Machine Learning and Higher Education

Hasti Samadi

University of Melbourne

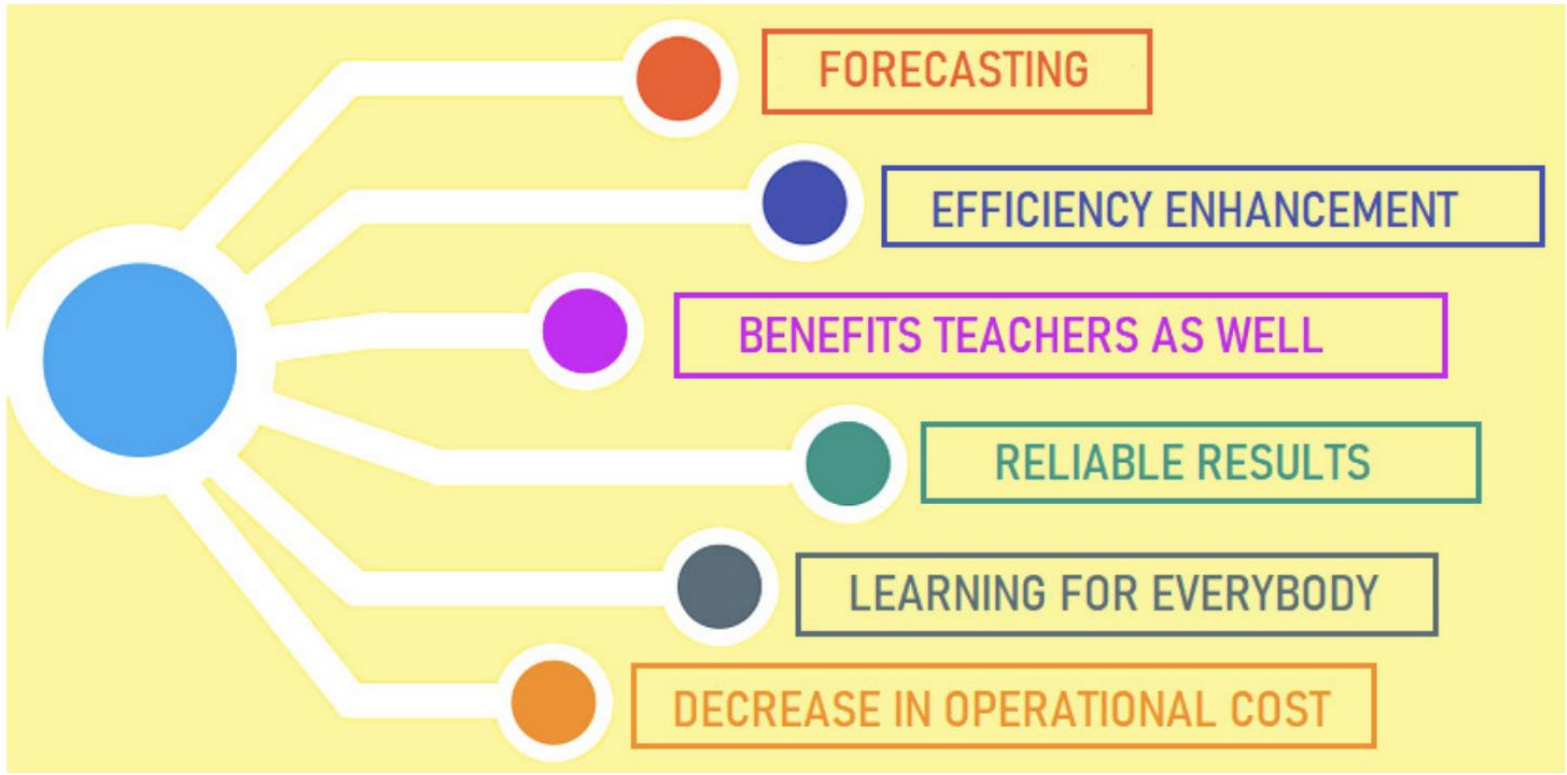
Machine Learning in Future World

- Machine Learning is learning by example

Machine Learning in Higher Education

- What are our examples?
  - Historical data
    - Educational Material
    - Students' results
    - Assessments
    - Students (demographical information)
- What can we learn from them?

