Digital Education:
Educational Data Analytics & Artificial Intelligence

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TALOS JOINT RESEARCH WORKSHOP
Digital Education: the role of Artificial Intelligence
University of Crete, Rethymno, Greece
12 May 2023

Emergency Remote Teaching during Covid-19

Lessons & Opportunities

Digital Readiness: Schools & Teachers

The Changing Landscape of Education

The Role of Digital Technologies

Educational Data Analytics

Educational Data: The challenge and the opportunity

Educational Data Analytics: Methods & Tools - Barriers & Ethical Issues

Educational Data Literacy & Professional Development

Artificial Intelligence in Education (AIEd)

AI Definitions

AIED Taxonomy

Our Research Strands 2000-today

Adaptive & Personalised Learning Systems

Educational Data Analytics

Emergency Remote Teaching during Covid-19

Emergency Remote Teaching during Covid-19

During **Covid-19** almost all **Educational Institutions** (*K12 Schools, Colleges & Universities, Professional Development Training Centers*) around the world adopted **Emergency Remote Teaching** strategies to cope with the global public health crisis.

Covid-19 created an urgent need for **temporary online access to teaching** at **global scale**.

→ **lessons to be learnt & opportunities**

Lessons & Opportunities

- **Curriculum**
  - global problems - **internationalization** of the curriculum
  - a **smart citizenship** curriculum - **digital intelligence**
  - **effective thinkers** and **ethical global citizens**
- **Pedagogy**
  - more **flipped** and **blended** teaching & learning
  - need for more engaged **self-regulated** learners
- **Means – Technology**
  - unlock **existing technologies**: beyond access to digital content into orchestration of meaningful personalised learning experiences
- **Assessment of/for Learning**
  - integrate formative **e-assessment** strategies: enhance feedback & guidance
  - explore **educational data** collection and analysis
- **Leadership & Policies**
  - **data-driven** decision-making and performance evaluation – **school autonomy**

Digital Readiness: Schools & Teachers

Educational Data a Big Part of it

Digital Education Action Plan (2021-2027) European Commission 30.9.2022

Priority 1:

Fostering the development of a high-performing digital education ecosystem

Action 5: **Digital transformation plans** for education and training institutions

Action 6: Ethical guidelines on the use of **AI and data** in teaching and learning for educators

Priority 2:

Enhancing digital skills and competences for the digital transformation

Action 7: Common guidelines for teachers and educators to foster **digital literacy** and tackle disinformation through education and training

Action 8: Updating the European Digital Competence Framework to include **AI and data-related skills**

Action 9: **European Digital Skills Certificate (EDSC)**

Action 10: Proposal for a Council recommendation on improving the provision of **digital skills** in education and training

The Changing Landscape of Education

The Changing Landscape of Education

Objectives:

From acquiring new ***"knowledge"*** to develop new and relevant ***"competences"*** and build individual & community ***"identities"***

Methods:

From ***"classroom"*** based teaching to online & blended out-of-classroom ***"context-aware"*** personalized learning

Assessment:

From ***"life-long"*** **degrees** and certifications to ***"on-demand"*** and ***"in-context"*** **accreditation of qualifications** & **micro-credentials**

The Role of Digital Technologies

enabler for incremental or disruptive **transformations**

allows for **innovative** learning experiences, processes, products, services, that *would not be possible without* the use of digital technologies

Supports educational institutions **complexity leadership**

*through exploiting **data-driven approaches** based on evidence and data collected from the otherwise **"black boxes"***

Students	**Self-Regulated & Personalised :** Learning Experiences, Guidance & Feedback, Recognition of Achievements
Teachers / Educators	**Transform the Teaching Profession:** Data-Driven Evidence-Based Reflective Teaching Practice
Educational Institutions *(K12, Universities, Professional Development Centers)*	**Transform Curriculum**: Orchestrate Teaching, Learning and Assessment in various settings on-campus (lecture halls, labs, reflection / collaboration spaces, library), off-campus (professional placements), online
	Transform Teaching and Learning Spaces: Physical / Campus & Virtual / Online Facilities
Graduates	**Individual Professional Identity** and **Competence Profiles** for **Employability** - **Creativity** - **Entrepreneurship**
Industry	**Ready to Job Graduates** Knowledge and Competence Alliances with Higher Education Institutions
Society	**Digital Citizenship**

Educational Data Analytics

Educational Data:
The challenge and the opportunity

Educational Organisations and **Teachers**

are challenged to

Personalise Teaching and Learning:

- ***Learning Experiences***
- ***Guidance & Feedback***
- ***Recognition of Achievements***

for **each** Individual Student.

Educational Data:
The challenge and the opportunity

As teachers, **how much** do we know about our ***students***?

- do they *understand*?
- are they *bored*?
- are they *distracted*?

Educational Data:
The challenge and the opportunity

Educators have a fairly good understanding of their students' needs and capacities *when* they **interact** with them ***daily*** in the ***classroom*** or in the ***lab***

And yet, they would like to be able to **discover more** and **personalise** their teaching for **each** one of their students – ***"differentiate instruction"***

What happens when **Teaching and Learning** moves

- from the **Physical Classroom** to the **Online Virtual Space** (Web, MetaVerse)
- from the **Small Groups** of Students to the **Massive Audiences** of a MOOC

Educational Data:
The challenge and the opportunity

Online Teaching and Learning are typically supported by **Course** or **Learning Management Systems** (CMS or LMS) which are web-based systems that handle teaching and learning activities online, such as **Moodle**.

Effective online and blended teaching require **updated professional competences** compared to those assumed at the traditional face to face education and training programs.

- Pre-Service Teacher Education Programs
- In-Service Professional Development Programs

Educational Data:
The challenge and the opportunity

A recent advancement in online and blended teaching and learning is **Educational Data Analytics (EDA)**:
the use of educational data generated during teaching and learning (including assessment) to better support individual learners' in online and blended courses and beyond.

As a result, most Course Management Systems are now incorporating **Educational Data Analytics tools**.

However, ***these tools are not widely used*** mainly because of the low **Educational Data Literacy (EDL)** competences of the professionals that could be using them (educators, instructional designers and trainers, leaders).

Educational Data:
The challenge and the opportunity

Benefits

- **Students:** take control of their learning
- **Educators:** reflect & improve their practice
- **Institutions**: take evidence-based decisions

Educational Data Literacy

Educational Data Literacy is a **core competence** for all **education professionals**, including school teachers, instructional designers and tutors of online and blended learning course, as well as educational institutions' leaders.

Data Literacy for Educators

- is the ability to **understand** and **use** data effectively to inform educational and pedagogical **decisions**
- it requires a **competence set** to locate, collect, process & store, analyze & understand, visualize & interpret and act upon Educational Data from different sources so as to support improvement of the teaching, learning and assessment process

Educational Data

Collected and organised to represent all aspects of teaching and learning (and assessment), including

