

# Designing an Algorithm for Automated Analysis of Completed Tasks in a Mobile Learning System

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**Abstract: Purpose:** this abstract discusses an urgent problem in the modern education system associated with the need to adapt to rapid changes in social spheres and the economy. The main purpose of the study is to develop an adaptive mobile learning environment for higher education institutions, with an emphasis on the use of electronic (mobile) learning and information and analytical support for the educational process.

**Methods:** to achieve this goal, an analysis of existing research and publications in the field of educational technologies and the effectiveness of e-learning was carried out. The objectives of adaptive mobile learning technologies are formulated, including the creation of a virtual learning environment and the development of effective methods of text processing in distance learning.

**Results:** in the course of the study, an algorithm for an adaptive mobile learning environment system based on an autonomous analysis of completed tasks using neural networks was proposed. To ensure the reliability of the system, it is proposed to implement a task analysis service as a background process. A scheme for transferring information from mobile applications to a background analytical service has been developed, taking into account the use of the RabbitMQ queue for organizing communication between services. An algorithm for detailed analysis of the text of completed assignments of students has also been developed.

**Conclusions:** the study highlights the need to adapt educational systems to modern challenges and the possibility of using adaptive mobile learning technologies. The developed algorithm and system provide an effective analysis of assignments and text responses of students, which makes them relevant in the context of modern information technologies and education.

Keywords: distance education, Internet technologies, neural networks, text information analysis, latent semantic analysis.

## 1. INTRODUCTION

The rapid process of development of various social spheres of activity and economic sectors that have unfolded in the world in recent decades necessitates the introduction of changes in the education system, the transition to a new level of requirements for the quality of training graduates of higher educational institutions. The development of information technologies in the XXI century has made the problem of modernization of the domestic education system urgent. The modern world of the educational space, including in Uzbekistan, is changing at an accelerated pace, especially in the context of the global spread of the COVID-19 pandemic and the need for higher education institutions to switch to online education.

Educational technologies are an integral part of the modern education system today. They play a key role in achieving two important goals: education and upbringing. With the help of modern educational technologies, curricula and programs are being introduced, the knowledge system becomes more accessible to students, and methods and tools are being used to create, collect, transmit, store and process information.

Over the years, vast experience has been accumulated in transferring knowledge from teacher to student, creating educational technologies and trainings, as well as building their models. However, the current reality requires us to

make rapid changes and decisions in the conditions associated with emergency challenges, such as the global situation in the healthcare sector, including Uzbekistan.

The current situation in the world, complicated by the spread of the COVID-19 pandemic, has led to a clear confirmation of the effectiveness of electronic (mobile) learning as a special form of organizing the educational process. This efficiency is achieved through the use of information and communication technologies that allow you to organize training not only in conditions of geographical distance between the student and the teacher, but also directly at the university. This is especially important for the formation of independent activity of a student when mastering educational programs in various specialties.

It is thanks to such characteristics as flexibility, mobility, convenience, equality and accessibility that students receiving vocational education can study at a convenient time and in a convenient place. E-learning and mobile learning are becoming key tools for providing education in a rapidly changing world.

Today, electronic (mobile) training has proven its ability to be as effective as traditional classroom training, provided that the methods and technologies used are in accordance with the tasks set. The main components of success in this area are the interaction between students and the availability of timely feedback between teachers and students.

Mobile learning is an approach to education in which mobile electronic devices are used to create a mobile educational environment. This environment allows students to have access to educational materials posted on the Internet, wherever they are and at any time. Compared to traditional methods of electronic and distance learning, mobile learning gives students a greater degree of freedom and interactivity. It offers a variety of technical tools, including ultra-mobile PCs, tablet PCs, portable laptops, PDAs, audio players, multimedia educational consoles, e-books, mobile phones, smartphones and other devices.

That is why designing an adaptive mobile learning environment is becoming an extremely urgent task for Uzbekistan higher education institutions. It allows you to adapt the educational process to modern challenges, providing students with flexibility and availability of educational resources.

The purpose of this study is to improve the efficiency of the educational process in higher education institutions. We strive to create a system of adaptive mobile learning environment using a complex of Internet technologies. This will help create an environment that combines learning materials, interactivity and flexibility, providing students with a quality education, regardless of place and time.

## **2. MATERIALS AND METHODS**

The methodological basis of the research consists of modern theoretical methods and systematic approaches to the design, construction of algorithms and their implementation in the creation of electronic educational resources.