Machine Learning in Higher Education (what we can learn)



Proceedings of the Fifth International Conference on Computing Methodologies and Communication (ICCMC 2021)

Using ML in Higher Education (Use Cases)

- Exam and Material generation
- Personalized Learning
- Academic Misconduct Analysis
- Crowd work Assessments

Using ML in Exam and Material Generation

- Identify similarities, redundancies, inconsistencies → Content Cohesiveness
- Identify the deficiencies of the students → Adapt the Content
- Automatic Multiple Choice Question Generation from Text → 2022 Research

Exam and Material Generation (Cont.)

- What are the steps:
  - A Platform to store and process available material
    - LMS (Learning Management Systems)
      - E.g., Canvas, Blackboard, Navid, …
    - Specific Forums
      - E.g., Slack, Github, Kaggle, Play Pen, …
  - NLP (Natural Language Processing) tools for embedding the instances (e.g., BERT, Word2Vec, GloVe,…)
  - Machine Learning Models to connect the dots (Deep Learning)

Exam and Material Generation (Cont.)

- What are the steps:
  - A Platform to store and process available material
    - LMS (Learning Management Systems)
      - E.g., Canvas, Blackboard, Navid, …
    - Specific Forums
      - E.g., Slack, Github, Kaggle, Play Pen, …
  - NLP (Natural Language Processing) tools for embedding the instances (e.g., BERT, Word2Vec, GloVe,…)
  - Machine Learning Models to connect the dots (Deep Learning)

Storing the historical data

- LMS (Learning Management System)
  - Creation, management, and delivery of courses and other eLearning material, and a data repository for key information
  - Communication between instructor and learner (e.g., announcements, forums, …)
  - Assessments tools (delivery and evaluation)
  - Reporting and Analysis
  - Content and Questions repository

Processing the data

- Natural Language Processing Tools and Techniques
  - Giving computers the ability to understand text and spoken words
  - Combination of computational linguistics (rule-based modeling of human language) with statistical, machine learning, and deep learning models
  - Examples:
    - Chatbots (e.g., Siri, Google Assistant, Alexa, …)
    - Auto translation (e.g., Google translate, …)
    - Sentiment analysis (e.g., Reviews, tweets, comments, …)

Processing the data (Cont.)