Profiling and **Interaction** Data

of & between

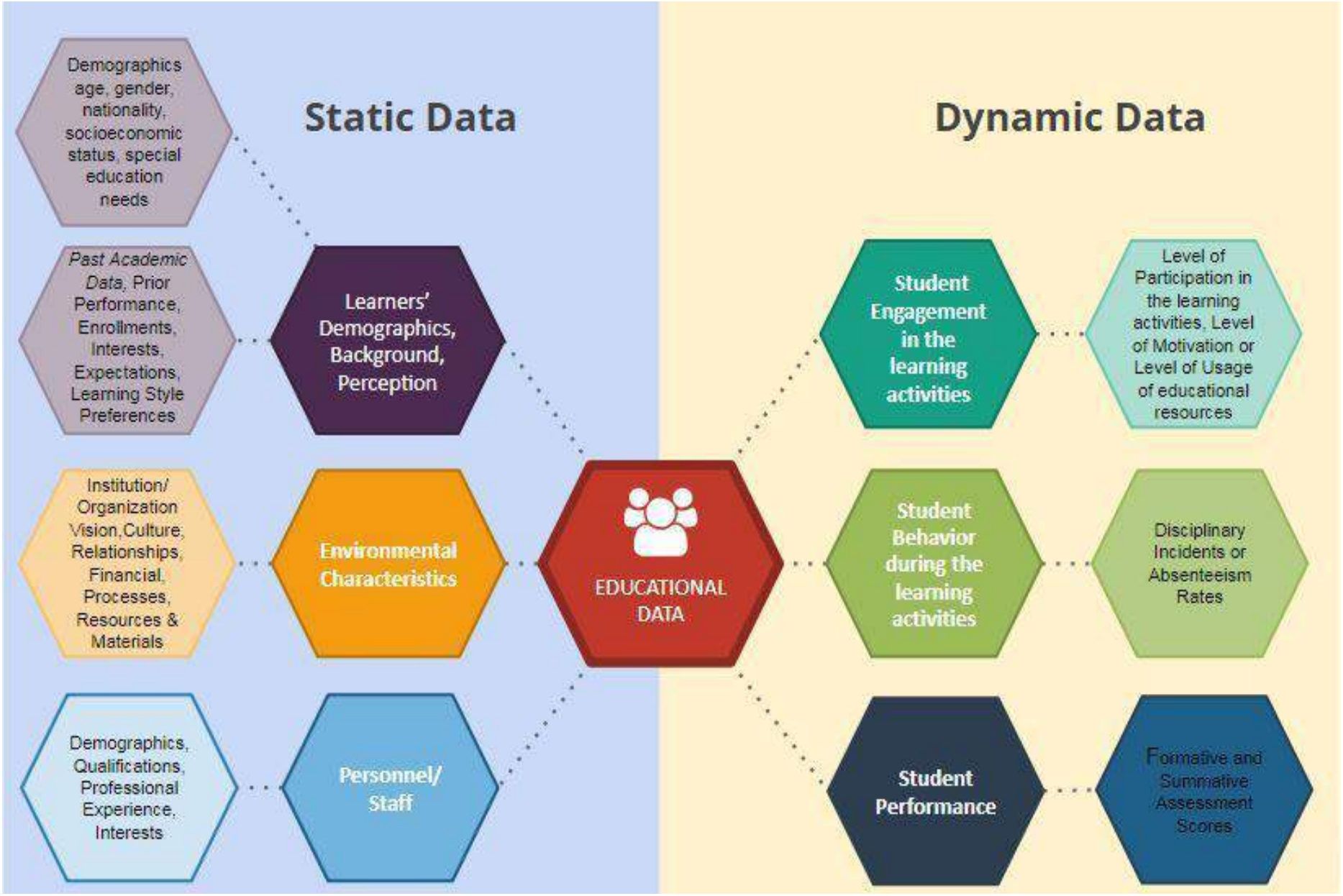
Students, **Teachers**, **Learning Environment**

derived from

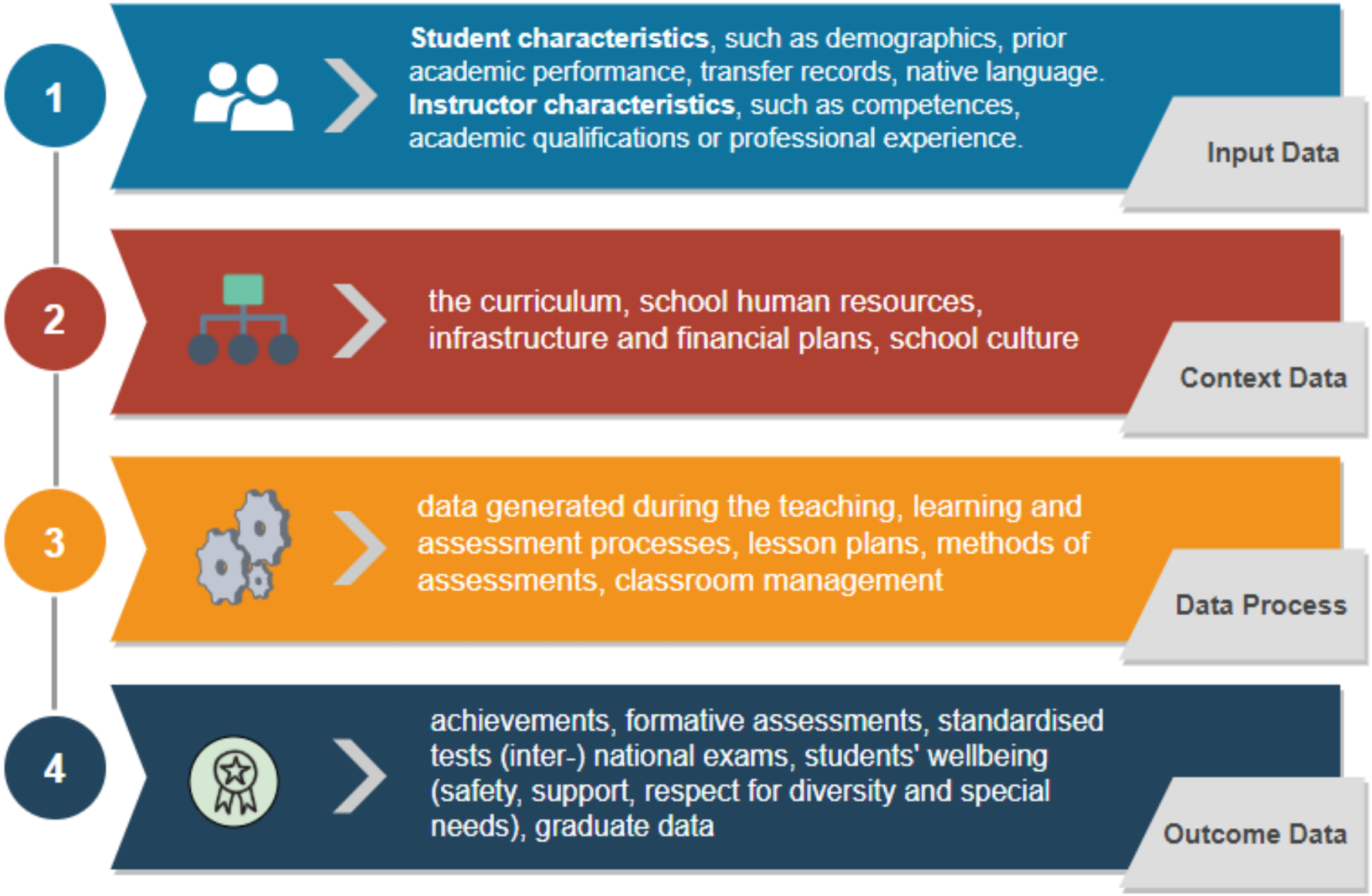
both ***qualitative*** and ***quantitative*** methods

collected from *multiple sources*

through ***Logs*** and/or ***Real-Time***



Sofia Mougiakou, Dimitra Vinatsella, Demetrios Sampson, Zacharoula Papamitsiou, Michail Giannakos, Dirk Ifenthaler, Educational Data Analytics for Teachers and School Leaders, Springer, 2022, Fig 1.14, pg 37 - adopted by Data Quality Campaign



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Educational Data Analytics Methods & Tools

Teaching Analytics

methods and digital tools to visualize, analyze, and/or assess **teaching design & practice**

Learning Analytics

methods and digital tools to collect, analyze and report student-related educational data towards monitoring the **learning process**

Teaching & Learning Analytics

to support the process of **reflective practice**: facilitating teachers to reflect on their teaching design using evidence from the actual delivery to their students

Teaching Analytics: Analyse Teaching Design

for self-reflection and improvement

visualize the ***elements*** of a lesson plan
visualize the alignment of a lesson plan to ***educational objectives / standards***
validate whether a lesson plan has potential ***inconsistencies*** in its design

through sharing with peers or mentors to receive feedback

support the process of ***sharing*** a lesson plan with ***peers or mentors,***
allowing them to provide ***feedback*** through comments and annotations

through co-designing and co-reflecting with peers

allow ***peers*** to ***jointly analyze*** and ***annotate*** a common teaching design in order to allow for co-reflection

Support Educators as Designers of (Personalised) Learning Experiences

Learning Analytics

Collection of learner data during the delivery of a teaching design (e.g., a lesson plan) to ***build/update individual student profiles***.

Types of learner data typically are "*Dynamic Student Data*":

Engagement in learning activities. For example, the progress each learner is making in completing certain learning activities.

Performance in assessment activities. For example, formative or summative assessment scores.

Course Activities & Engagement: Interaction with Educational Resources & Tools, Peers & Tutors. For example which educational resources each learner is viewing/using.

Emotional Data. For example stress, boredom, anxiety.

Support Educators to Reflect, Adjust, Improve
Support Students towards Self-Regulation

Educational Data Analytics Technologies

Descriptive Analytics: use data *aggregation* and data *mining* to provide insight into the past and answer: **"What has happened?"** (e.g., reports and descriptions).

Diagnostic Analytics: dissect the data with methods like data *discovery*, data *mining and correlations* to answer the question **"Why did it happen?"** (e.g., interactive visualizations).

Predictive Analytics: utilize a variety of data to make the prediction and apply sophisticated analysis techniques (such as *machine learning*) to answer the question **"What is likely to happen?"** (e.g., trends and predictions).

