Academic Paper

Universal Design Concept with Machine Learning for Developing Special Education

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Abstract

Universal Design for Learning (UDL) is an approach that creates learning environments that respond to the diverse needs of learners. This particularly includes students with special needs. In the digital age, technology and Machine Learning (ML) are used to help design and improve teaching and learning to make education efficient and appropriate. Machine learning-based systems can support universal instructional design for special education teachers in using data and algorithms to analyze and recommend appropriate teaching methods to suit individual students. This paper shows how machine learning can serve as a prototype system for special education teachers to analyze data and implement it in a real teaching environment. Its accessibility systems can help teachers design effective instruction based on information obtained from students with special needs. It is expected that the developed prototype of machine learning can help create educational equity in serving learners in special education for the betterment for all citizens.

Keywords: Universal design for learning, machine learning, special education

1. Introduction

Digital education is a foundation for human resource development, which takes into account the diversity and specific needs of all learners, especially students with special educational needs (SEN) who need additional support to fully access learning. Universal Design for Learning (UDL) focuses on creating a learning environment that can meet the diverse needs of learners comprehensively (Piticari, 2023). Digital education management, including new technologies and innovations for Machine Learning (ML), has played an important role in changing teaching methods. ML can help analyze learner data and suggest teaching methods that are appropriate for each learner, making teaching more effective and appropriate (Hilbert et al., 2021).

The focus of machine learning is to explore and present its use in universal instructional design for professional development of special education teachers. The main purpose is to enhance teachers' abilities to create learning environments that respond to individual students with special needs by using data and algorithms to analyze and suggest appropriate teaching methods. Teachers can adjust their teaching to the needs and problems in students with special

needs. It is therefore important for teachers to begin with a prototype system that uses machines to learn and test it in a real teaching environment (Molnar, 2021).

In providing special education for those learners in need, it is important for users or teachers to pay attention to (i) the classroom that creates intelligent and interactive learning environments, with cautions toward users' security and privacy (Santhuenkaew, 2024); (ii) analytical thinking for systematic step-by-step problem solving skills required in real life situations (Santhuenkaew, 2023); (iii) a variety of major digital tools that integrate computer assisted instruction, electronic books, video conference, and online learning, as seen appropriate (Santhuenkaew et al., 2024); (iv) personalization in learning experience and engagement via various tasks that can generate predictive insights as well (Rerkpichai & Santhuenkaew, 2024); and (v) the importance of communication and collaboration, particularly via a new messages design tools for communication (Santhuenkaew & Athikiat, 2025).

2. Universal Design for Learning

Universal Design for Learning (UDL) is a framework for designing instruction that provides equal access to learning for all, regardless of the diversity of learners in abilities, learning levels, or cultural backgrounds. Such a framework emphasizes flexibility and adaptability of instruction to meet the needs of each learner. UDL can be applied to all levels of education, from primary to higher education, to create an open and equitable learning environment for all (Thongphanit, 2024).

Key Principles of Universal Instructional Design
The key principles of universal instructional design are as follows:
(1) Multiple Means of Engagement
   (i) Stimulate learners' interest and motivation to learn.
   (ii) Create a learning environment that allows learners to fully participate.
   (iii) Adjust assessment methods to meet the needs of diverse learners.
(2) Multiple Means of Digital Tool
   (i) Present teaching content in a variety of media formats, such as text, audio, images, or videos.
   (ii) Present content that is not complicated and easy to understand.
   (iii) Give learners options to receive information in a way that is appropriate for them.
(3) Multiple Means of Action and Expression
   (i) Give learners opportunities to demonstrate their knowledge and skills in a variety
      of formats, such as writing, speaking, or using technology.
   (ii) Help learners develop creative problem-solving and management skills.
   (iii) Support the use of different learning tools and resources according to learners' needs.

3. Machine Learning

Machine Learning (ML) is a branch of Artificial Intelligence (AI) that focuses on developing algorithms and statistical models that allow computers to "learn" from data without having to be explicitly programmed to perform a particular task. This means that computers can improve their performance in certain tasks by analyzing existing data and generating new knowledge from it (Mandala Team, 2023).

