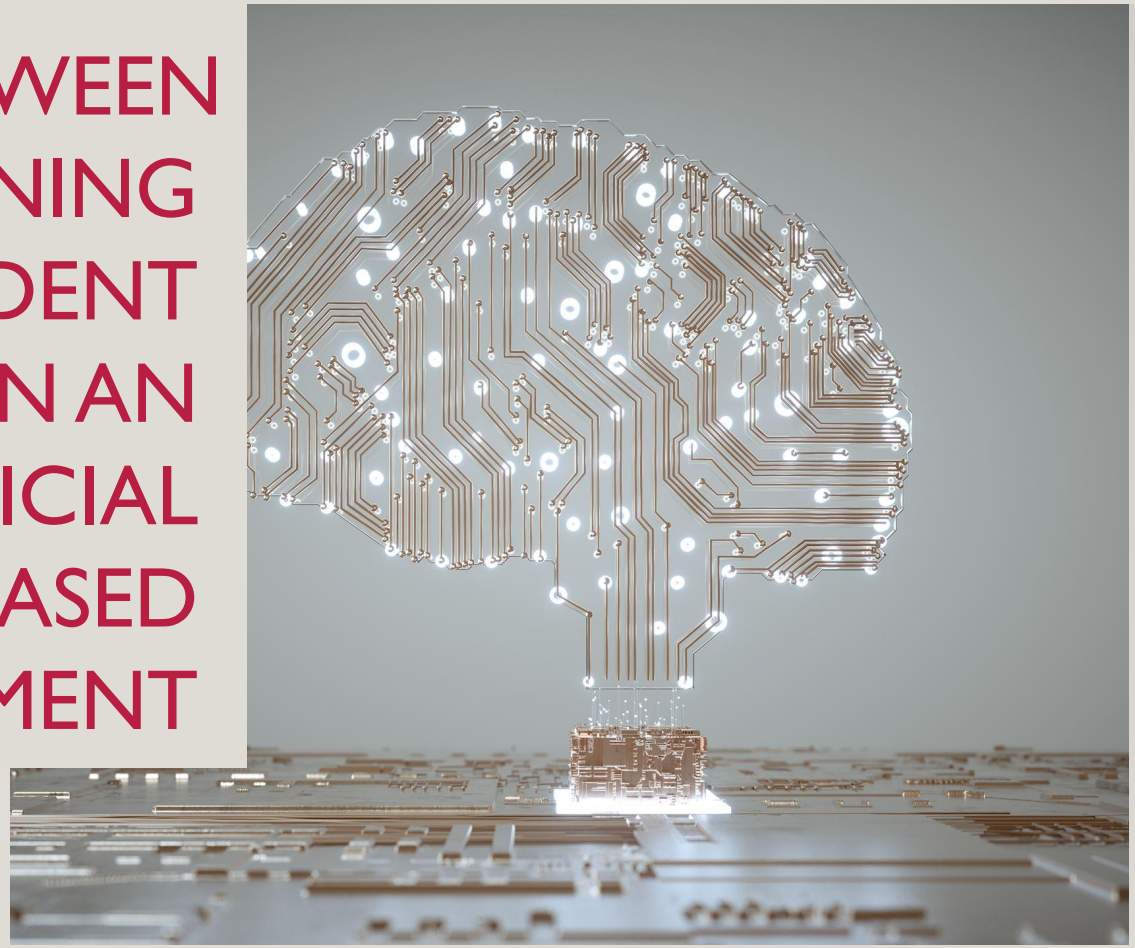
Dr. habil. Dalma Lilla Dominek – Nóra Barnucz

THE RELATIONSHIP BETWEEN ADAPTIVE LEARNING SYSTEMS AND STUDENT COMPETENCIES IN AN ARTIFICIAL INTELLIGENCE-BASED ENVIRONMENT



INTELLIGENT TECHNOLOGIES SHAPING THE FUTURE OF LEARNING

RESEARCH CONTEXT & RELEVANCE

THE IMPACT OF DIGITAL SOCIETY AND ARTIFICIAL INTELLIGENCE ON EDUCATION

- **Developing Complex Competencies**
  - Education focuses on critical thinking, collaboration and digital literacy in response to the needs of the 21st-century labour market.
- **AI-Based Adaptive Learning**
  - AI systems personalize learning content by adapting it to learners' prior knowledge and individual needs.
- **Digital and Pedagogical Challenges**
  - Digital transformation requires new pedagogical roles and assessment methods in education.