Prescriptive Analytics: utilize an understanding of "*what has happened*", "*why it has happened*" and a variety of "*what-might-happen*" analysis to *recommend best next actions in context to take* and answer the question ***"What do I need to do?"*** (e.g., alerts, notifications, recommendations).

Educational Data Analytics for supporting School Teachers as Reflective Practitioners

Reflect-**IN**-action	Takes place while the practice is executed and the practitioner reacts **on-the-fly**
Reflect-**ON**-action	Takes a more **systematic** approach in which practitioners intentionally **review, analyse** and **evaluate** their practice **after** it has been performed, documenting the process and results

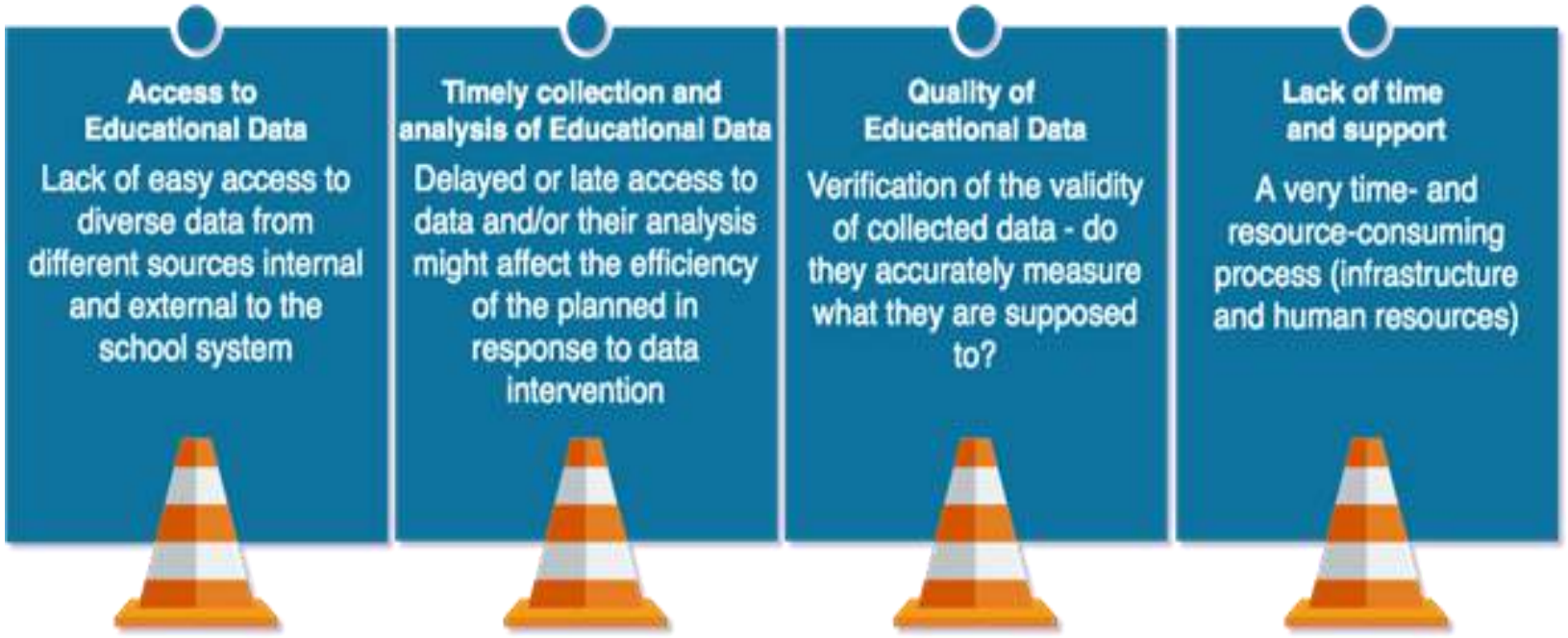
Educational Data Analytics for supporting School Teachers as Reflective Practitioners

Barnes, F. D. (2004). *Inquiry and action: Making school improvement part of daily practice.*
Providence, RI: Annenberg Institute for School Reform, Brown University.

Teaching and Learning Analytics

Teacher Inquiry Cycle Steps	How TLA can contribute
Identify a Problem to Inquiry	**Teaching Analytics:** capture and analyse the **teaching design** and help the teacher to: • pinpoint the specific elements of their teaching design that relate to the problem they have identified; • elaborate on their inquiry question by defining explicitly the teaching design elements they will monitor and investigate in their inquiry.
Develop Inquiry Questions and Define Inquiry Method	
Elaborate and Document Teaching Design	
Implement Teaching Design and Collect Data	**Learning Analytics:** • collect the **learner data** relevant to inquiry question. • analyse and report on the collected data to facilitate interpretation.
Process and Analyse Data	
Interpret Data and Take Actions	The combined use of **Teaching and Learning Analytics** can be used to map the analysed data to the initial teaching design, answer the inquiry question and generate insights for teaching design revisions.

Barriers to Educational Data



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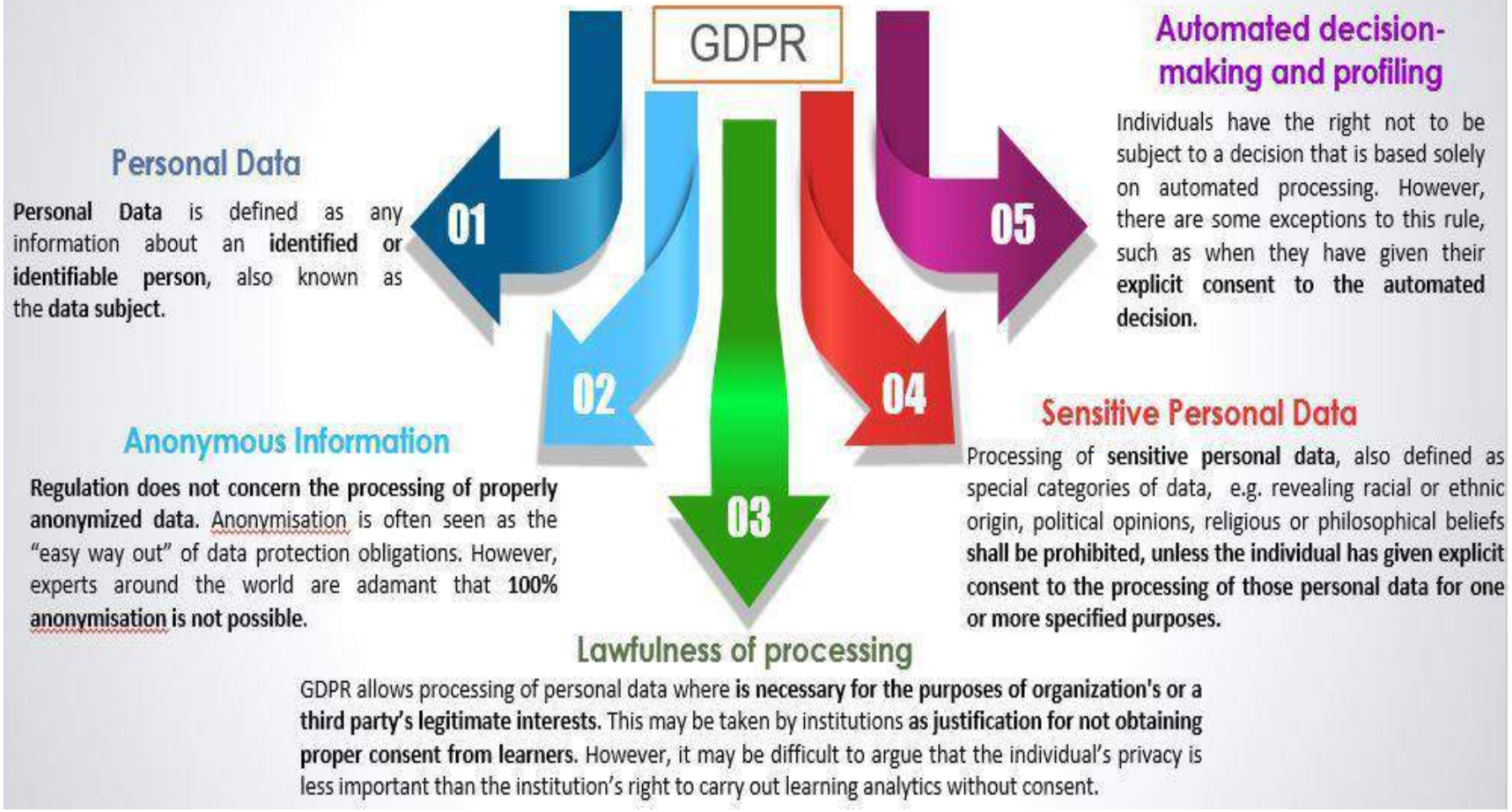
Principles and challenges to comply with GDPR



Personal Data

Personal Data is defined as any information about an **identified or identifiable person**, also known as the **data subject**.