The Working Principle of Machine Learning

The working principle of machine learning can be seen in several steps as follows:
(1) Data Collection. A large amount of diverse and diverse data is collected to be used to train the algorithm. This data can come from various sources, such as online databases, sensors, images, text, and others.
(2) Data Preparation. The collected data may need to be examined, filtered, and transformed into a form suitable for use in training the algorithm.
(3) Model Selection and Training. This step involves selecting the appropriate algorithm for the task to be performed and using the prepared data to train the algorithm. The machine analyzes the data and improves it to increase its efficiency in predicting or classifying the data.
(4) Testing and Optimization. The trained model is tested on a new set of data that has never been used for training before to assess its efficiency and accuracy. The model is then improved if necessary.
(5) Deployment. Once the model has achieved adequate efficiency and accuracy, it is put to use in real-world applications, such as analyzing text on social media, classifying images, or assisting with special education in the form of mixed media or multimedia.

Types of Machine Learning

Machine learning can be divided into several types based on the learning method and main applications (Molnar, 2021), as follows:
(1) Supervised Learning. The model is trained with labeled data, such as predicting house prices from historical price data.
(2) Unsupervised Learning. The model is trained with unlabeled data, such as segmenting customers based on their purchasing behavior.
(3) Reinforcement Learning. The model learns through experimentation and improves its actions based on the feedback received, such as training a robot to walk.

Therefore, machine learning is a potential tool to improve the efficiency of processes in many fields, including medicine, finance, education, and marketing.

4. Principles of Special Education Development

Special education plays an important role in supporting the learning and development of students with specific needs. In order to have equal and full access to education, the development of special education teachers is the core of creating an appropriate learning environment for such students. This paper discusses the key principles in the development of special education teachers, which include appropriate

education and *training*, strengthening *communication* skills and the use of technology, promoting *collaboration*, and providing *emotional and professional support* (Ketmak et al., 2022). Details are as follows:

(1) Appropriate Education and Training

The development of special education teachers must begin with providing the basic knowledge and skills necessary to teach students with special needs, including understanding the characteristics and specific needs of each group of students, such as students with learning disabilities, students with communication disabilities, and students with physical disabilities. In addition, continuous training and further education to develop new knowledge and modern teaching methods are also important so that teachers can adapt and apply new methods to teaching effectively.

(2) Strengthening Communication Skills and the Use of Technology

Special education teachers need to have good communication skills in order to communicate effectively with students with special needs, including using clear language and using appropriate teaching aids. In addition, the use of technology in teaching can help increase efficiency and interest in learning, such as the use of learning software that is adapted to individual students' abilities as their technological tools to communicate.

(3) Promoting Collaboration

Collaboration between teachers, parents and other professionals is important for developing the learning of students with special needs. Special education teachers should have teamwork skills and network with various stakeholders to exchange information and teaching experiences. Collaboration also helps to develop lesson plans that are appropriate for each student.

(4) Emotional and Professional Support

Special education teachers face high challenges and stress in teaching students with special needs. Therefore, emotional and professional support is very important. Having an emotional support system, such as counseling and support from administrators, can help reduce stress and increase confidence in working. In addition, professional support through continuous training and knowledge development can help teachers have up-to-date skills and knowledge in teaching.

Therefore, the development of special education teachers is a process that requires effort and support from many parties. The goal is for teachers to create appropriate and effective learning environments for students with special needs. The main principles in the development of special education teachers include appropriate education and training, strengthening communication skills and the use of technology, promoting collaboration, and emotional and professional support. Applying these principles will help increase teaching efficiency and develop the quality of education for students with special needs.

5. Benefits of Using Machine Learning in the Development of Special Education

The use of a machine learning prototype in special education for teachers' development can yield the following benefits:

(1) Analyzing Learner Data: Machine learning can quickly and accurately analyze learner data, such as learning behavior, learning outcomes, and special needs, which allows teachers to design a teaching prototype that meets the needs of individual learners.

(2) Improving Teaching Content and Methods: By using ML, teachers can continuously test and improve teaching content and methods to make them suitable for each group of learners, which can be adjusted based on the data obtained from the analysis.

(3) Creating Learning Media Responsive to Learners: Using ML to create learning media that is adaptable and responsive to learners' behaviors and needs, such as creating exercises with different levels of difficulty or presenting different content according to the age range and aptitude of the learner.

(4) Supporting Teacher Professional Development: ML can help teachers' training and develop new skills that respond to changes in teaching and learning conditions by presenting training content pertinent to the problems that teachers have encountered.

Cautions

Cautions in the use of ML include the following:

(1) Data Privacy and Security: The use of ML requires the collection and analysis of student data, which requires attention to privacy and data security.

(2) Integration of Technology into Education Systems: The introduction of ML into education systems may require changes in infrastructure and operating methods, which can be challenging to adapt to.

(3) Development of Teacher Skills and Knowledge: Teachers need to have the knowledge and skills to use new technologies, which may require additional training and support.