- Natural Language Embedding
  - Converting a statement to a vector

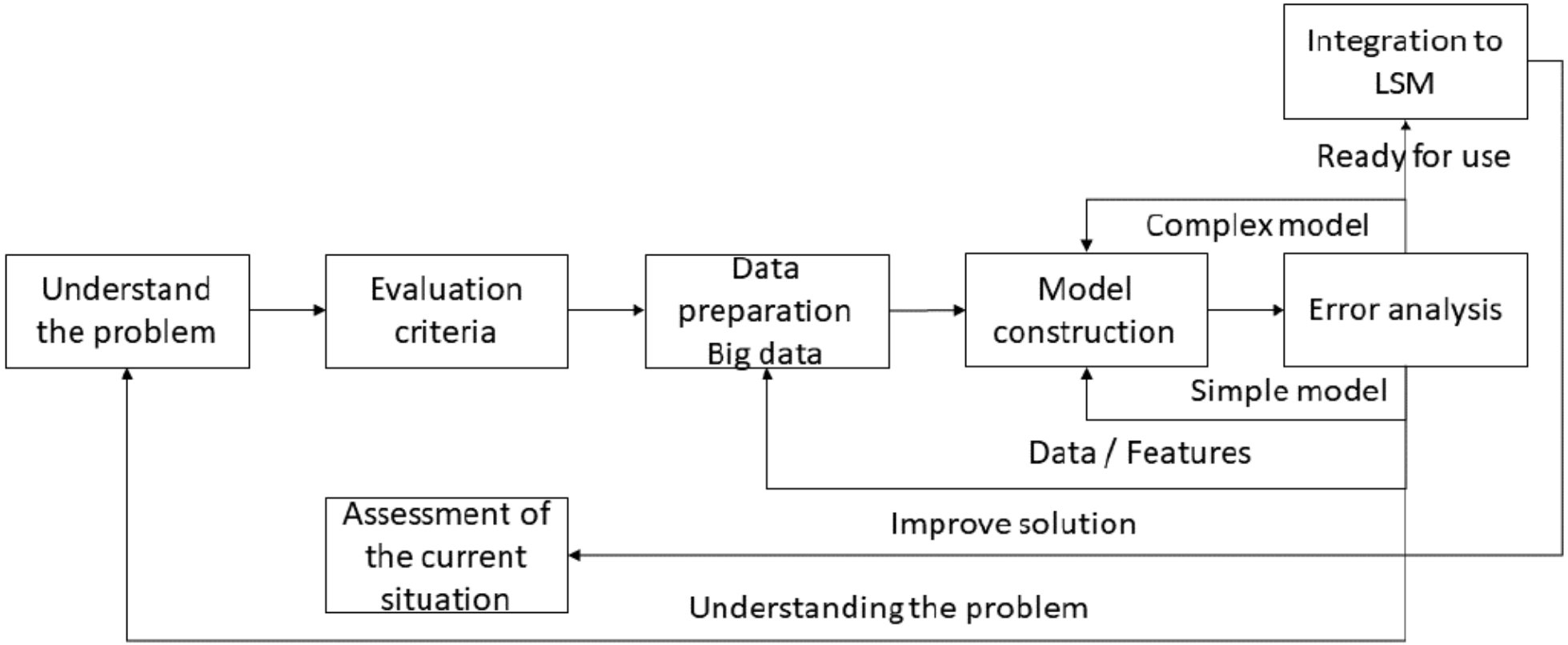
    “I am grout.” → [0.6474391, -0.16008961, -0.0384805, -0.055743, ...]
  - Analyse instead of extract
    - “Knowledge is power”
    - “The more you know, the more power you have”
    - “Knowing more increase your power”

Processing the data (Cont.)