THE TRANSFORMATION OF 21ST-CENTURY SKILLS AND COMPETENCY REQUIREMENTS

- **New Competency Requirements**
  - Digitalization and globalization require new skills, such as critical thinking and problem solving.
- **Digital Literacy**
  - The conscious, ethical and effective use of digital tools is essential for navigating online environments.
- **Adaptive Learning Systems**
  - These systems provide personalized learning pathways and support independent learning.
- **The Need for Pedagogical Support**
  - Technology alone is insufficient; deliberate pedagogical design and teacher support are necessary for development.

THE RELEVANCE OF THE RESEARCH FOR EDUCATIONAL POLICY PRACTICE

Educational Policy Investments

- For educational policymakers, evaluating the effectiveness and equity of technologies is essential when making investment decisions.

Institutional Innovation and Quality Assurance

- Adaptive systems facilitate the introduction of educational innovation and support the development of digital strategies in schools.

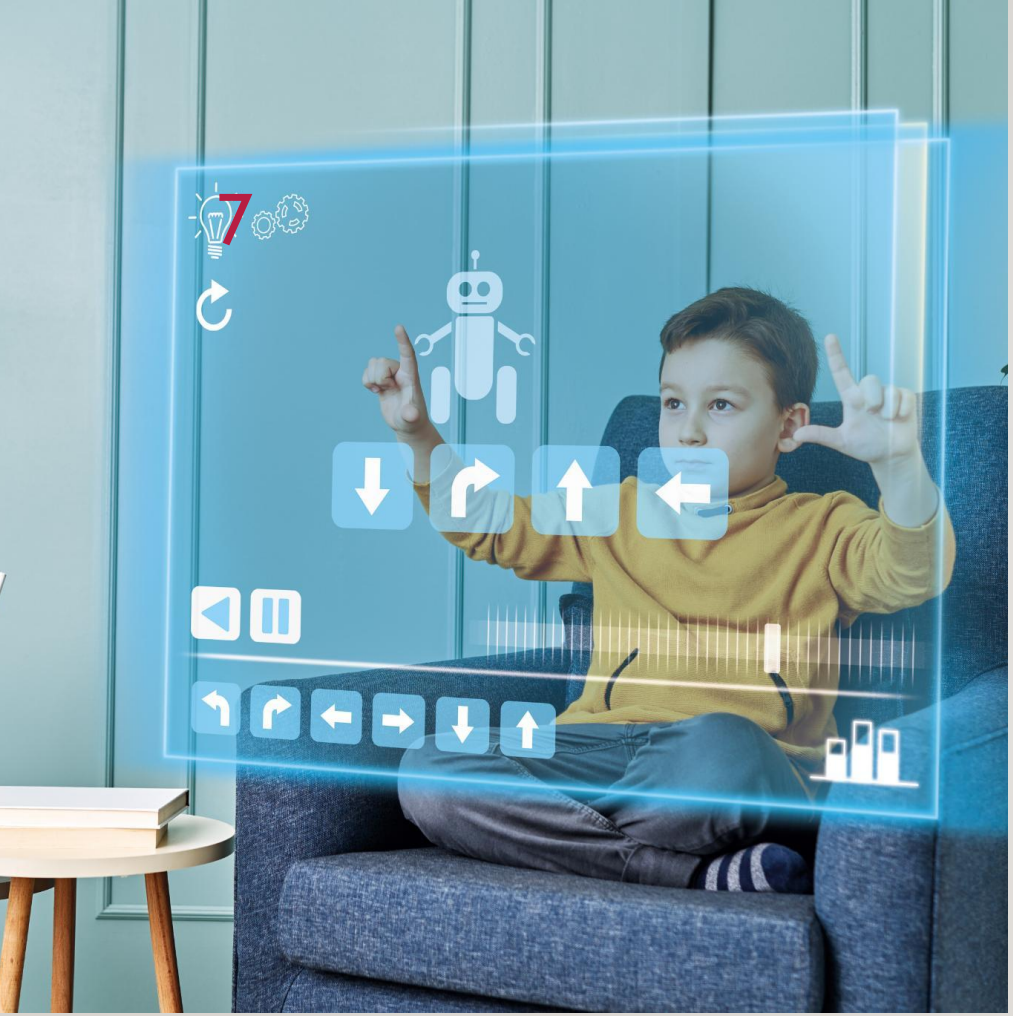
Pedagogical Integration and Student Development

- The research provides practical guidance on integrating AI tools into teaching in order to develop student autonomy and competencies.