Considerations for machine learning technology in developing special education are summarized in Table 1 as shown below.

Table 1: Machine Learning Technology in Developing Special Education

Technology/Tools	Strengths	Limitations	Application in Special Education
Supervised Machine Learning	- Able to learn from labeled data - High accuracy when there is enough data	- Requires a large amount of labeled data - Modeling takes a long time	Used to screen students with learning problems.
Unsupervised Machine Learning	- No need for labeled data - New patterns can be discovered	- May not be as accurate as expected - Results may be difficult to interpret	Used in analyzing student groups
Deep Learning	- High data processing efficiency in large data sets - Used in image and audio processing	- Requires high computing resources	Used to develop software to assist in intelligent teaching.

Technology/Tools	Strengths	Limitations	Application in Special Education
Natural Language Processing (NLP)	- Able to understand and create natural language - Used in chatbots to help students	- Need quality information - Sometimes there may be misunderstandings in the use of language in communication	Used to answer questions and introduce learning content.
Reinforcement Learning	- Can improve performance through trial and error - Used in contextually changing environments	- Training takes a long time - High complexity	Used to create a learning system that adapts to students.

6. Conclusion and Recommendation

As reported in Sections 4-5 and demonstrated in Table 1, this paper emphasizes Universal Design for Learning (UDL) as a concept that focuses on creating inclusive and flexible learning that responds to the diverse needs of learners, especially those with special needs. In particular, Machine Learning (ML) can be used to increase efficiency and adaptability to learners' unique characteristics and varied learning modes. Evidently, the use of machine learning in universal design of learning can increase the efficiency and flexibility of teaching, especially in the development of special education teachers in helping learners with special needs to access appropriate education and reach their full learning potential. It should be noted that the challenges and risks that may occur must be carefully managed to maximize the use of machine learning technology for the betterment of educational provision in terms of safety and equity for learners in special education.

7. The Author

Thanarak Santhuenkaew is a staff member of the Faculty of Education, Ramkhamhaeng University, Bangkok, Thailand. His research interest lies in the areas of digital technology in communication arts and educational management, communication message design, and current issues in digital technology innovation and management.

8. References

Hilbert, S. et al. (2021). Machine learning for the educational sciences. *British Educational Research Association Journal, 9*(3), 53-65. (Online). https://doi.org/10.1002/rev3.3310, June 21, 2024.

Ketmak, P. et al. (2022). Development of special education teachers in the process of providing transition services to students with special needs, Surat Thani Special Education Center. *Journal of Special Education Research and Development*, *11*(1), 153-165.

Mandala Team. (2023). Machine learning what is it? Why is it important? (Online). https://blog.mandalasystem.com/th/machine-learning, June 21, 2024.

Molnar, C. (2021). Interpretable Machine Learning. (Online). https://srakrn.github.io/interpretable-ml-book-th/, June 21, 2024.

Piticari, P. (2023). Effects of the Universal Design for Learning (UDL) principles on the motivation of children with SEN integrated in mainstream schools. *Journal Revista de Psihopedagogie,* (1), 154-168. (Online). https://www.ceeol.com/search/article-detail?id=1230488, June 21, 2024.

Rerkpichai, C. & Santhuenkaew, T. (2024). Artificial intelligence for marketing. *RICE Journal of Creative Entrepreneurship and Management, 5*(1), 65-73. doi 10.14456/rjcm.2024.5

Santhuenkaew, T. (2023). Guidelines for organizing computer science courses at the elementary level. *RICE Journal of Creative Entrepreneurship and Management, 4*(2), 78-88. doi 10.14456rjcm.2023.12

Santhuenkaew, T. (2024). Internet of Things (IoT) for a creative intelligent interactive classroom. *RICE Journal of Creative Entrepreneurship and Management, 5*(3), 72-78. doi 10.14456/rjcm.2024.18

Santhuenkaew, T. & Athikiat, K. (2025). A New Messages Design for Communication in the Digital Age. *RICE Journal of Creative Entrepreneurship and Management, 6*(2), 93-101. doi 10.14456/rjcm.2025.12

Santhuenkaew, T., Jaikaew, S. & Athikiat, K. (2024). Information technology for school guidance. *RICE Journal of Creative Entrepreneurship and Management, 5*(1), 74-82. doi 10.14456/rjcm.2024.6

Thongphanit, P. (2024). Universal Design for Instruction. (Online). https://panpongpat.blogspot.com/p/4-universal-design-for-instruction-u.html, June 21, 2024.