

Implementing Deep Learning in Azerbaijani Education for Enhanced Learning Experiences

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Abstract

Numerous chances for individualized learning experiences arise from this, especially when it comes to customizing course material to suit the interests and learning styles of students. To evaluate and improve course delivery, instructors may now use analytics and reports from learning management systems, which offer quantitative data. However, it takes a lot of time and effort to manually analyze this data to find trends and improve the course contents regularly. By combining deep learning techniques with learning management systems, this procedure can be automated, enabling the creation of intelligent course materials with high accuracy and eliminating the need for manual intervention. To predict and improve learning outcomes at scale, a deep learning model is proposed in this research, with an analysis of the factors affecting the application of deep learning in Azerbaijani education. Adopting such a model might lower development and maintenance costs, lessen risks, and improve communication among the parties involved in Azerbaijan's educational system.

Keywords: Smart education, deep learning, LLM, LMS, learning analytics, reforming education strategy

1. Introduction

With the advent of *e-Learning* and *Learning Management Systems* (LMSs), traditional classrooms have become a self-sufficient means of dispensing information. This is a significant evolution in educational technology. *Artificial Intelligence* (AI), *Machine Learning* (ML), and *Deep Learning* (DL) are examples of digital technologies that have transformed computing methods by showing patterns and forecasting future events. For data scientists and analysts, AI-based gadgets, often called smart devices, are helpful because they ease and hasten data gathering, processing, and interpretation.

2. Methodologies

Digital technologies like AI, ML, and DL enhance education by simplifying instructional material generation and introducing innovative learning and collaboration methods (Palanivel Kuppasamy & Suresh Joseph, 2021)

Machine Learning (ML) applications enable systems to learn and improve from experience without being programmed automatically. They use algorithms to analyze data, produce outputs within acceptable ranges and are categorized into supervised, unsupervised, and reinforcement learning. ML has made operations in the education sector more accessible, faster, and more efficient than manual operations. It offers personalized learning, content

analytics, grading, and assistance to teachers. The recommended system is considered the most utilized modern-day system in the education sector (Palanivel Kuppusamy & Suresh Joseph, 2021).

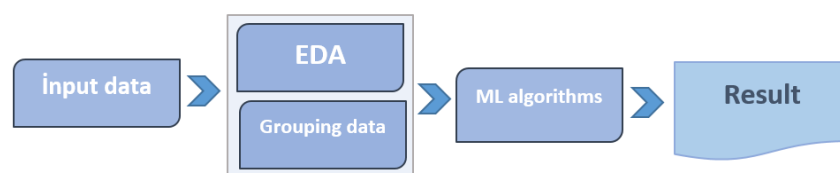


Fig 1. How ML works and get the result

Deep Learning (DL) is a learning technique that uses artificial neural networks (ANNs) to simulate human thought and learning. It maps inputs to outputs and discovers correlations, enabling neural networks to approximate unknown functions (Nesterenko, 2023). Classification, grouping, and regression are some examples of deep learning approaches. DL is a ground-breaking method for processing enormous amounts of data, with machine performance improving as more data is analyzed. It resulted in an explosion of data from various sources, including social media, search engines, and e-commerce platforms (Palanivel Kuppusamy & Suresh Joseph, 2021).