Ethical and Social Issues

- Data protection, algorithmic transparency and the management of digital inequalities are essential for the sustainability of AI-based education.

THEORETICAL FRAMEWORKS & PEDAGOGICAL MODELS



PEDAGOGICAL FOUNDATIONS OF ADAPTIVE LEARNING

Individual Learner Differences

- Adaptive learning responds to learners' differences in knowledge, learning styles, motivation and pace.

AI-Based Personalization

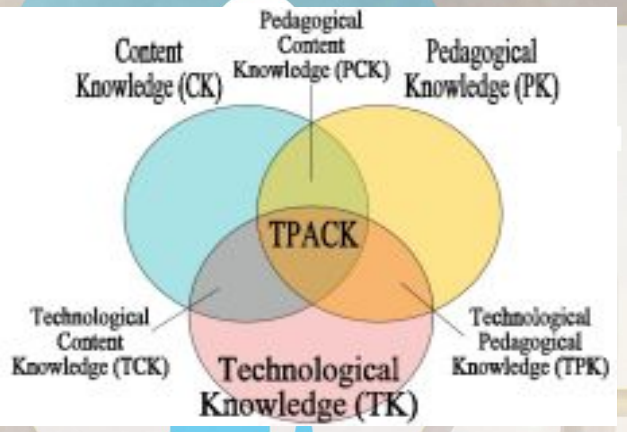
- AI-based systems continuously analyse learner data and provide personalized learning pathways.

The Teacher's New Role

- In adaptive learning environments, teachers support learners' development as mentors and facilitators.