The empirical basis of the research is the domestic and foreign experience in the development of information technologies in the field of educational resources.

### ***Literary review***

The information base is legislative and regulatory acts, monographic and periodical foreign publications. In recent years, many studies have been conducted and publications related to the development and use of information and analytical support tools for the educational process of higher education institutions. R. Gurevich, M. Kademia, L. Shevchenko [1] offer the latest methods of implementing information and communication technologies, their creative self-realization. At the same time, attention is paid to innovative forms and methods of teaching, the use of interactive technologies, the information educational environment, the organization of project training.

The problem of informatization of education has long attracted the attention of researchers and teachers. Among them are such outstanding scientists as V. Bykov, R. Gurevich, I. Zakharova, Y. Mashbits, N. Morse, E. Polat, S. Sysoeva, I. Robert and many others. These researchers were engaged in an important task-the transition from simple teaching of computer science to a broader informatization of education. They stressed that successful informatization is possible only if there is a unified educational information environment created by all participants in the educational process.

An important step in this direction is the use of innovative information and communication technologies in education. These technologies include a variety of tools, such as software and pedagogical tools for educational purposes, educational and information complexes, electronic textbooks, electronic educational and methodological complexes and virtual laboratory work in various subject areas, as well as multimedia technologies.

Many researchers, such as M. Zhaldak, I. Levin, V. Pinkas, I. Teplitsky and others, are actively engaged in the development of software and pedagogical tools using computer modeling. Their work indicates the need for widespread introduction of modeling and information technologies into the educational process, as well as the creation of appropriate software.

Today, the active use of adaptive learning in open education has become a key change in the education system. Classics of pedagogy, such as Y. Komensky and I. Pestalozzi, have long laid the foundations of adaptive learning. Modern research in this area is reflected in the works of B. Skinner, N. Crowder, P. Brusilovsky, J. Ferreira and others. Adaptive technologies are focused on personalized learning, which makes it possible to improve the programs and learning outcomes of students.

Some researchers, including Amelina V. and Semotyuk V., offer methods for solving emerging problems in the design and implementation of tool systems for the dynamic creation of training programs for mobile systems.

Consequently, the analysis of literary sources shows that the existing approaches to teaching in the higher education system require modernization in the light of rapidly changing modern conditions. In this regard, the development of an adaptive mobile learning environment that can help students learn on individual trajectories using Internet technologies becomes an urgent and urgent task.

### **3. RESULTS**

The goal of adaptive mobile learning technologies is to create a virtual educational environment that is as close as possible to the real one and contributes to the effective acquisition of knowledge by students. This system not only helps students fill in knowledge gaps, but also speeds up the learning process, making it mobile, interesting and relaxed [4].

Despite the widespread use of multimedia in education, text is still one of the main media. The development of effective methods of text processing in distance learning systems, such as filtering, the formation of semantic portraits and the assessment of the accuracy of answers, is becoming one of the most relevant areas of modern information technology.

Currently, there is a significant increase in the use of borrowed information in the learning process, which can lead to plagiarism. This includes collections of abstracts, finished laboratory papers, term papers and diploma projects. In addition, students can use the available information to answer test tasks without demonstrating individual assimilation of the material. Therefore, it becomes important to identify the unfair use of other people's works and materials in educational institutions, as well as an objective assessment of learning outcomes.

There are several software products for checking documents for unfair use of information on the Internet [5]. One of the solutions to this problem is the use of automated learning Management Systems (Learning Management System, LMS) [6]. In LMS, all students upload their laboratory, control and term papers, which allows you to create an archive database and use it by teachers to check for duplication of information.

The existing approaches to text analysis can be divided into two classes. The first class includes fast and language- and domain-independent methods of analysis, most often based on statistical methods. The second class is more precise methods that depend on the language and subject area and usually use linguistic methods. The ideal approach will combine the speed of algorithms of the first class and the high quality of methods of the second class.

One of the main algorithms for analyzing textual information is latent semantic analysis (LSA). The most common variant of LSA is based on the use of the decomposition of a materially significant matrix using a singular decomposition (SVD - Singular Value Decomposition) [7-9]. This method allows you to obtain semantic connections and relationships between words and texts, which makes it an effective tool for analyzing text data.

In the adaptive mobile learning environment system, it is proposed to use an algorithm for autonomous analysis of completed tasks. This analysis is performed based on a template and using an automated algorithm created using several text analyzers running on neural networks. Today, neural networks are considered the most progressive way to analyze large amounts of data because of their ability to learn from a variety of examples.