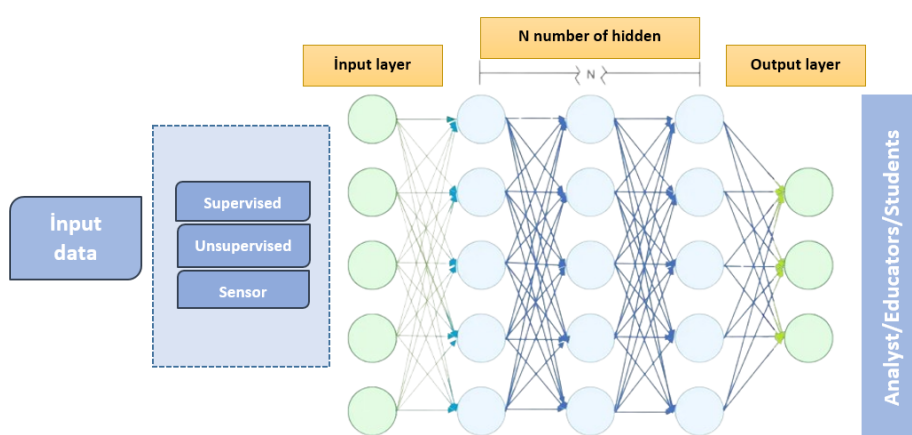


Fig 2. How deep learning works

The DL method consists of three layers: input, hidden, and output. The input layer processes raw data, the hidden layer adds extra information, and the output layer refines the machine's pattern at all layers of the neuron network.

3. Discussion:

SMART Education

Smart education (Nesterenko, 2023) is an innovative approach to teaching that uses innovative technology to improve learning results. It can take place in either virtual or actual contexts, or a combination of both. (Nguyen et al., 2024) Teachers use advanced tools like online virtual classrooms, cloud computing, and mobile devices to deliver engaging and comprehensive learning experiences. This unique method prepares students for a rapidly changing environment, encouraging instructors to adapt and incorporate the latest learning approaches into traditional classrooms (Palanivel Kuppusamy & Suresh Joseph, 2021). Educators acknowledge that knowledge transfer is not the sole responsibility of teachers in

educating students who actively seek, accumulate, critique, and construct knowledge for themselves. Smart-guiding educations' concepts are including: (Nesterenko, 2023)

- The use of current curricular materials is critical for resolving academic challenges, since global information flow and professional activities accelerate, demanding replenishment with current knowledge.
- Independent project, study, and cognitive activity of an organization.
- Smart-guiding education's concept underpins the implementation of the educational process in a dispersed learning environment, as well as the training of specialists to solve creative real-world challenges.

This approach is critical for implementing educational procedures in a distributed learning environment, and educating professionals to identify original solutions to real-world challenges. Smart education, encompassing concepts like smart pedagogy, smart environments, and smart learning, represents a recent trend in the ongoing shift from traditional teacher-centered methods to learner-centered approaches, utilizing adaptive and interactive technologies (European Commission, 2020).

UNESCO (2019) published the Beijing Consensus to support the Education 2030 Agenda, with seventeen OECD member nations developing digital education strategies between 2015 and 2019 (UNESCO, 2019; OECD, 2019). The European Union's *Digital Education Action Plan (2021-2027)* focuses on fostering a high-performing digital education ecosystem and enhancing digital skills for digital transformation (European Commission, 2020). The study also highlights two major subjects in the OECD's digital strategies in education: "Fostering the Development of a High-Performant Digital Education Ecosystem" and "Enhancing Digital Skills and Competencies for the Digital Transformation" (OECD, 2020; Van der Vlies, 2020).

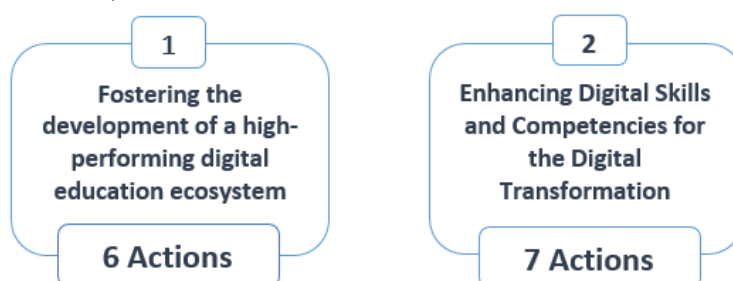


Fig 3. OECD digital strategy

Although Azerbaijan is not a member of the European Union, the Ministry of Education should look for ways to apply the European Union's (EU) *Digital Education Action Plan* in reshaping our educational goals. The EU's plan has been adopted for 2021-2027, and consists of a total of thirteen actions, each of which is detailed in the following explanation: (European Commission, 2020).

1. The priority focus is on developing a robust, digital education ecosystem across the EU, ensuring the development of reliable internet connectivity, access to devices, and digital learning platforms. It also focuses on building the educational institution's capacity to develop and implement digital learning strategies, including teacher training and strong organizational capabilities. The EU Digital Education Action Plan emphasizes the importance of high-quality, engaging, and inclusive learning content that caters to diverse learning styles and abilities.