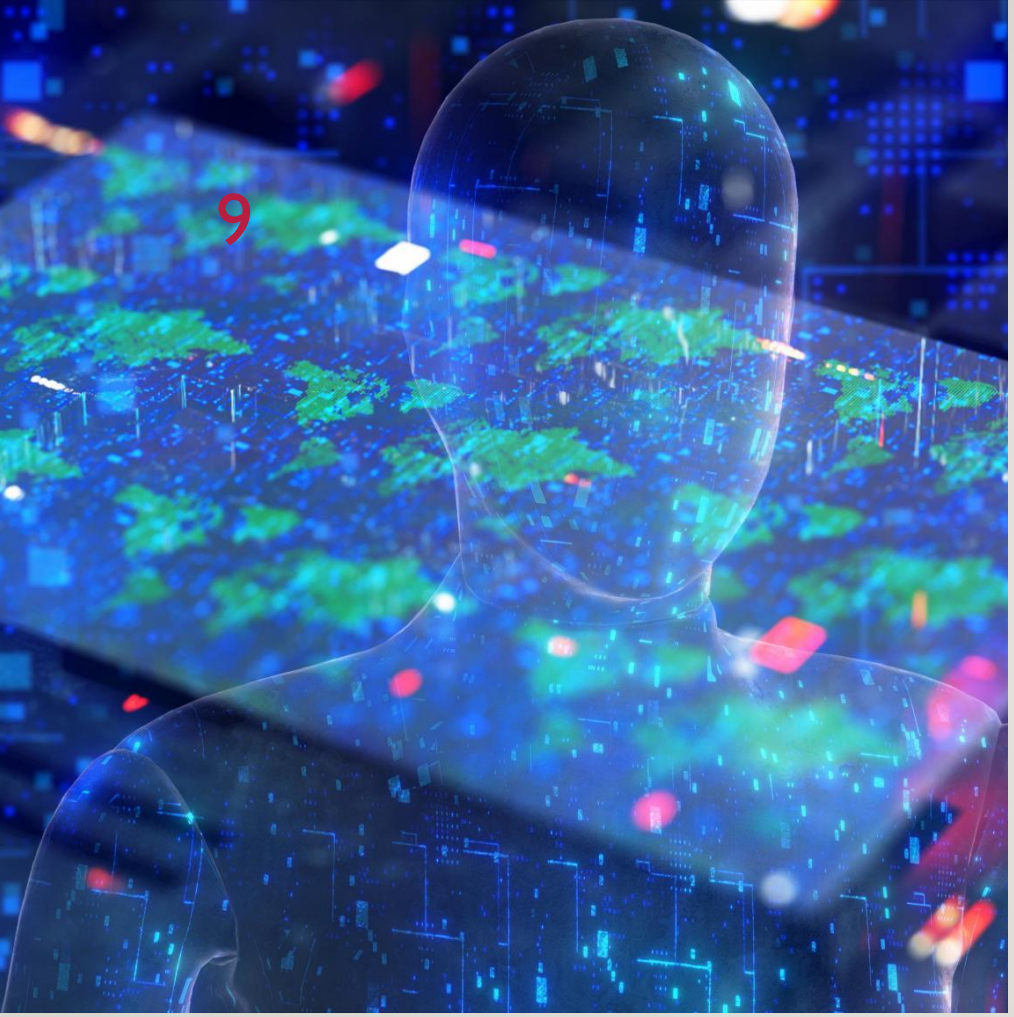
Pedagogical Design and Alignment

- Aligning learning objectives, content and assessment is essential for competency development.



THE ROLE OF DIGTAL-BASED MODEL IN AI INTEGRATION

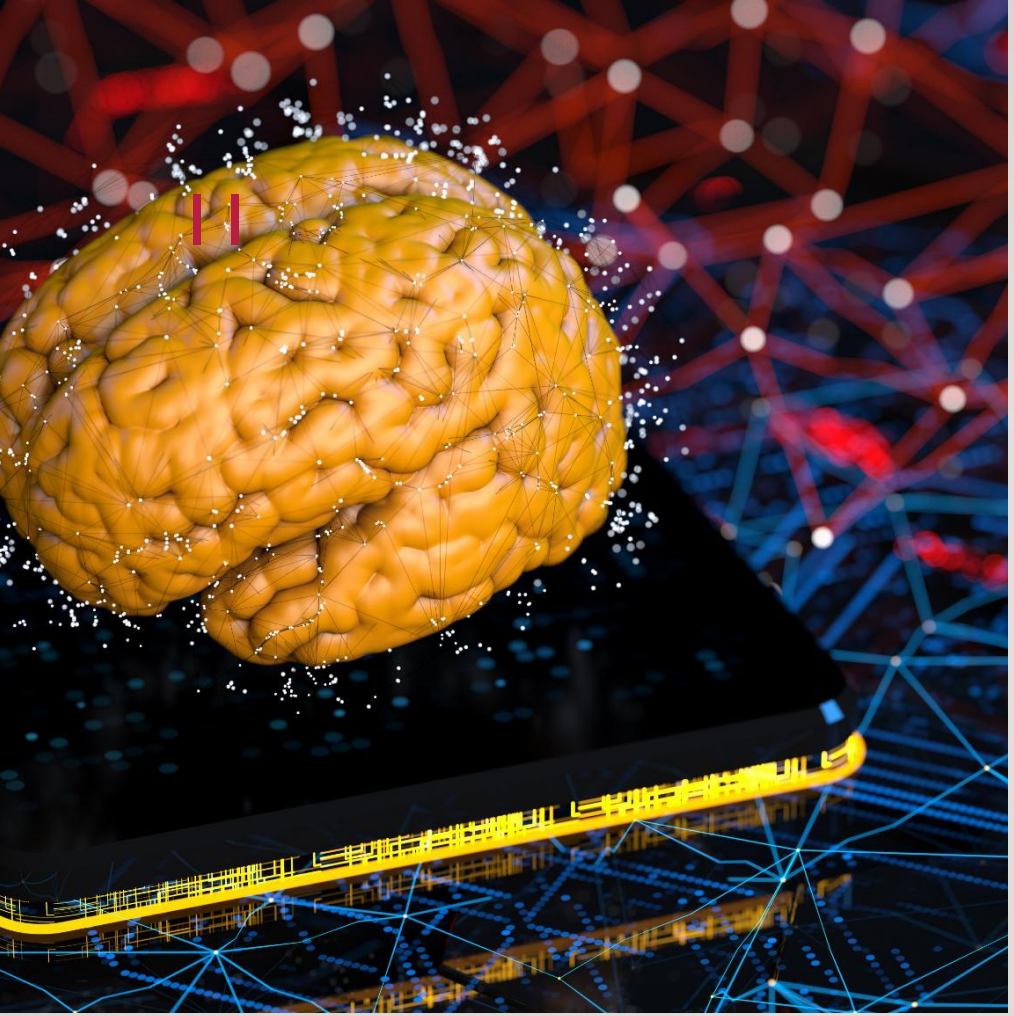
- **Foundations of the TPACK Model**
- TPACK integrates pedagogical, content and technological knowledge in order to make education more effective.
- **Challenges of AI Integration**
- Integrating AI requires teachers to acquire new technological knowledge and **pedagogical strategies.**
- **Support for Teacher Education**
- TPACK helps identify the competencies to be developed and supports the design of teacher education.
- **Student Competency Development**
- **The model promotes the use of adaptive learning systems to increase learners' autonomy.**