- Natural Language Embedding
  - Converting a statement to a vector

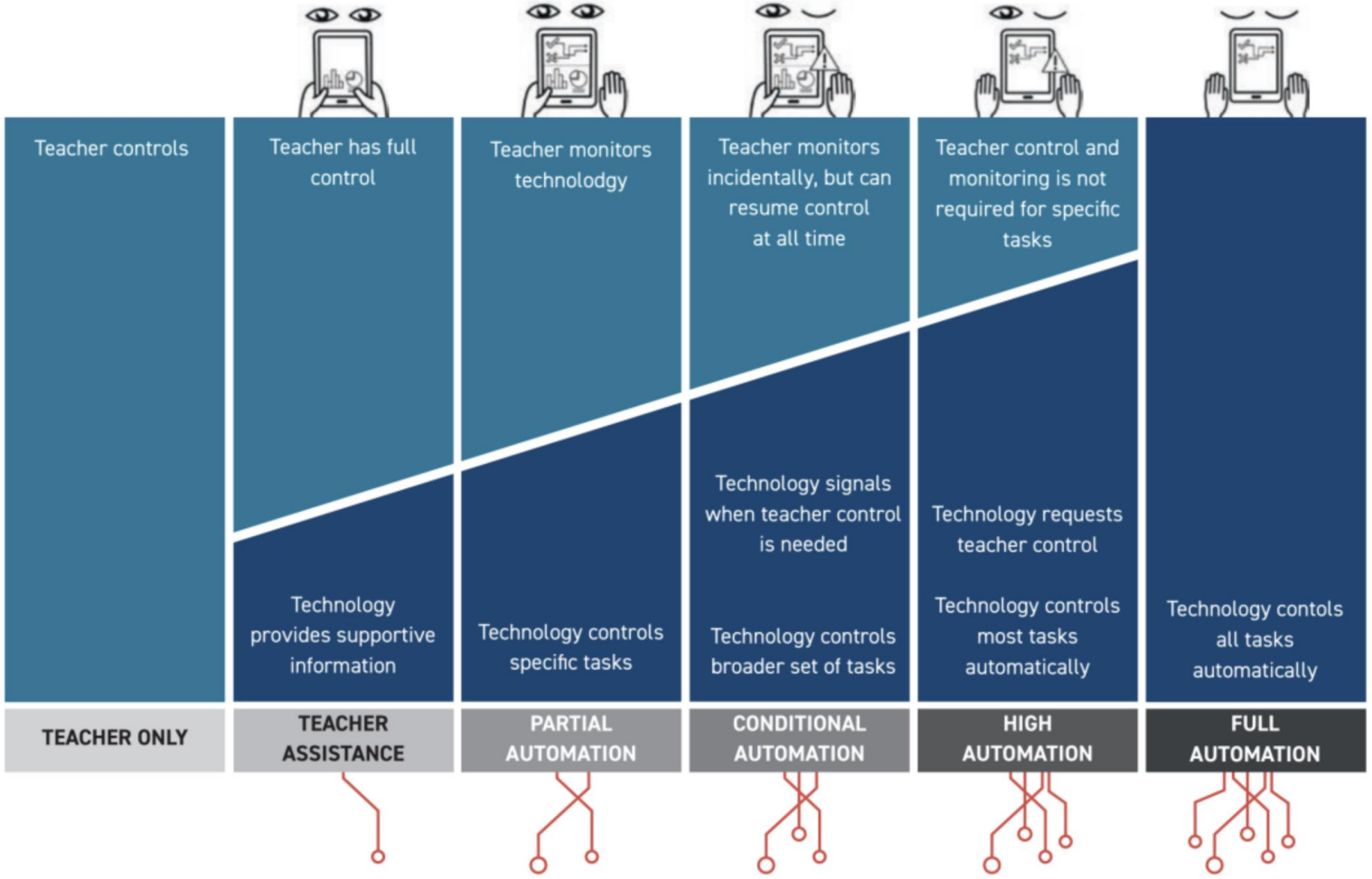
    “I am grout.” → [0.6474391, -0.16008961, -0.0384805, -0.055743, ...]
  - Analyse instead of extract
    - “**Knowledge** is power”
    - “The more you **know**, the more power you have”
    - “**Knowing** more increase your power”

Building the model



Personalized (Adaptive) Learning

- Hybrid Human-AI learning technologies to adjust to the needs of individual learner



levels of automation of personalised learning – level 1

- Teacher dashboards that provide teachers with concurrent information about students' activities, progress and performance
  - which students need additional feedback or extended instruction
  - what instruction is appropriate in the next lesson

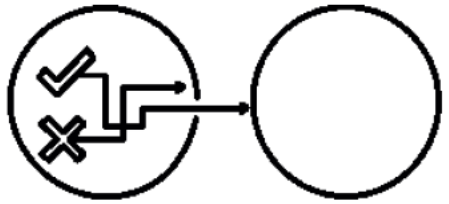
levels of automation of personalised learning – level 2

- teachers control most organisational tasks in the learning environment with a few exceptions where the technology takes over control
- The system (LMS) selects problems adjusted to the needs of individual students or provides feedback on a student's solution of a maths problem

levels of automation of personalised learning – level 3

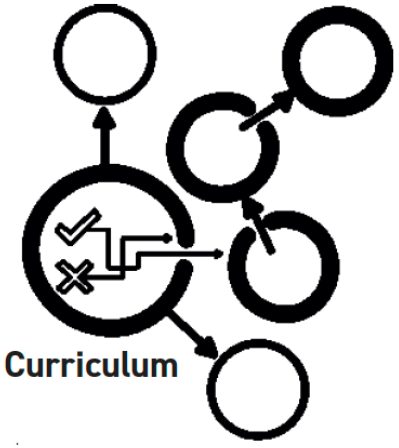
- technology takes control over a broader set of tasks in organising the learning environment.
- Teachers continue to hold a central position in organising the learning environment and they monitor how the technologies function.
- technology recognises under what conditions it functions effectively and when teachers need to resume control.
- For example, when a student is not progressing at the anticipated speed, the technology notifies the teacher to step in