2. The second priority of the United Nations' Digital Transformation Strategy (2019-2021) is to enhance digital skills and competencies for digital transformation. This includes ensuring citizens have foundational digital skills such as information literacy, communication, and problem-solving in a digital environment (United Nations, 2018).

After the dissolution of the Soviet Union in 1991, the Azerbaijani education system began its national education reform. In the comparative analysis of the years 2006-2022, the percentage of school attendance in Azerbaijan increased by 22%, in Armenia by 18%, in Georgia by 36%, and in Russia by 10%. During those years, the percentage of students enrolled in higher education (HE) from general education institutions increased by 112%. However, every 1% of admitted students drop out of HE before completing their studies (World Bank, 2018, p. 12). Higher education (HE) in Azerbaijan has had to adapt to global trends and changes in higher education institutions (HEIs), as well as address local and national challenges, such as limited funding, outdated infrastructure, and bureaucratic inefficiencies. Academic systems worldwide, whether in developed or less-developed nations, face distinct issues, including intense competition and social pressure. Notably, even in wealthier nations, disparities in resource distribution and access to education remain significant challenges. Therefore, striking a suitable balance between societal expectations, governmental regulation, and university autonomy was the primary goal of public policy (Suleymanov, 2020).

The primary challenge is determining how Azerbaijan can improve the quality assurance indicators of its Higher Education Institutions (HEIs) while maintaining strong quantitative indicators, such as enrollment rates, graduation rates, and research output. In the current era of education, which is increasingly shaped by global best practices, Azerbaijan should prioritize reforms in its education system by aligning with advanced frameworks such as Informatization 2.0 and the European Union's Digital Education Action Plan (European Commission, 2020). These frameworks emphasize the integration of digital technologies, innovative teaching methods, and quality assurance mechanisms to enhance educational outcomes and global competitiveness. The industrial revolutions, spanning from Industry 1.0 (circa 1750–1840) to Industry 5.0 (emerging in the 2020s), represent key periods of technological and societal transformation. Industry 1.0, beginning in the late 18th century in Britain, introduced mechanized production through water and steam power. Industry 2.0 (late 19th to early 20th century) brought mass production and assembly lines, powered by electricity. Industry 3.0 (mid-20th century) marked the advent of digitalization, automation, and computers. Industry 4.0 (early 21st century) expanded on this with smart technologies, the Internet of Things (IoT), and artificial intelligence. Finally, Industry 5.0 (emerging in the 2020s) emphasizes a human-centric approach, focusing on collaboration between humans and machines to enhance creativity, sustainability, and personalized solutions (European Commission, 2021; Xu, Xu, & Li, 2018). The COVID-19 pandemic has accelerated the trend toward online and hybrid learning, revealing innovative ways for students and educators to interact online. However, the uptake of digital technologies has revealed challenges and inequalities between those with access and those without, including those from disadvantaged backgrounds. These challenges relate to the digital capacities of education and training institutions, teacher training, and overall digital skills and competencies. The EU needs to support these systems to develop a long-term vision for European digital education. The EU needs to support these systems to develop a long-term vision for European digital education. However, since the EU's influence is primarily limited to its member states, collaboration with other key institutions—such as the

Council of Europe, the Organisation for Economic Co-operation and Development (OECD), and the Commonwealth of Independent States (CIS)—is essential to ensure a cohesive and inclusive approach to digital education across the broader European region (European Commission, 2020; OECD, 2019).