Automated decision-making and profiling

Individuals have the right not to be subject to a decision that is based solely on automated processing. However, there are some exceptions to this rule, such as when they have given their **explicit consent to the automated decision.**

Anonymous Information

Regulation does not concern the processing of properly anonymized data. Anonymisation is often seen as the "easy way out" of data protection obligations. However, experts around the world are adamant that **100% anonymisation is not possible.**

Sensitive Personal Data

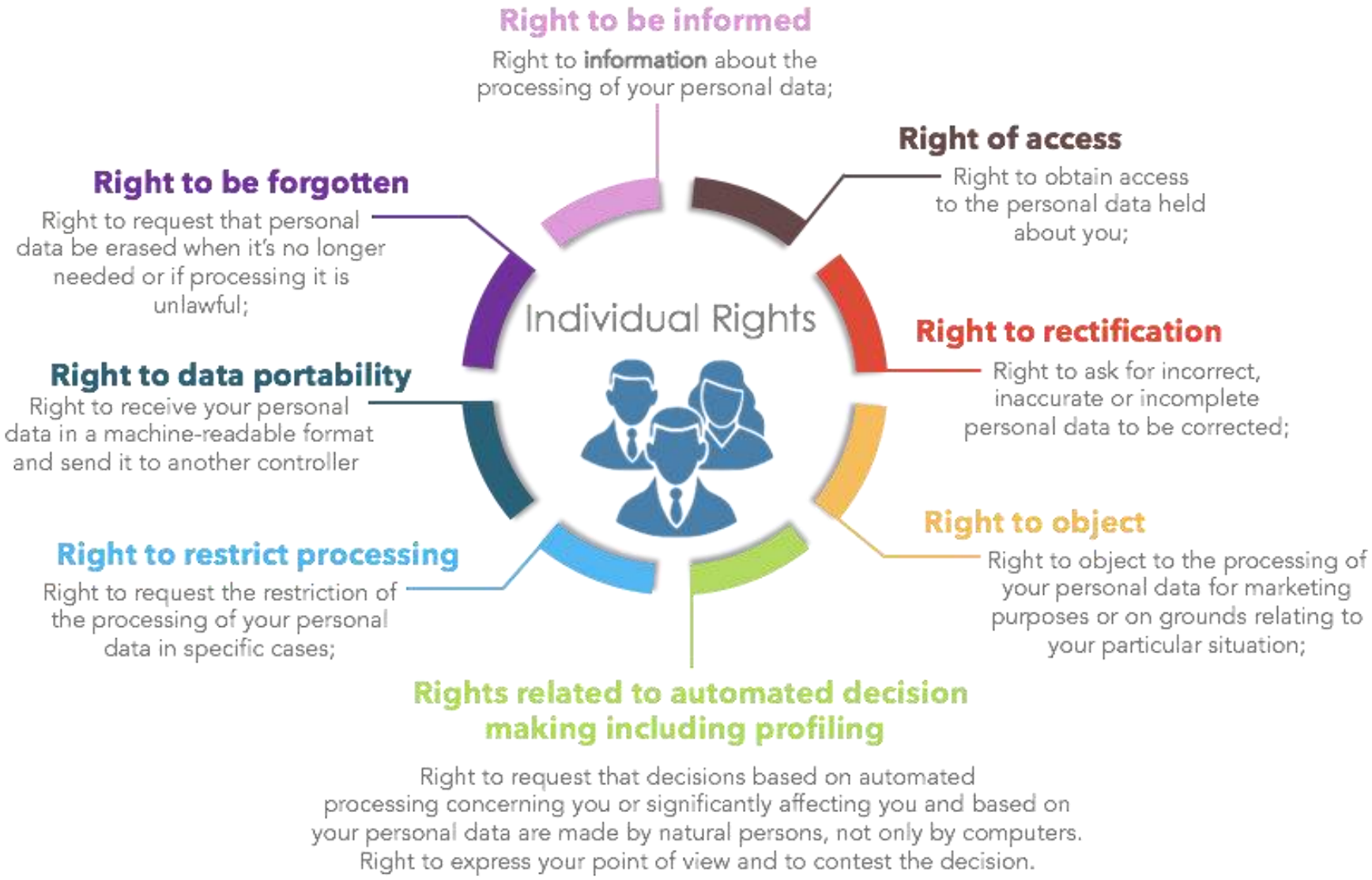
Processing of **sensitive personal data**, also defined as special categories of data, e.g. revealing racial or ethnic origin, political opinions, religious or philosophical beliefs **shall be prohibited, unless the individual has given explicit consent to the processing of those personal data for one or more specified purposes.**

Lawfulness of processing

GDPR allows processing of personal data where **is necessary for the purposes of organization's or a third party's legitimate interests.** This may be taken by institutions **as justification for not obtaining proper consent from learners.** However, it may be difficult to argue that the individual's privacy is less important than the institution's right to carry out learning analytics without consent.

Sofia Mougiakou, Dimitra Vinatsella, Demetrios Sampson, Zacharoula Papamitsiou, Michail Giannakos, Dirk Ifenthaler, Educational Data Analytics for Teachers and School Leaders, Springer, 2022, Fig 2.17, pg 96

Control over Personal Data under GDPR



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Professional Development 4
Educational Data Literacy

EDU1x: Analytics for the Classroom Teacher

edX MOOC, Curtin University

EDU1x Analytics for the Classroom Teacher

Nearly 30.000 enrollments from 180 countries since October 2016

Learn2Analyze:

An Academia-Industry Knowledge Alliance for enhancing Online Training Professionals' (**Instructional Designers** and **e-Trainers**) Competences in **Educational Data Analytics**

European Commission

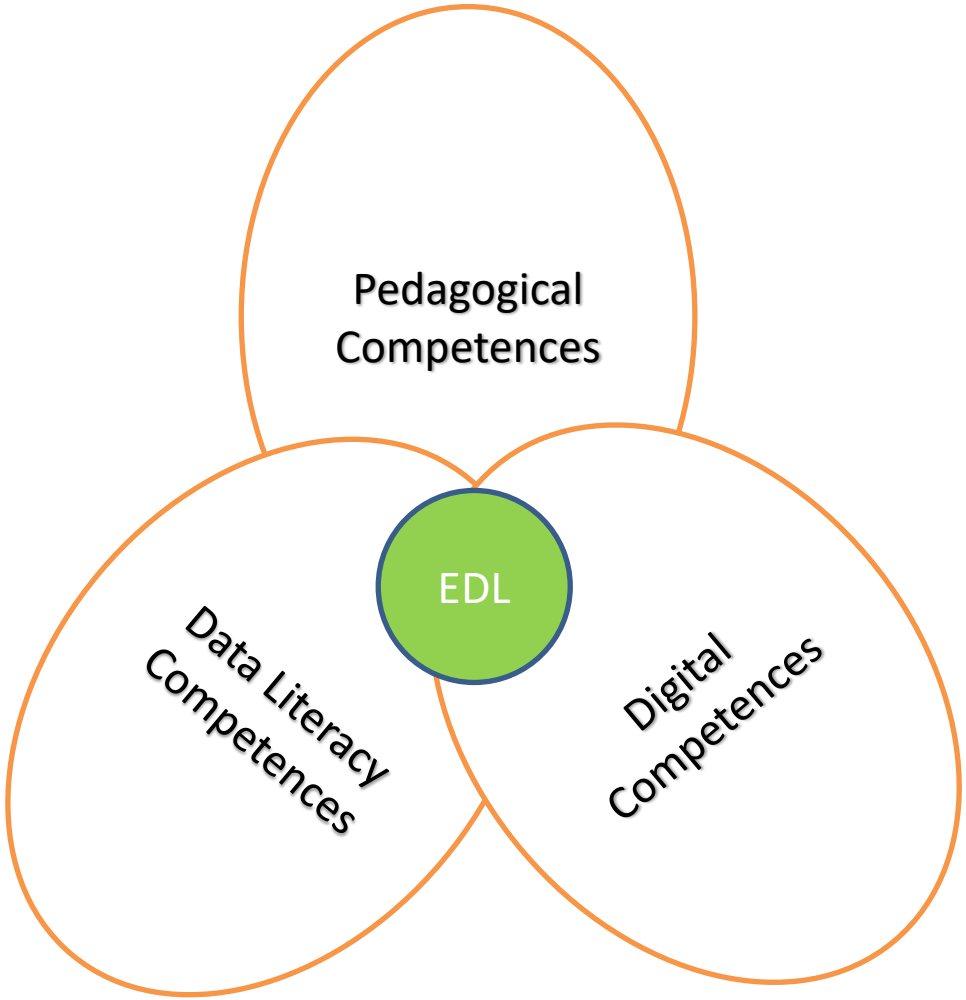
ERASMUS+ Key Action 2 "***Cooperation for innovation and the exchange of good practices - Knowledge Alliances***"