TECHNOLOGY-ENHANCED PEDAGOGY AND ARTIFICIAL INTELLIGENCE

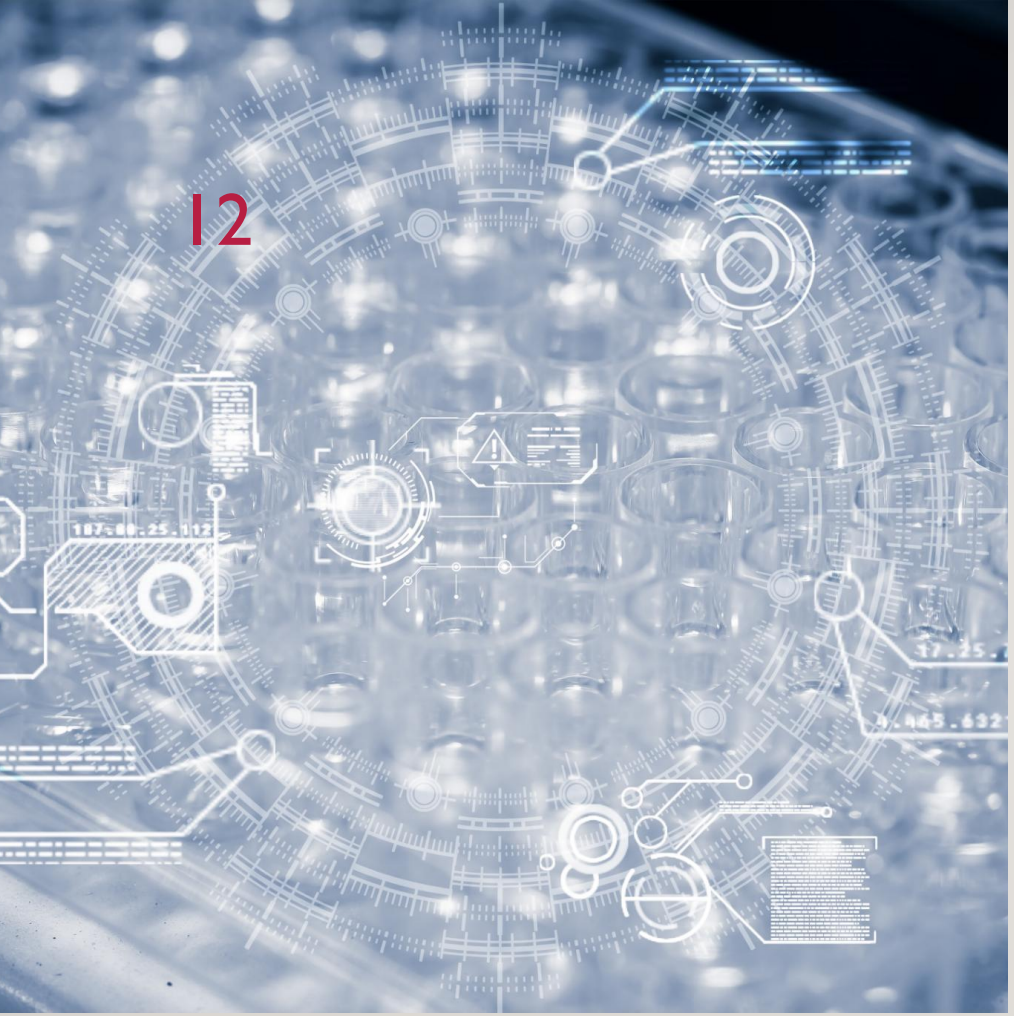
- **Technology in Teaching**
  - Digital tools are deliberately aligned with teaching and learning objectives and methods, thereby supporting pedagogy.
- **AI and Personalized Learning**
  - AI supports personalized learning processes through complex data analysis and recommender systems.
- **The Teacher's Role and Decision-Making**
  - Teachers interpret AI-generated data and make didactic decisions to support learning.
- **Challenges and Pedagogical Perspectives**
  - A critical pedagogical stance is important for addressing technological dependence on AI and issues of transparency.