Smart Education key features

Smart education has 4 main branches: (Palanivel Kuppusamy & Suresh Joseph, 2021)

1. **Smart environment** refers to creating a physical and digital learning space that fosters engagement and supports personalized learning. Smart environment utilizes intelligent information, interactive boards, SLE, devices, LMS, apps, data centers, dashboards, and communication for smart collaboration among students, teachers, parents, administrators, and staff, enhancing educational processes and promoting innovative strategies.
2. **Smart Learning Analytics** involves collecting and analyzing data about student learning to personalize instruction and identify areas where students need help. Learning analytics (LA) and educational data mining seek to improve learning outcomes by supporting stakeholders in making decisions. One approach that shows promise for comprehending learner behavior is interaction analysis. To maximize learning and surroundings, SLA entails gathering, evaluating, and reporting data about students and their circumstances.
3. **Smart Education Model** refers to a framework for designing and delivering instruction that leverages technology to personalize learning. A smart education solution is a technology-driven strategy that improves teaching, learning, and administration by utilizing smart devices, e-resources, and technology. In addition to enabling the connection between home and postsecondary educational institutions, it has an education cloud platform that uses sensors to monitor classroom settings, including temperature, humidity, heart rate, and pictures.
4. **DL in Education** involves using artificial neural networks, a type of AI loosely inspired by the human brain, to personalize learning and create intelligent tutoring systems. Academic analytics provides teachers, students, and educators with information about academic behavior using statistical analysis, predictive modeling, and data from educational institutions. It can track learning, recommend changes, and optimize content modules. Through the improvement of thinking, memory, and cognitive skills, DL techniques help kids succeed academically and create a happy learning environment.

The question is whether the proposed learning model will be able to create artificial intelligence that can influence the behavior of student teachers, education managers, curriculum designers, and education policy developers. Currently, the priority approach in many technologically advanced education systems, such as those in the European Union, the United States, and East Asian countries like South Korea and Singapore, is Deep Learning for Smart Education. The DL model collects all information related to education under one cloud and passes it through its layers, and the resulting information will allow for management issues such as the quality of education of students, the training needs of teachers, the management of library resources, and the assessment of the quality of lessons. It will be the responsibility

of researchers, developers, and policymakers to organize and manage the controllable processes behind deep learning. However, they cannot directly interfere with the processes occurring in the closed, opaque layers, which function like a black box. The proposed deep learning model consists of input, hidden, and output layers, as shown in Fig 4. (Palanivel Kuppusamy & Suresh Joseph, 2021)

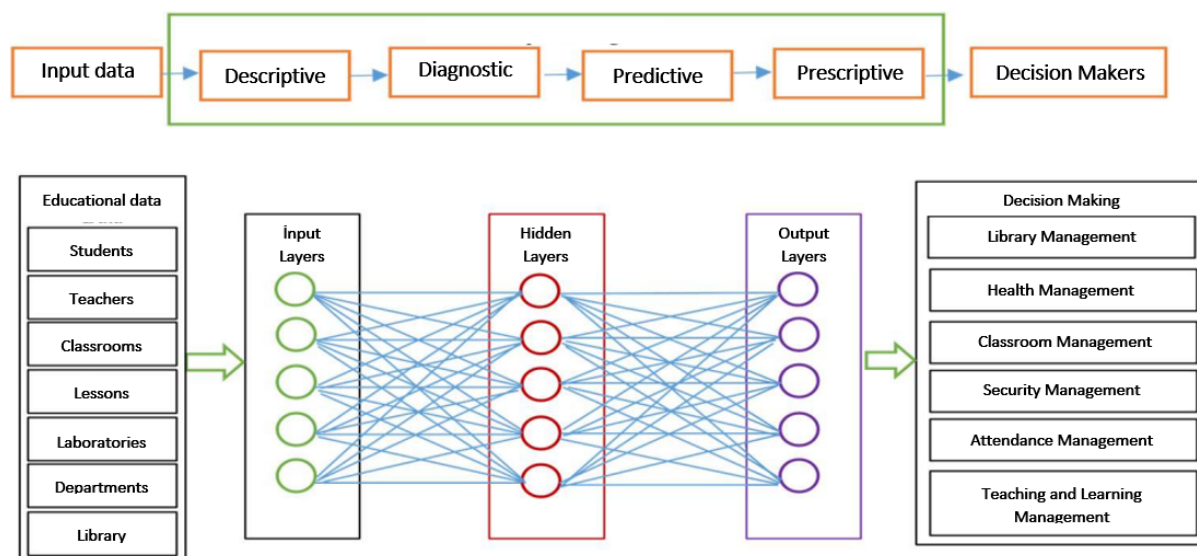


Fig 4. Proposed Deep Learning to Smart Education

The approach may be used for a range of educational tasks, including social network filtering, speech recognition, language translation, automatic academic processing, picture analysis, material inspection, and game development. Instructional messages and DL algorithms for training are part of the input layer. Data is gathered from a variety of sources, including libraries, sensor data, and more. The data is processed by a software engine, stored in a secure layer, and saved in a database system. For decision-making applications, the output is shown on a graphical user interface (GUI) or dashboard. (Palanivel Kuppusamy & Suresh Joseph, 2021)