Academia – Industry - End User Communities

2018-2021

Learn2Analyze

Learn2Analyze
Educational Data Literacy Competence Dimensions



Learn2Analyze
Educational Data Literacy Competence Dimensions

L2A EDL Competence Profile

1. Data Collection	2. Data Management	3. Data Analysis	4. Data Comprehension & Interpretation	5. Data Application	6. Data Ethics
1.1 Know - understand - be able to obtain, access and gather the appropriate data and/or data sources	2.1 Know - understand - be able to apply data processing and handling methods (i.e., methods for cleaning and changing data to make it more organized – e.g., duplication, data structuring)	3.1 Know - understand - be able to apply data analysis and modeling methods (e.g. application of descriptive statistics, exploratory data analysis, data mining).	4.1 Know - understand - be able to interpret data properties (e.g., measurement error, outliers, discrepancies within data, key take-away points, data dependencies)	5.1 Know - understand - be able to use data analysis results to make decisions to revise instruction	6.1 Know - understand - be able to use the informed consent
1.2 Know - understand - be able to apply data limitations and quality measures (e.g., validity, reliability, biases in the data, difficulty in collection, accuracy, completeness)	2.2 Know - understand - be able to apply data description (i.e., metadata)	3.2 Know - understand - be able to apply data presentation methods (e.g., pictorial visualisation of the data by using graphs, charts, maps and other data forms like textual or tabular representations)	4.2 Know - understand - be able to interpret statistics commonly used with educational data (e.g., randomness, central tendencies, mean, standard deviation, significance)	5.2 Be able to evaluate the data-driven revision of instruction	6.2 Know - understand - be able to protect individuals' data privacy, confidentiality, integrity and security
	2.3 Know - understand - be able to apply data curation processes (i.e., to ensure that data is reliably retrievable for future reuse, and to determine what data is worth saving and for how long)		4.3 Know - understand - be able to interpret insights from data analysis (e.g., explanations of patterns, identification of hypotheses, connection of multiple observations, underlying trends)		6.3 Know - understand - be able to apply authorship, ownership, data access (governance), re-negotiation and data-sharing
	2.4 Know - understand - be able to apply the technologies to preserve data (i.e., store, persist, maintain, backup data), e.g., storage mediums/services, tools, mechanisms		4.4 Be able to elicit potential implications/links of the data analysis insights to instruction		

Learn2Analyze

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NTNU
Norwegian University of Science and Technology

Curtin University

UNIVERSITY OF MANNHEIM

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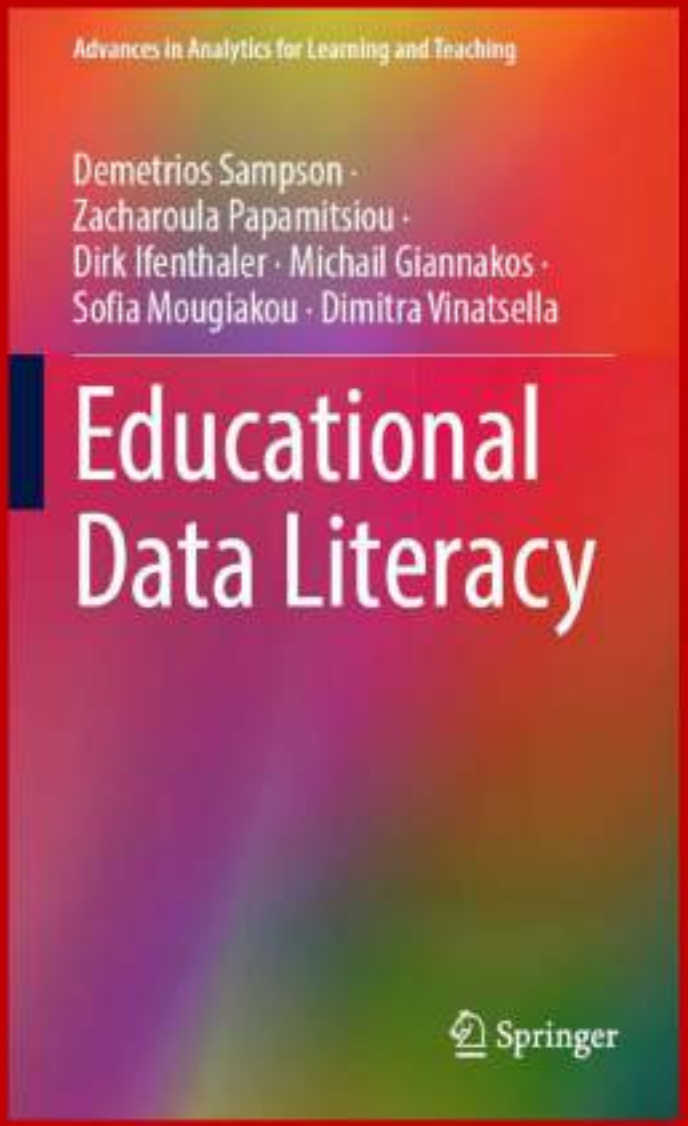
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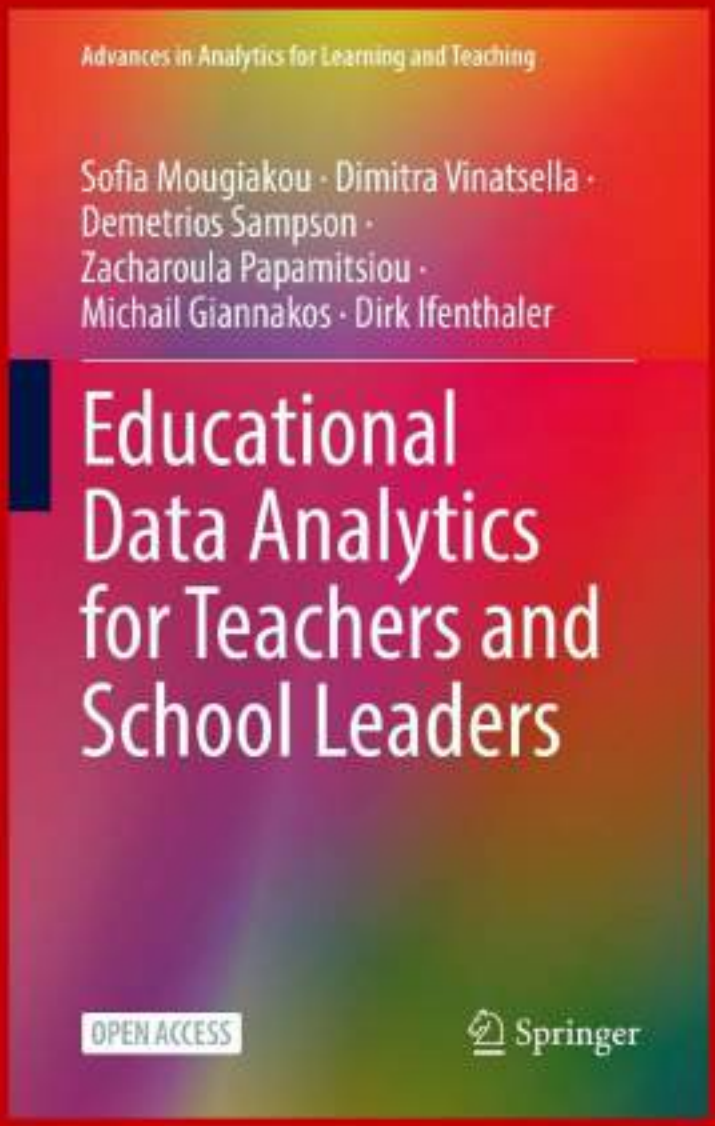
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Course Designers and Moderators

	**Sofia Mougiakou**
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	**Demetrios Sampson**

European Union

eu | academy

Explore by topic

What would you like to learn today?

Home > Educational Data Analytics For School Teachers To Enhance Your Blended And Online Teaching

Educational Data Analytics for School Teachers to Enhance your Blended and Online Teaching

More than one week

Novice

Enrol

Course details

This course introduces the fundamentals of the Educational Data Analytics in the school context. It aims

An official website of the European Union How do you know?