RESEARCH OBJECTIVES, RESEARCH QUESTION AND METHODOLOGY



RESEARCH OBJECTIVES AND FOCUS AREAS

- **AI-Based Adaptive Learning**
  - AI-based systems support learners' competency development in digital environments.
- **Self-Regulated Learning and Metacognition**
  - Self-regulated learning and metacognitive skills **play a key role in lifelong learning.**
- **Pedagogical and Technological Conditions**
  - **Understanding teacher roles, learner attitudes and institutional support** is important for the effective application of AI.
- **Alignment with International Educational Policy**
  - **The objectives of the research are aligned with the development of digital competencies and innovative learning environments**.



RESEARCH QUESTION AND DIMENSIONS OF INVESTIGATION

Central Research Question

- The impact of AI-based adaptive learning environments on learners' competency development and autonomy in digital education.

Dimensions of Investigation

- The research analyses learner motivation, self-regulation, metacognition and learning outcomes in adaptive systems.

The Role of the Pedagogical Environment

- **It examines educators' attitudes toward AI and their methodological preparedness for digital learning.**

Multiple Methodological Approaches

- **The complexity of the research requires the combined application of several methods in order to gain a nuanced understanding of the results.**

Research question: What impact do AI-based adaptive learning environments have on learners' competency development and learning autonomy in digital educational environments?

COMBINING QUALITATIVE AND QUANTITATIVE METHODS

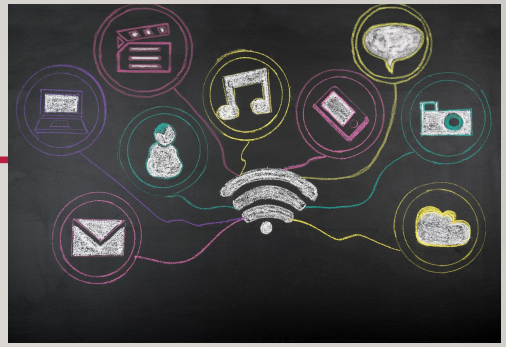
- **Literature Review**
  - The literature review provides the theoretical foundation and identifies global research trends for the study.
- **Use of Case Studies**
  - Case studies offer deeper insight into the practical use of AI-based systems.
- **Questionnaire-Based Data Collection**
  - Questionnaires (two self-developed questionnaires) are used to collect quantitative data on students' experiences and motivation. (n=208 students, NUPS Faculty of Public Governance and International Studies / Faculty of Law Enforcement)
- **Methodological Triangulation**
  - Combining qualitative and quantitative methods increases the validity and reliability of the research.

RESULTS, CHALLENGES & CONCLUSIONS

PRELIMINARY RESULTS OF ADAPTIVE LEARNING SYSTEMS

Positive Impact on Motivation

- Adaptive learning systems increase learners' motivation and engagement through personalized tasks.