Adjusting problems and feed backs



Task

Step



Curriculum

- **Task Level:** Based on a student's answers, technologies determine when a learner knows a certain topic well enough to proceed to the next topic.
- **Step level:** system can not only detect students' current knowledge level, but can also analyse the type of errors students make (Intelligent Tutor Systems)
- **Curriculum level:** The order in which a student works on different topics (learning pathway).
  - Modelling the forgetting curve for each student

Personalized (Adaptive) Learning

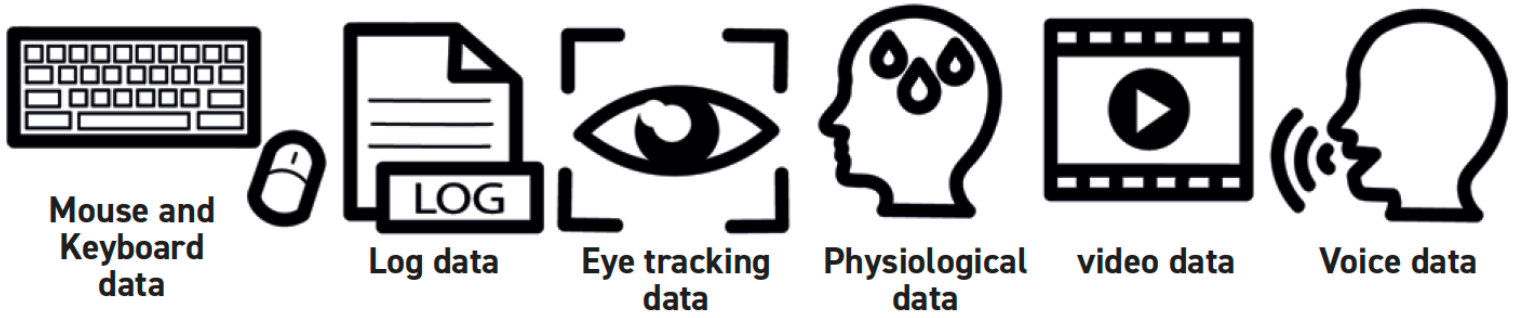
- For student with special needs
  - English as a second language
  - Physical (sight or hearing) disabilities
  - Learning difficulties (Dyslexia, ADHD, …)

Academic Misconduct Analysis

- Growth of academic integrity concerns
  - Growth in accessibility of resources
  - Online exams and digital assessments
  - Online forums and social media
- Solutions
  - Plagiarism: Tools for analyzing similarities (e.g., Turnitin)
  - Cheating: Exam Question Pools, Outlier detection tools
  - Falsifying/Fabricating: Outlier detection tools