Duration and workload

Start date: Monday 22 May 2023
End date: Wednesday 7 June 2023

Duration: 2 weeks and 2 days
Workload: 10 hours in total

Schedule

How to get started with this course

Module 1: Educational Data

Module 2: Learning Analytics

Module 3: Final Assessment

Target audience

School Teachers and Leaders engaged in blended (using the flipped classroom model) and online teaching and learning as well as higher education students (undergraduates & postgraduates)

Learning objectives

By completing this course, you will:

- Know the basics for collecting and managing educational data to make them useful and understand their limitations.
- Know the basics for organising, analysing, presenting and interpreting learner-generated data.
- Understand issues related with educational data ethics and privacy.

Artificial Intelligence
In Education

Artificial Intelligence: Definitions

AI is research that develops technologies that can **do things that would require intelligence if done by humans** (Minsky, 1969).

Research on AI can **reveal how the human mind works** (Gardner, 1985).

AI refers to machine-based systems that can, given a set of **human-defined objectives**, make **predictions, recommendations**, or **decisions** that influence real or virtual environments. AI systems **interact** with us and **act on** our environment, either directly or indirectly. Often, they appear to operate **autonomously**, and can **adapt their behaviour** by **learning about the context**. (UNICEF, 2021, p. 16)

Minsky, M. (Ed.). (1969). Semantic information processing. The MIT Press.
Gardner, H. (1985). The Mind's new science: Cognitive revolution in the computer age. Basic Books
UNESCO. (2021). Recommendation on the ethics of artificial intelligence.

Artificial Intelligence: Definition

Data-Driven AI

artificial neural networks, machine learning, deep learning

Given a large enough set of **data items** and a **criterion for 'improvement'** a computer can gradually find a **model** that **optimises** its **predictions**.

Calculate how much the output of the system would change if any of the **system parameters** were incrementally changed.

OpenAI's GPT-3 *language model has 175 billion adjustable parameters and 400 billion words were collected from the Internet.*

Knowledge-based or Symbolic AI or Rule-based AI

Human knowledge and expertise can be represented in a form that can be processed by computer programs. **Expert systems** to imitate **expert decision-making**.

Knowledge-based intelligent tutoring systems

Domain model describes a conceptual structure of the area of study (math & physics).

"Intelligence" is in the conceptual structures extracted from human experts.

Generic inference engine that selects stored **heuristic rules** that tell the machine what to do next. **Rules** are higher-level descriptions of what is known about the domain in question, **"if-then-else"**.

Holmes, W., & Tuomi, I. (2022). State of the art and practice in AI in education. European Journal of Education, 57(4).

Artificial Intelligence in Education: Taxonomy

Student Learning

Intelligent Tutoring Systems (ITS)
AI-assisted Apps (e.g., maths, text-to-speech, language learning)
AI-assisted Simulations (e.g., games-based learning, VR, AR)
AI to Support Learners with Disabilities
Automatic Essay Writing (AEW) & Feedback
Chatbots
Automatic Formative Assessment (AFA)
Learning Network Orchestrators
Dialogue-based Tutoring Systems (DBTS)
Exploratory Learning Environments (ELE)
AI-assisted Lifelong Learning Assistant

Holmes, W., & Tuomi, I. (2022). State of the art and practice in AI in education. European Journal of Education, 57(4).

Assigning Tasks based on Individual Competences (Recommendations for Personalised Learning)
Provide Human-Machine Conversations (Chatbots, Language Learning)
Analyse students ' work (outcomes, process) for Feedback
Increase Adaptability & Interactivity (capture & analyse student learning data , profile learners, adapt learning environments, personalise learning experiences)

Chiu. T., Xia, Q., Chiu, T. K., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. Computers and Education: Artificial Intelligence, 4.

Artificial Intelligence in Education: Taxonomy

Teacher support

Plagiarism detection
Smart Curation of Learning Materials
Classroom Monitoring
Automatic Summative Assessment
AI Teaching Assistant (including assessment assistant)
Classroom Orchestration

Holmes, W., & Tuomi, I. (2022). State of the art and practice in AI in education. European Journal of Education, 57(4).

Adaptive Teaching Strategies: Recommendations Content / Tasks
Enhance Teachers' Ability to Teach: Classroom Management, Automatic Assessment & Grading
Support Professional Development: Inspired by System Recommendations, Analyse Classroom Data, Self Reflect on Teaching Practice

Chiu. T., Xia, Q., Chiu, T. K., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. Computers and Education: Artificial Intelligence, 4

Assessement

Automatic Marking & Grading
Predict Student Performance

Chiu. T., Xia, Q., Chiu, T. K., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. Computers and Education: Artificial Intelligence, 4

Artificial Intelligence in Education: Taxonomy

Institutional Support / Administration

Admission (ie Student Selection)
Course Planning, Scheduling, Timetabling
School Security (Facial Authentication, Detect Danger) !!!
Identify Drop Outs & Students At Risk
E-Proctoring

Holmes, W., & Tuomi, I. (2022). State of the art and practice in AI in education. European Journal of Education, 57(4).

Security: Facial Authentication for Exams
Course Planning, Scheduling, Timetabling
Administrative Personalised Services (ie Campus Navigation)
Evidence Based Decision Making supported with Educational Data Analysis

Chiu. T., Xia, Q., Chiu, T. K., Zhou, X., Chai, C. S., & Cheng, M. (2023). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. Computers and Education: Artificial Intelligence, 4

ORIGINAL ARTICLE

WILEY

State of the art and practice in AI in education

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Abstract

Recent developments in Artificial Intelligence (AI) have generated great expectations for the future impact of AI in education and learning (AIED). Often these expectations have been based on misunderstanding current technical possibilities, lack of knowledge about state-of-the-art AI in education, and exceedingly narrow views on the functions of education in society. In this article, we provide a review of existing AI systems in education and their pedagogic and educational assumptions. We develop a typology of AIED systems and describe different ways of using AI in education and learning, show how these are grounded in different interpretations of what AI and education is or could be, and discuss some potential roadblocks on the AIED highway.

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Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education

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Assessment

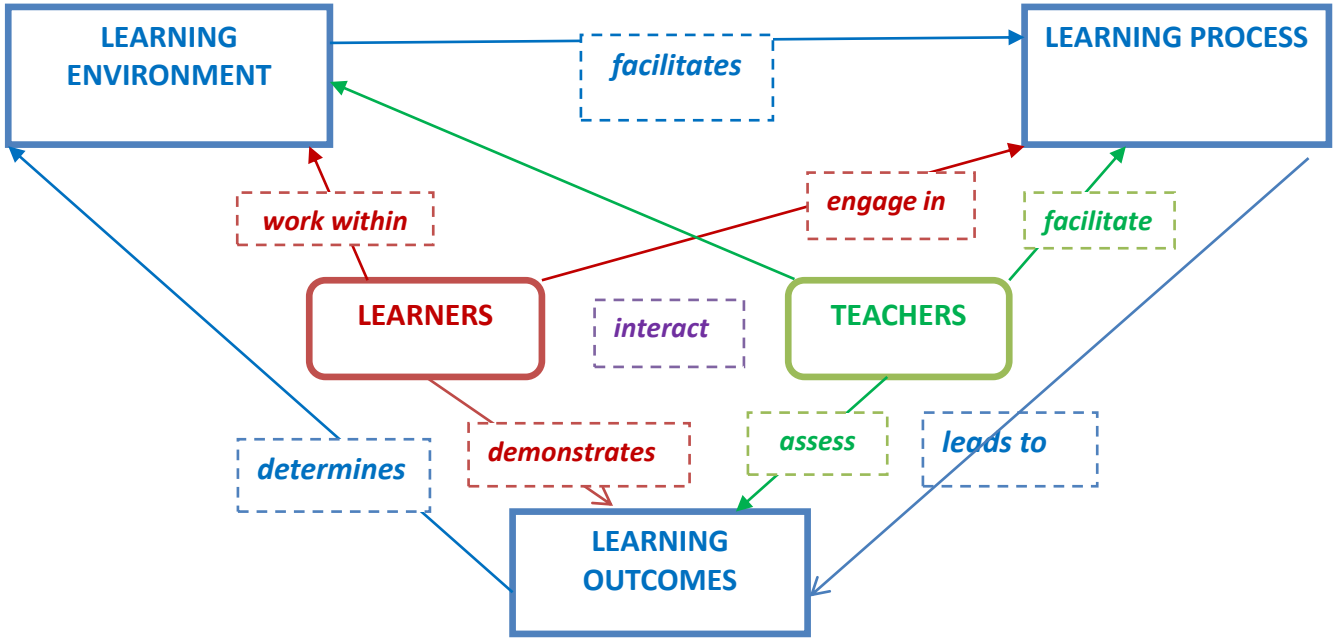
ABSTRACT

Applications of artificial intelligence in education (AIEd) are emerging and are new to researchers and practitioners alike. Reviews of the relevant literature have not examined how AI technologies have been integrated into each of the four key educational domains of learning, teaching, assessment, and administration. The relationships between the technologies and learning outcomes for students and teachers have also been neglected. This systematic review study aims to understand the opportunities and challenges of AIEd by examining the literature from the last 10 years (2012–2021) using matrix coding and content analysis approaches. The results present the current focus of AIEd research by identifying 13 roles of AI technologies in the key educational domains, 7 learning outcomes of AIEd, and 10 major challenges. The review also provides suggestions for future directions of AIEd research.

