception in the learning process is divided into sensory or intuitive, which can be understood as concrete and conceptual, as fact and theory.

Sensory learners prefer facts and concrete details, while intuitive learners prefer abstract concepts and connections between them.

3 scale. Information input is divided into visual or verbal. Images and diagrams are visual information, reading/writing is verbal.

Visual learners learn information better when presented in the form of images, diagrams and charts, while verbal learners prefer written and oral explanations.

4 scale. Understanding information can be sequential or global. That is, either a step-by-step, orderly understanding of the material or broad thinking.

Sequential learners prefer a logical and linear approach to learning, assimilating information step by step, while global learners prefer to see the big picture and then understand the details.

Each area can be understood as a separate approach to learning.

Understanding the learner's preferences in style helps adapting or collecting most suitable learning content and arranging the learning process.

In group learning and in creation of online courses the diversity of learning styles is usually addressed though it may lead to unnecessary duplication of information.

6. Application of the FS Model in Education

The FS model can be applied in such cases.

1. *To adapt learning materials:*

Teachers can use the model to develop learning materials that suit different learning styles. For example, more interactive activities can be added for active learners, and more hands-on examples can be added for sensory learners.

2. *Diversification of teaching methods:*

The model helps to vary the teaching methods to suit the needs of different learners. For example, lectures, group discussions, practical work, and independent study can be used.

3. *Increased student engagement:*

Recognizing and accommodating different learning styles can increase student engagement in the learning process, as they will feel that their needs are being taken into account.

The FS model provides a valuable tool for understanding and satisfying different learning styles, which contributes to a more comfortable and enjoyable learning process.

It is assumed that the learning style will not change throughout the learning content. However, informal discussion in the focus group revealed significant changes in the parameters depending on the learning situation.

The combination of the parameters (styles) of the FS model forms individual learning preferences.

Now it is turn to the methodology for obtaining recommendations using the learning style.

7. Construction of Recommendation System

Recently, personalization of information has become a key factor, as it allows the selection of information taking into account the interests of the user.

Continuous electronic learning is becoming increasingly popular, as it allows people of different ages to study in different conditions, both to obtain a diploma and simply to refresh their knowledge in some subjects. Taking into account the personal preferences of the student can make learning more comfortable, and there is a greater likelihood of completing the course.

To select suitable educational resources from a large volume of offered ones, a recommendation system would be very useful, which, based on the collected information about the courses and students who have completed them, would prepare recommendations for new students, taking into account the situation in which the student selects a resource for training. This would allow more efficient use of the student's time to select a resource and select a resource that best suits the student's needs, which would improve the quality of the skills or knowledge acquired.

The quality of recommendations issued by a recommendation system may depend on the available information about students and learning resources. The more complete the information is, the more likely it is that the result will be most suitable for the student.

8. Methodology for Preparing Recommendations

The task of preparing recommendations during training is aimed at improving the process of acquiring knowledge and skills. This can help the student select resources for training, considering the style and purpose of training. Therefore, the development of a recommendation system that would allow automatic preparation of recommendations for choosing a training resource for a specific user, taking into account the style of presentation of materials that is comfortable for him, is a relevant task.

In this study, we consider resources where the author of each of provides their characteristics. The metadata structure recommended by the standard [20] – descriptions of educational resources – is intended primarily for general characteristics (format, duration, language, etc.) Additional information on whether this resource is suitable for a certain style can be formed separately. Then this information characterizing this resource can be checked for compliance with the user's request (template). In addition, if any resource has been tested in a similar situation by a trusted partner with similar tastes, then his opinion must be taken into account.

Thus, the user receives a recommendation, the reason for which can be known and explained. It is related to a specific educational situation and, therefore, will help the user get what he would like with a greater probability.

This approach can be useful for solving the cold start problem. First, the resources already have an initial description that is reliable and not specific to the user. It is assumed that users provide information about their preferences specific to a particular situation, but this information (template) is independent of the resource. If a complete template is missing, the most important parameters can be requested separately and processed individually.

We will assume that the preliminary selection of resources has already been completed and the resources analyzed for compliance with the style have matched it (meaning the resource topic and language, and possibly the duration of study, price and other critical characteristics).

To generate recommendations, information is used both on the properties of the resource and on the preferences of users. Since the discussion of preferences within our small group showed that the characteristics of the style depend on the situation - the purpose of study, then we will link the corresponding user profile to the situation and request confirmation the next time the resource is requested for a recommendation.

We propose using individual learning style preferences specific to a particular situation. The methodology for preparing recommendations involves stages, the sequence of which is shown in Fig. 1.