Immediate Feedback

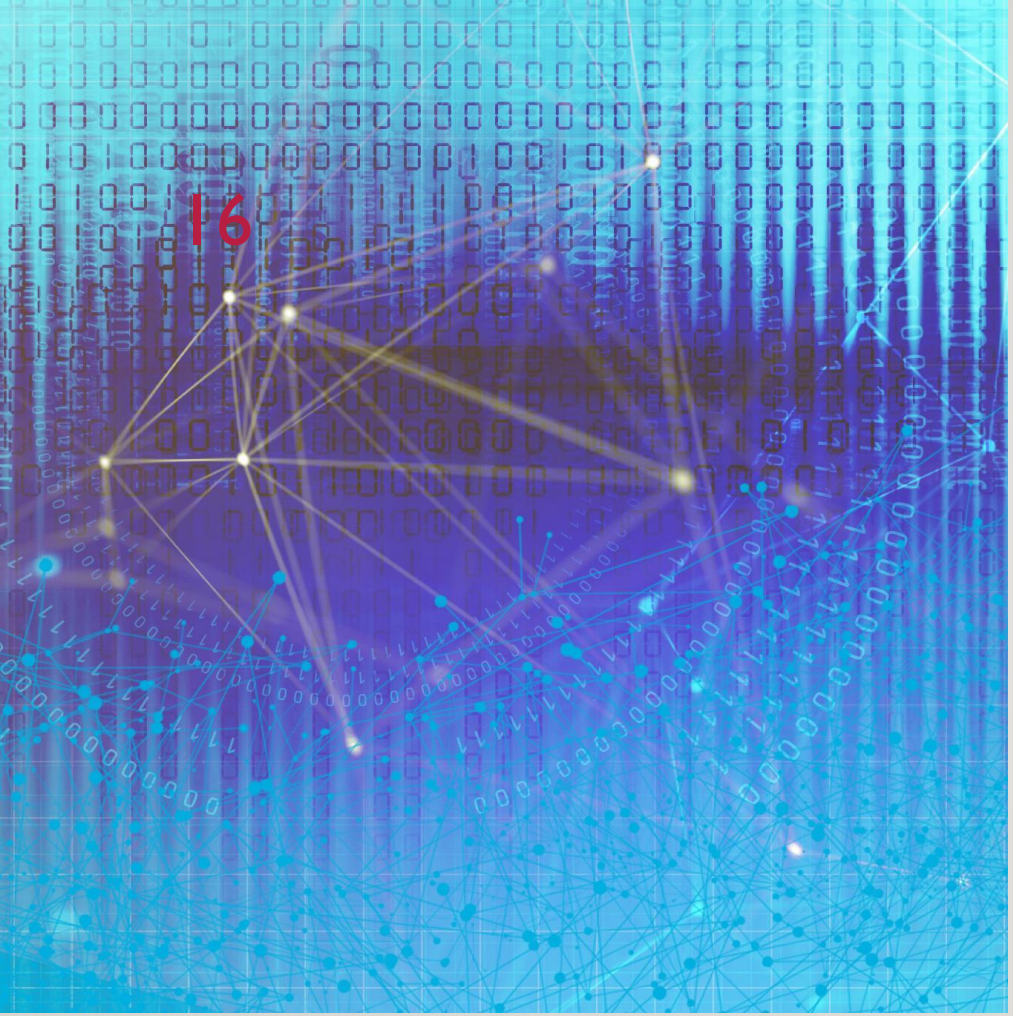
- Immediate feedback supports the recognition of errors and the development of effective learning strategies.

Self-Regulated Learning

- Learners assume greater responsibility and actively monitor their own learning progress.

The Role of the Pedagogical Environment

- The effectiveness of adaptive systems depends on teachers' preparedness and the quality of the learning environment.



ETHICAL, TECHNOLOGICAL AND SOCIAL CHALLENGES

Data Protection and Security

- Adaptive systems collect large amounts of personal data; therefore, data security and informed consent are crucial.