Our Research Strands
2000-today

Learning Environment, Learning Processes and Learning Outcomes (LEPO) Framework

Interrelations between	Roles
• Learning Environments • Learning Processes • Learning Outcomes	• Learners • Teachers



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Adaptive and Personalised Learning Systems

(Half-of-the) Problem

Individual	Learners	Adaptive	Learning Experiences *(including monitoring of progress, feedback, scaffolding)*
Groups of		Personalised	Recognition of Achievements *(including performance in certain tasks, building competences and professional identity profiles)*

The Framework

Orchestration		
Learning Activities		Assessment Activities
On-Campus	Off-Campus	Virtual & Online
Teaching Halls, Flipped Classrooms, Labs, Collaboration / Reflection Rooms, Self-Study Spaces, Library	*Professional Placements, Informal Settings (Museums, etc)*	*Simulations, Virtual and Remote Labs, Digital Games, 3D Virtual Worlds*
Physical Interactions		Online / Virtual Interactions
Resources, Tools, People, Environments		

Core Elements / Definitions

ADAPTIVITY (system)	**PERSONALISATION (user)**
Automatic changes to **System Behavior** based on the analysis of the **"context of learning"** **context-aware** Learners' (profile) + Learning Environment (conditions)	Customisation of a System's features both automatically (as part of "adaptivity") and manually ("by the user") **user-driven**

Types of Adaptations		
Educational Resources	Learning Activities	Learning Environment

Methods & Tools

Context-Aware Systems	Extract – Interpret - Use Contextual Information
	Adapt Behavior - Functionalities

Modeling Teaching and Learning Context		Tools for Context-Aware Authoring and Delivery Systems
	Collect and Analyse *(Educational) Data*	Rules at the Design Decisions at the Runtime
	Design – Build – Validate *Adaptation Engines*	
	(Intelligent) Systems for *Recommendations*	

Key Research Publications 2001-2004

- C. Karagiannidis, D. Sampson and F. Cardinali, “Integrating Adaptive Educational Content into Different Courses and Curricula”, *Educational Technology & Society Journal* , Special Issue on *Curriculum, Instruction, Learning and the Internet*, vol. 4(3), pp. 37-44, July 2001
- D. Sampson, C. Karagiannidis, A. Schenone and F. Cardinali, “Knowledge-on-Demand in e-Learning and e-Working Settings”, *Educational Technology & Society Journal* (ISSN 1436-4522), Special Issue on *Integrating Technology into Learning and Working*, vol. 5(2), pp. 107-112, April 2002
- D. Sampson, C. Karagiannidis and Kinshuk, “Personalised Learning: Educational, Technological and Standardisation Perspective”, *Interactive Educational Multimedia*, Special Issue on *Adaptive Educational Multimedia*, vol. 4, pp 24-39, April 2002
- D. Sampson, C. Karagiannidis and F. Cardinali, “An Architecture for Web-based e-Learning Promoting Re-usable Adaptive Educational Content”, *Educational Technology & Society Journal,* Special Issue on *Innovations in Learning Technologies*, Volume 5, Issue 4, pp. 27-37, October 2002
- N. Manouselis and D. Sampson, “Multi-Criteria Decision Making for Broker Agents in eLearning Environments”, *Operational Research: an International Journal*, Volume 2, Issue 3, pp. 347-361, December 2002
- N. Manouselis and D. Sampson, “Agent-based e-Learning Course Recommendation: Matching Learner Characteristics with Content Attributes”, *International Journal of Computers and Applications* (IJCA) Special Issue on *Intelligence and Technology in Educational Applications*, ACTA Press, Volume25, Issue 1, pp. 50-64, 2003
- N. Manouselis, C. Karagiannidis and D. Sampson, “Layered Evaluation in Recommender Systems: A Retrospective Assessment”, *Journal e-Learning and Knowledge Society*, Volume 10, Issue 1, pp 109-127, January 2014
- P. Brusilovsky, C. Karagiannidis and D. Sampson, “Layered Evaluation of Adaptive Learning Systems”, *International Journal of Continuing Engineering Education and Lifelong Learning* (ISSN 1560-4624), Special issue on *Adaptivity in Web and Mobile Learning Services*, Inderscience Pub., Volume 14, Issue 4/5, pp. 402-421, November 2004
- P. Karampiperis and D. Sampson, “Adaptive Learning Object Selection in Intelligent Learning Systems”, *Journal of Interactive Learning Research*, Special Issue on *Computational Intelligence in Web-Based Education* AACE Press, Volume 15, Issue 4, pp. 389-409, November 2004

Key Research Publications 2005-2014

- P. Karampiperis and D. Sampson, "Automatic Learning Object Selection and Sequencing in Web-Based Intelligent Learning Systems", in Zongmin Ma (Ed.), *Web-Based Intelligent e-Learning Systems: Technologies and Applications* (ISBN 1-59140-729-3), Chapter III, pp. 56-71, Information Science Publishing, 2005
- P. Karampiperis and D. Sampson, “Adaptive Learning Resources Sequencing in Educational Hypermedia Systems”, *Educational Technology & Society Journal*, Volume 8, Issue 4, pp. 128-147, October 2005
- P. Karampiperis, T. Lin, D. Sampson and Kinshuk, “Adaptive Cognitive-based Selection of Learning Objects”, *International Journal on Innovations in Education and Teaching International*, Taylor & Francis, Volume 43, Issue 2, pp. 121-135, May 2006
- D. Sampson and P. Karampiperis, "Decision Models in the Design of Adaptive Educational Hypermedia Systems", in Sabine Graf, Fuhua Lin, Kinshuk and Rory McGreal (Eds), *Intelligent and Adaptive Learning Systems: Technology Enhanced Support for Learners and Teachers* (ISBN 9781609608422), chapter 1, pp. 1-18, IGI Global, 2011
- P. Karampiperis and D. Sampson, "Performance Evaluation of Decision-based Content Selection Approaches in Adaptive Educational Hypermedia Systems", in Alejandro P. Ayala (Ed.), *Intelligent and Adaptive Educational-Learning Systems: Achievements and Trends*, Chapter 7, pp 161-182, 978-3-642-30170-4 Springer, 2013
- P. Zervas, D. Sampson, S. Gomez, and R. Fabregat, "Designing Tools for Context-Aware Mobile Educational Content Adaptation", in D. Sampson, D. Ifenthaler, P. Isaias, and J. M. Spector (Eds), "*Ubiquitous and Mobile Informal and Formal Learning in Digital Age*", Chapter 3, pp. 37-50, ISBN 978-1-4614-3328-6 Springer, 2013
- D. Sampson and P. Zervas, “Context-Aware Adaptive and Personalised Mobile Learning Systems”, in D. Sampson, D. Ifenthaler, P. Isaias, and J. M. Spector (Eds), "*Ubiquitous and Mobile Informal and Formal Learning in Digital Age*", Chapter 1, pp. 3-17, ISBN 978-1-4614-3328-6, Springer, 2013
- S. Gomez, P. Zervas, D. Sampson and R. Fabregat, “Context-Aware Adaptive and Personalized Mobile Learning Delivery Supported by UoLmP“, *King Saud University – Computer and Information Systems Journal*, Elsevier, Volume 26, Issue 1, pp. 47-61, January 2014

Educational Data Analytics

Key Research Components

- **Profiling**:
  - Students, Teachers, Curricula, Schools, Professional Placements, Graduates, Jobs
- **Educational Data Analytics**:
  - Learning, Teaching, Organisational
- **Recommender Systems**:
  - Resources, Tools, Peers, Tutors, Courses, Professional Placements, Curricula, Jobs

Educational Data Analytics

Learning Analytics	methods and digital tools to collect, analyze and report student-related educational data towards monitoring the **learning process**
Teaching Analytics	methods and digital tools to analyze, assess and/or visualize **teaching practice**; in combination with Learning Analytics, can support *evidence-based* ***reflection*** on teaching practice.
Organisational Analytics	methods and digital tools to collect, analyze and report data related to the '**Business Intelligence**' of educational institutions

Teaching and Learning Analytics for Reflective Educational (re)Design in Inquiry-based STEM Education