Trained neural networks are capable of solving problems in which there may be unknown patterns or dependencies between input and output data. They are also capable of operating in conditions where numerous uninformative or noisy input signals are present, without the need for their pre-filtering. Neural networks have adaptive abilities, which means that they can adapt to changes in the environment and can be retrained to work in different conditions.

To take full advantage of adaptability, the system must have parameters that are stable in the sense that they do not respond to minor external disturbances, and flexible in the sense that they can quickly respond to significant changes in the environment [10-11]. This allows the system to adapt to different situations and remain effective even in a changing environment.

In addition to high performance, neural networks have potential fault tolerance. This means that even under adverse conditions, such as damage to a neuron or its connections, their performance drops slightly. This is due to the fact that neural networks have distributed information storage, which makes them relatively resistant to damage. Thus, the decrease in the quality of the neural network is slow.

To ensure additional reliability of the task analysis system, it is proposed to implement it as a background service. This service will not have any external interface, and all tasks will arrive to it via the message bus, which will be implemented based on the RabbitMQ queue. A queue is a data structure with a first-in-first-out access discipline. This allows you to add items only to the end of the queue and extract them only from its beginning, while the selected item is removed from the queue [12]. Message queues provide many advantages and features that allow you to create complex and scalable solutions for processing structured and voluminous data.

Among the key features of message queues should be highlighted [13]:

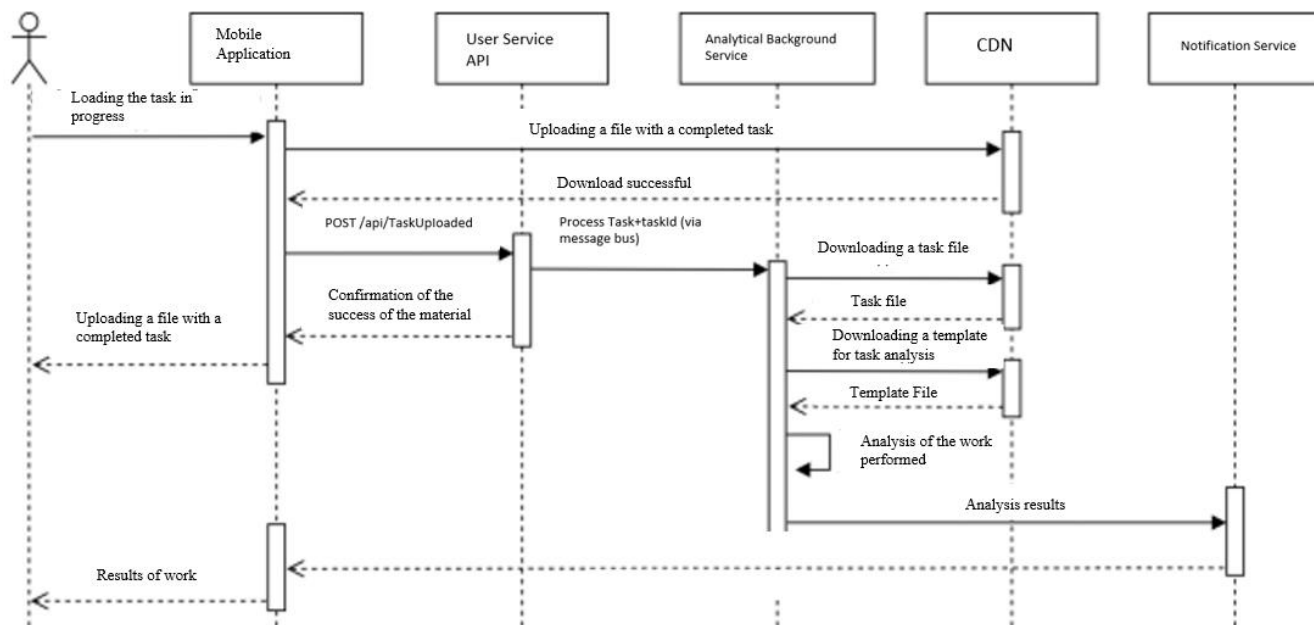
1. Weak binding: message queues create implicit data exchange interfaces, which allows processes to be independent of each other.
2. Redundancy: message queues allow you to avoid inefficient use of process resources by storing only the necessary information.
3. Scalability: message queues allow you to distribute information processing processes, which makes it easy to increase processing speed.
4. Elasticity and ability to withstand peak loads: message queues can act as a buffer for data accumulation in case of peak load.
5. Fault tolerance: message queues allow you to separate processing processes, and if one of the processes crashes, messages can be processed later.
6. Guaranteed Delivery: message queues ensure that the message is delivered and processed.
7. Guaranteed order of delivery: most message queuing systems are able to provide a guaranteed order of data processing.
8. Buffering: message queues allow you to send and receive messages with maximum efficiency.
9. Understanding data flows: message queues allow you to detect bottlenecks in program data flows and optimize the architecture.
10. Asynchronous communication: message queues provide the possibility of asynchronous data processing, which helps the system process messages when there are free resources.