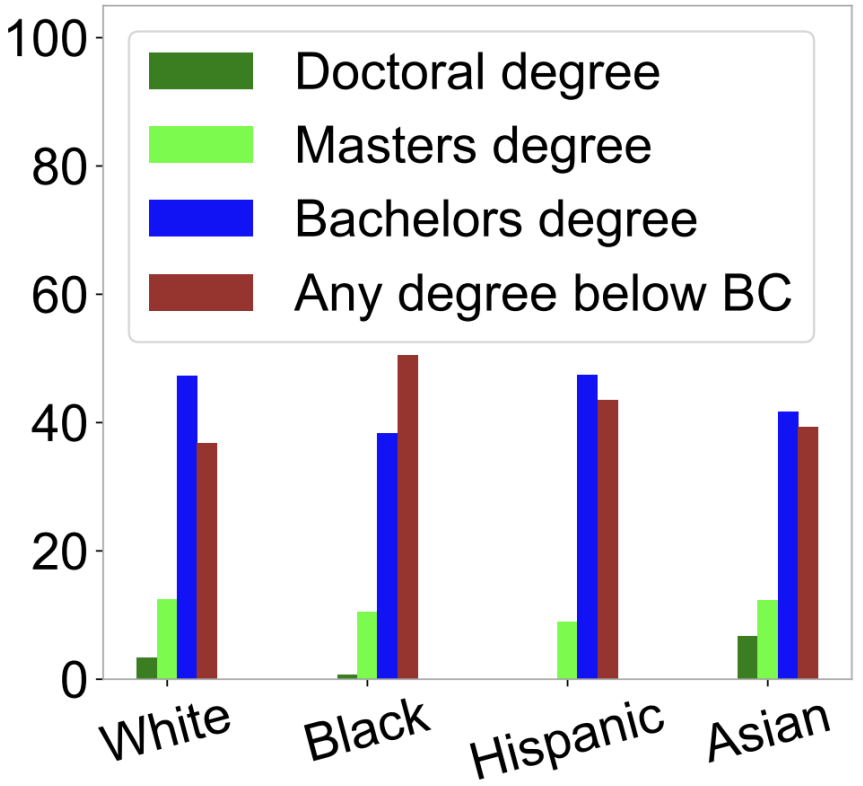
CrowdWork Assessments

- **Crowdworking:** the execution of work by a large number of people who each contribute a small amount of the task
- **Crowdwork assessment:** give a project for all the class to collaborate in development
- Assess students' engagement level by using Machine Learning
  - Facial behaviors (Image Processing)
  - Clicks and search histories (HCI)
  - Text and comment analysis (NLP)



Machine Learning and Fairness in Higher education

- Growing evidence shows that ML algorithms may not serve underprivileged communities well and at times and discriminate against them
- **Historical Bias:** A randomly sampled data set, reflects the world as it was including existing biases which should not be carried forward
  - The data sets do not faithfully represent the whole population
  - Minority groups are underrepresented



References

- EMMANUEL, I. C.; MITROFANOVA, E. Fairness of Machine Learning Algorithms in Demography. [s. l.], 2022.
- Thota, V., & Srinivas, G. (2022). Exemplifying the Applications of the Educational Institution Management System through Machine Learning-Education 4.0. *Available at SSRN 4026527*.
- Molenaar, I. (2021). Personalisation of learning: Towards hybrid human-AI learning technologies. *OECD Digital Education Outlook 2021 Pushing the Frontiers with Artificial Intelligence, Blockchain and Robots: Pushing the Frontiers with Artificial Intelligence, Blockchain and Robots*, 57.
- Agarwal, R., Negi, V., Kalra, A., & Mittal, A. (2022, January). Deep Learning and Linguistic Feature Based Automatic Multiple Choice Question Generation from Text. In *International Conference on Distributed Computing and Internet Technology* (pp. 260-264). Springer, Cham.

References

- Gupta, M., & Batra, G. (2021, April). Investigation of Machine Learning Assistance to Education. In *2021 5th International Conference on Computing Methodologies and Communication (ICCMC)* (pp. 777-782). IEEE.
- Li, S., Lajoie, S. P., Zheng, J., Wu, H., & Cheng, H. (2021). Automated detection of cognitive engagement to inform the art of staying engaged in problem-solving. *Computers & Education*, *163*, 104114.
- Ilić, M. P., Păun, D., Popović Šević, N., Hadžić, A., & Jianu, A. (2021). Needs and Performance Analysis for Changes in Higher Education and Implementation of Artificial Intelligence, Machine Learning, and Extended Reality. *Education Sciences*, *11*(10), 568.
- Villegas-Ch, W., Román-Cañizares, M., & Palacios-Pacheco, X. (2020). Improvement of an online education model with the integration of machine learning and data analysis in an LMS. *Applied Sciences*, *10*(15), 5371.