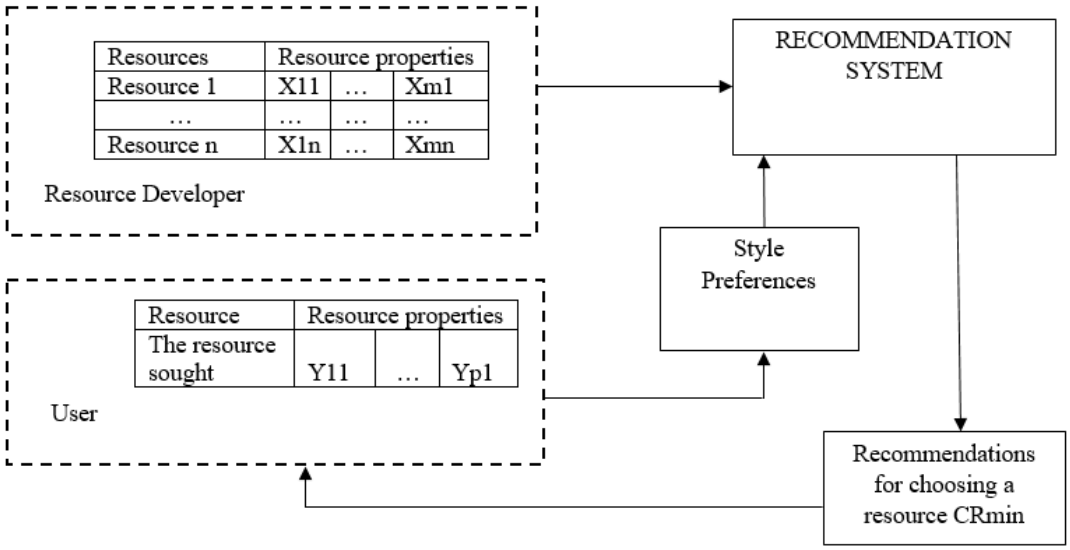

Figure 1: Sequence of preparation of recommendations for selection of a resource for learning

Fig. 1 shows the following main blocks.

Resource Developer block. Here, n resources are presented in the matrix, for which m of their characteristics are known.

User block. It is represented by a vector, where the user defines p properties that he would expect to see in the educational resource.

Style Preferences block. The user also defines his preferences for the style of presentation of the material.

The Recommender System block: based on the data on resources and the user's preferences for the styles of educational resources, prepares recommendations, ranking them according to the CRmin criterion.

Recommendations for choosing a resource CRmin block. Here, the final result is given in the form of three best recommendations, but the final choice of the resource remains with the user, who takes into account the recommendation, but makes the choice himself.

This allows for the individual learning style preferences of a particular user to be taken into account in a particular learning situation. This approach can make learning more comfortable and motivated for further development, since the selected learning process can be more enjoyable than others.

9. Example of preparing recommendations

Let's consider a small example of how recommendations differ depending on preferences.

Suppose we have information about 10 courses presented by a certain university.

Suppose that users who have completed some courses have chosen the following styles - recommendations:

- *Sveta* - Sequential, Reflective, Verbal (txt);
- *Kate* - Global, Visual, Reflective;
- *Olha* - Active, Visual, Sequential.

Comments about the courses of users who have already completed them can also be presented. These comments can be recommendations for new users who are choosing a course for themselves to study.

For example, Comments Kate: I liked the recommendation of the resource for repetition, because it briefly and clearly shows the use of prepositions.

A new user who forms his preferences about the learning style will be closer to one of the presented users who have already completed these courses. Then the recommendation system will prepare recommendations for the new student about three courses, recommended by one of the recommendations that is closer to the student in terms of learning style.

This technique will be discussed in more detail with examples in subsequent articles.

10. Discussion

This section discusses the key points of the article.

Although group learning, including distance learning, seeks to address the needs of learners with different styles whenever possible, it is assumed that the use of resources aligned with an individual's learning style reduces cognitive load and increases satisfaction with the learning process—an aspect particularly important in lifelong learning.

The choice of the FS model for describing learning styles is justified by the fact that it accounts not only for the form of information presentation but also for the ways in which learners engage with it.

During the study, the need to adapt the FS model was identified, specifically:

- clarifying the form of verbal information presentation (text or audio);
- considering the learning objective (situation) when searching for educational resources.

As the discussion indicates, both the choice of information presentation format and the preferred learning activities depend on the purpose of accessing a resource. The diversity of learning situations explains the use of scales to determine the values of individual style parameters. For example, the standard preference may be verbal (text), but for repetition, a combination of visual and audio modalities is more effective. Such an interpretation provides richer insights than relying solely on numerical values [21].

The methodology proposed by the authors allows, based on descriptions of a set of resources provided by developers, offering learners the three most suitable resources that match their preferred learning style.

Conclusions

This paper proposes an approach to providing recommendations for selecting educational resources for various learning objectives, taking into account students' learning style preferences. A framework for constructing a recommender system has been developed that enables the generation of personalized recommendations for students based on their accumulated learning experience. Incorporating such recommendations into resource selection can improve the learning experience by accommodating students' individual preferences.

Future research will focus on implementing the proposed recommendation system and testing it on specific use cases, providing tailored recommendations for various learning purposes.

Declaration on Generative AI

During the preparation of this work, the authors have not employed any Generative AI tools.

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