The use of message queues, such as RabbitMQ, allows you to ensure the reliability and efficiency of the task analysis system in an adaptive mobile learning environment.

Taking into account all the advantages and features of using neural networks to analyze completed tasks and queues for organizing communication between services, a scheme was developed for transferring information from a mobile application to a background analytical service for processing text arrays of data, which we will call "Analytical background service". This procedure has an asynchronous nature of execution. This means that the result of information processing will not be delivered to the mobile application immediately after downloading the file with the answers. Instead, the result will be transmitted to the mobile app after a certain time using the message service. The asynchronous approach was chosen in order to ensure maximum stability of the system during load distribution.

Since the system can be used by many users at the same time, it is possible to download a large number of response files in parallel. As a result, using a synchronous approach to information processing can lead to a situation where the service stops responding to requests and the processed information may be lost.

The scheme of the algorithm for uploading files to the storage and subsequent analysis is shown in Figure 1.



**Figure 1.** Procedure for analyzing a file with a completed task

The system's background analytical service scales horizontally using monitoring of the number of available messages in the queue. This allows you to respond to changes in the load and optimize the use of computing resources. If too many messages accumulate in the queue for a certain time, the load balancer activates additional servers to speed up information processing. When the load decreases, the extra servers are shut down, which optimizes resource costs and reduces the cost of system maintenance.

The process of analyzing the work performed consists of two main parts. The beginning of the process includes a preliminary check, in which the validation of input data is carried out. This includes checking the data format, the correctness of the division into tasks, as well as a preliminary check for plagiarism both among Internet resources and among already uploaded works. In addition, a rough check is carried out for the presence of keywords in the text.

The next step is to check for compliance with the task. This stage is key, because at this stage the work performed is evaluated, and the student is assigned a grade, whether positive or negative. If the analysis reveals discrepancies with the template set by the teacher, the student is assigned additional tasks to consolidate the material. Additional points are also awarded for completing additional tasks.

#### 4. DISCUSSION

The algorithm for analyzing students' text responses is a sequence of three key steps that allow the system to effectively process and evaluate the texts provided [14]:

1. Parsing the text of the completed task: at the first stage, the system scans the text of the student's response, highlighting all sentences and phrases from this text. Next, phrases and keywords that are relevant for further analysis are extracted. This stage helps the system to create a data structure that will be carried over to the next step to filter the data.
2. Filtering the text of the completed task: at this stage, the system filters the text in order to remove redundant information, the so-called "water", which can be used by students to set the volume of work without adding semantic value. Filtering allows you to highlight the most significant phrases and sentences that correspond to a given topic. This stage also records information about the amount of "water" in the work, which will be used in the next stage to make an assessment decision.
3. Text analysis itself: at the third stage, text analysis is performed using the LSA algorithm (latent semantic analysis). At the beginning of the system's operation, the internal module does not have the ability to evaluate students' work objectively, since preliminary training is required for the effective operation of the algorithm. During the training process, the system studies the characteristics and features of correct and incorrect answers in order to further contribute to more accurate and objective assessments.