Fig 4. depicts an architecture that processes input from various fields of learning as a biological brain structure (Scala et al., 2024, p. 30). Neural networks manage the acquired data of individual learners/learners from different aspects and provide relevant information for decision-making. For example, the student's grades, exam results, percentage of participation in classes, the knowledge the teacher imparts in those classes, the textbooks used, the student's feedback about that lesson, and the teacher will help the student make the right decision about himself ahead of time (Long, 2024). However, teachers can improve themselves by knowing what is missing from the feedback from the lessons. These examples can be extended, but we can see what effects deep learning can have in education.

To improve academic behavior, academic analytics makes use of statistical analysis, predictive modeling, and data from educational institutions. Through the development of learning analytics systems, content module optimization, and innovative test formats, data-driven learning (DL) approaches enhance understanding of data, learning, and behavioral patterns. Additionally, DL gives teachers personalized lesson plans that include ongoing feedback and observations from students. They facilitate the examination of the gaps in

teaching and learning and prepare the educational system to handle feedback from instructors and students, providing specialized instruction for various student populations.

4. Results

Difficulties with the DL Model in Education

Modern technology allows for better educational systems, but obstacles include adapting to diverse cultures, languages, and individual requirements, forecasting drop-out of students from courses, enhancing teacher training, and adopting individualized education programmes (Verdu Sanmartin & Niemi, 2024).

- **Data Availability:** Access to comprehensive educational data poses a significant challenge for institutions in Azerbaijan. Universities face a significant challenge due to the absence of centralized, real-time data systems for tracking student performance and institutional metrics, despite the State Statistical Committee's detailed educational statistics being fragmented across regions.
- **Infrastructure Costs:** For smaller educational institutions in Azerbaijan, the expenses related to setting up infrastructure can be a considerable burden.
- **Variety of Data Forms:** Educational data in Azerbaijan may be collected in various formats by different systems, necessitating efficient storage and processing solutions.
- **Instant Data Generation:** Sensors in Azerbaijan's educational environments may generate data in real-time, requiring adequate storage and processing capabilities.
- **Data Storage Challenges:** The volume of data generated by educational activities in Azerbaijan can be substantial, posing challenges for storage and management.
- **Heterogeneous Data:** A robust system in Azerbaijan should be capable of handling diverse data types effectively.
- **Data Mining Requirements:** Developing effective models for classification and prediction in Azerbaijan's education sector requires careful mining of relevant data.
- **Network Latencies:** Connectivity issues and network delays may arise during data transactions and communications in Azerbaijan's educational networks, particularly when dealing with large datasets.
- **Privacy Concerns:** Students in Azerbaijan may have privacy concerns and may prefer not to have their activities monitored.
- **Security Considerations:** When managing educational big data in Azerbaijan, ensuring robust security measures is crucial to safeguard sensitive information and build trust in the system.

5. Conclusion

With the ease and security of access to educational material currently, administrators and teachers can deliver high-quality instruction to students. Deep learning (Kappusamy & Suresh, 2021) and other technologies are essential to the sustainability of higher education. With the ability to forecast outcomes with precision, sensitivity, and specificity, these algorithms build intelligent learning environments. Teachers and parents can react properly with the aid of predictive analytics. The architecture that has been given may make it easier to create use cases for smart learning environments that support students and help them with their weaker topics. It could be difficult to argue for deep learning's hidden logic in transparent domains, as the

interpretability of such systems remains a significant challenge (Marcus, 2018). Nevertheless, ongoing research into explainable AI (XAI) may provide pathways to bridge this gap in the future.

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