Risk of Algorithmic Bias

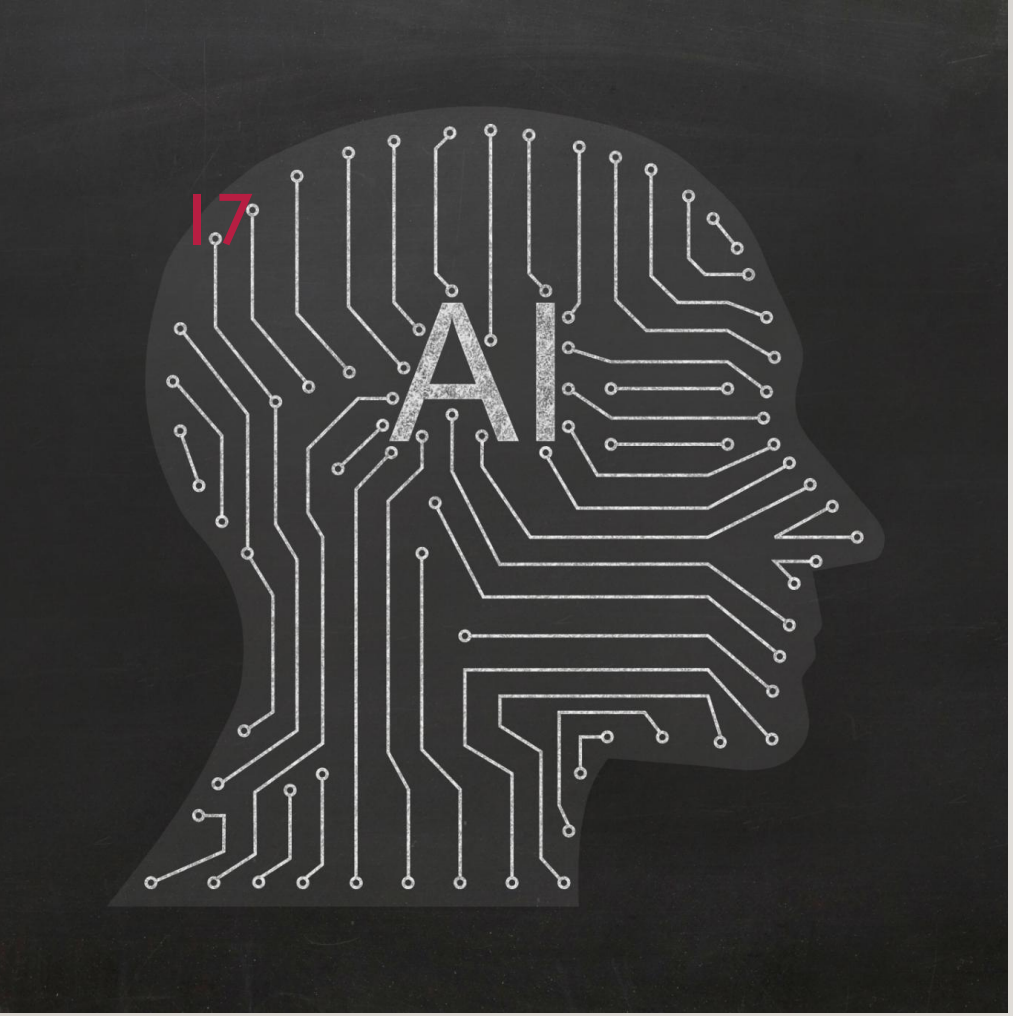
- Algorithmic bias may reinforce inequalities if recommendations are not transparent or are distorted.

Digital Inequality

- Not all learners have access to technological tools of the same quality, which constitutes a social problem.

Importance of Collaboration

- Addressing these challenges requires cooperation among educators, developers and policymakers.



CONCLUSIONS AND FUTURE DIRECTIONS

Benefits of AI-Based Learning Systems

- AI-based systems support learners' competency development and autonomous learning in a personalized manner.

Importance of the Pedagogical Framework

- **The effectiveness of technology** depends on deliberate pedagogical application, **which is critical for achieving positive outcomes.**

Future Research Directions

- Longer-term impact studies and comparative analyses are needed in different educational contexts.

Educational Policy and Ethical Considerations

- Regulations and guidelines are required for ethical, transparent and inclusive technological implementation.

THANK YOU FOR YOUR ATTENTION!

dominek.dalma.lilla@uni-nke.hu

barnucz.nora@uni-nke.hu