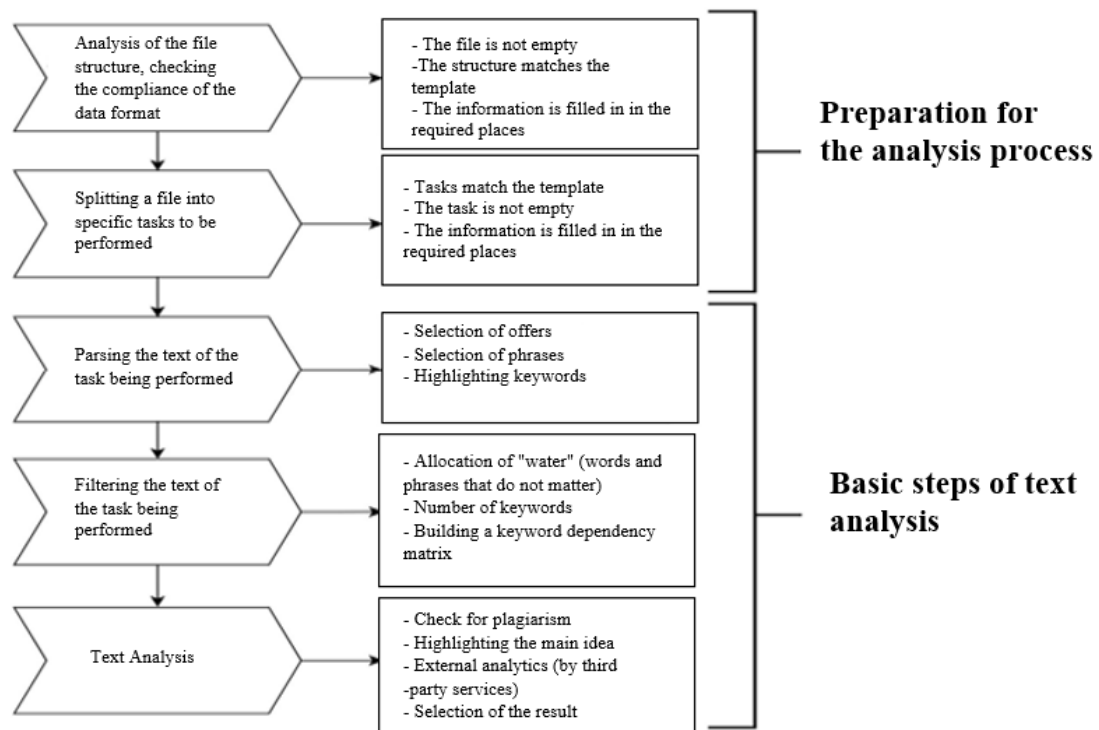
This algorithm allows the system to analyze and evaluate students' work, taking into account their content and compliance with the specified criteria, which ultimately provides more objective and fair assessments.

To teach an algorithm for evaluating students' work, large amounts of input data are required, as well as corresponding output results of a similar nature. By the time the system has collected enough input data, it will cooperate with services that provide similar functions. For example, it can be tools such as Oracle Inter-Media Text or IBM Intelligent text Miner. This cooperation will help the system to develop and learn from examples, which will allow achieving more accurate and reliable results in the future [15].

The final stage of the analysis of the completed works is the assignment of an assessment to students. The assessment is set by the teacher and depends on a number of parameters, such as the content, the presence of "water" in the text of the assignment, and the presence of keywords. Based on these criteria, the system makes decisions and sets points for work. Initially, the evaluation is carried out using conditional checks, but in the future the algorithm can be improved with the help of neural networks that will be able to make better decisions based on the accumulated data.

In addition, the teacher can ask additional tasks, assuming a decrease in points for the work. This method helps to correct students' grades and encourage them to a deeper and better understanding of the educational material in the course of independent work. For each additional assignment, a proprietary assessment system is developed that allows you to adapt the assessments to the specific requirements and educational needs of students.

A detailed illustration of the text analysis algorithm and its dependencies is shown in Figure 2. This algorithm provides an objective and reliable assessment of students' completed work and ensures their level of assimilation of educational material in independent work.



**Figure 2.** Detailed process of analyzing the text of the completed task

After the assessment is made and the additional task is determined (if necessary), a message is sent to the student by e-mail and to his mobile application, in which the result of his work is actually reported.

## 5. CONCLUSION

The developed algorithm is aimed at improving the efficiency of the educational process of students through automated analysis and evaluation of completed tasks, as well as the possibility of assigning additional practical tasks if necessary. This innovative approach is based on criteria and keywords, as well as pre-defined response patterns.

The practical implementation of this algorithm ensures reliable operation under high load conditions. This is achieved through the use of a data bus and the possibility of horizontal scaling. Thus, the system is able to automatically increase or decrease the number of servers processing information, depending on the current load.

The use of a neural network in an algorithm for analyzing textual information provides the prospect of its improvement through additional training of a neural network based on already collected and corrected data. This will allow the system to become more accurate and adaptive to various scenarios of analyzing students' assignments.

Further research may be aimed at improving the algorithm, including the introduction of additional checks using third-party systems, as well as better training of the neural network using reference data. These improvements will help to create a more accurate and reliable system for analyzing and evaluating students' work within the educational process.

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