Research Background

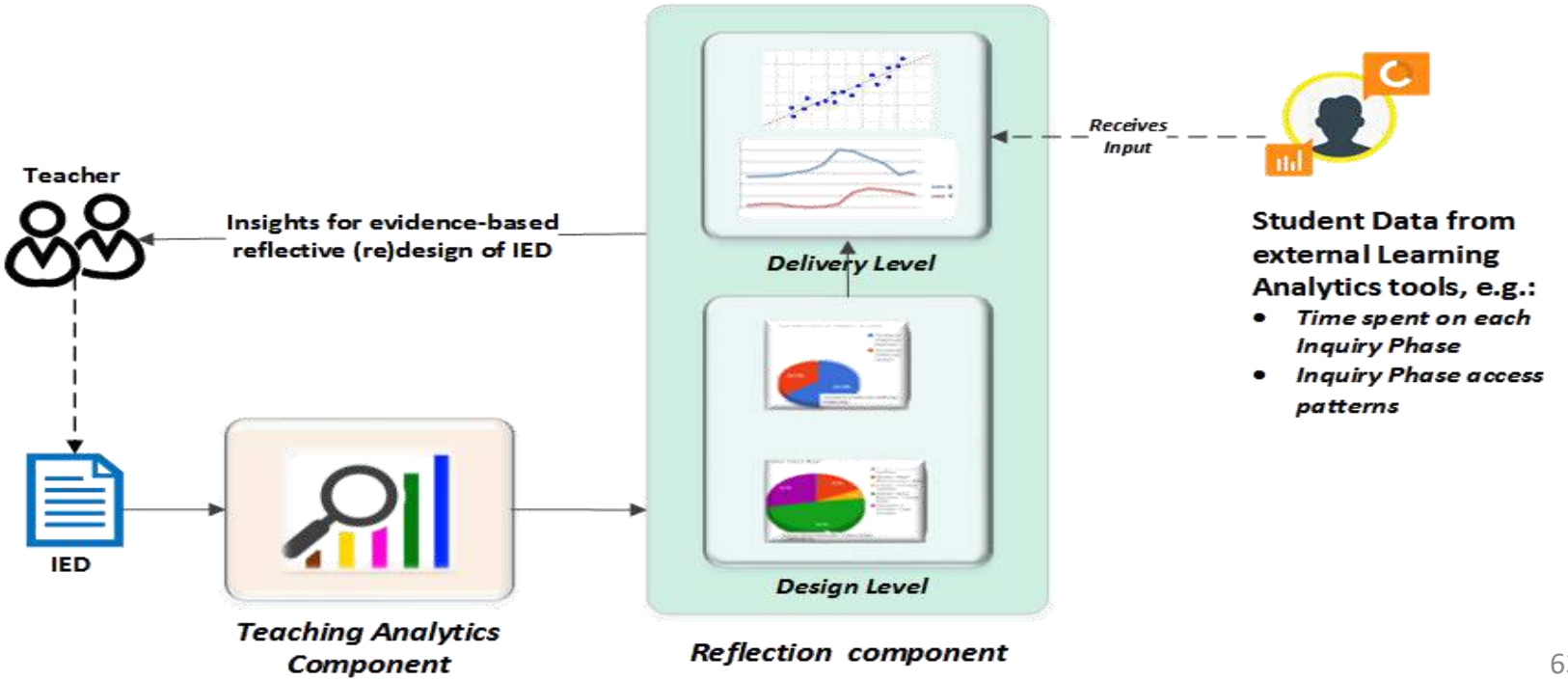
- **Guided Inquiry-based** teaching and learning the dominant approach in STEM education.
- Appropriate ***guidance*** to students, supported by various digital tools (including remote and virtual labs) is critical while engaging in the complex inquiry tasks
- Teachers need to:
  - At the **design level**: make assumptions about the level of technology-supported guidance to provide in their scenario plans
  - At the **re-design level**: refine their initial design based on evidences collected by monitoring the actual delivery.

Can we exploit the potential of Teaching and Learning Analytics to support this process and effectively inform teachers' reflection on their educational design?

Teaching and Learning Analytics for Reflective Educational (re)Design in Inquiry-based STEM Education

Research Contribution

- Develop and evaluate a Teaching and Learning Analytics method and research prototype tool to:
  - Analyze Inquiry-based educational designs (IED) in terms of the **tool-supported guidance** they offer and visualize the output using various dashboards
  - Correlate these analyses to individual **students' learning activity** data, generating insights to inform teachers on potential design improvements to make.



Teaching and Learning Analytics for Reflective Educational (re)Design in Inquiry-based STEM Education

Research Outcomes

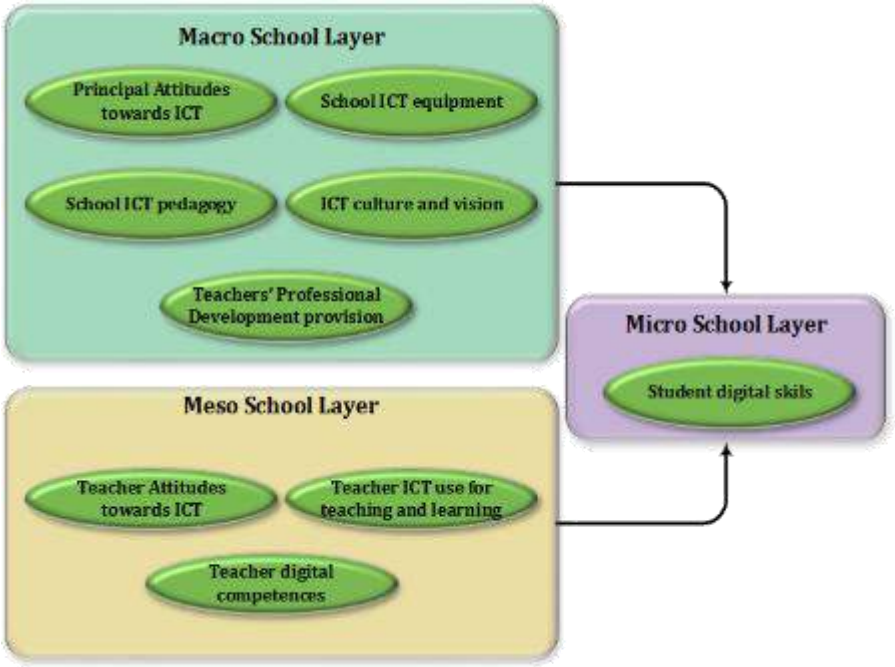
- The proposed method/tool provides data-driven evidence to **teachers** to **reflect** in their teaching practice and **create** better learning experiences through appropriate guidance provision to their students

- The outcomes of this research project so far include:
  - S. Sergis, D. Sampson, L. Pelliccione, M. Rodriguez, D. Gillet and T. de Jong, "A Teaching and Learning Analytics Tool for Reflective Educational (re)Design in Inquiry-based STEM Education", *Computers in Human Behavior*, Elsevier, 2018
  - S. Sergis and D. Sampson, "Towards a Teaching Analytics Tool for supporting reflective educational (re)design in Inquiry-based STEM Education", 16th IEEE International Conference on Advanced Learning Technologies (ICALT 2016), Austin, Texas, USA 25-28, July 2016 **[BEST FULL PAPER AWARD]**

Supporting school leadership decision making with actionable insights using holistic School Analytics

Research Background

- Sustainable **school improvement**: a core expectation from school leaders globally
- Create fostering learning conditions for all students and cultivate skills for the digital society, such as ***digital skills***
- This requires:
  - Collect educational data from diverse factors across school layers
  - Analyse them
  - Transform these data into actions for targeted improvement.



Can we extend the capacity of existing School Analytics methods to inform school leaders' strategic planning for school improvement with actionable insights?

Supporting school leadership decision making with actionable insights using holistic School Analytics

Research Contribution

- Design and evaluate a novel **School Analytics** approach **using fuzzy-set Qualitative Comparative Analysis**, that:
  - Understand school ecosystemic factors impacting students' digital skills by identifying specific configurations of these factors that can lead to high students' digital skills
  - And thus provide school leaders with actionable insights to create the school conditions that will better foster students' learning outcomes (related with digital skills, in our case study)

School Factors	Eight Configurations of school factors that can lead to higher student digital skills							
	1	2	3	4	5	6	7	8
Principal Attitudes	●	●	●		●	⊗		
Teacher Professional Development			●	⊗	⊗		⊗	⊗
School Equipment				⊗			⊗	●
School Culture / Vision		●	●	●	●	●	⊗	⊗
School Pedagogy			⊗			●	●	⊗
Teacher ICT use in classroom	●			●	●			
Teacher Attitudes	●	⊗		●		●	●	●
Teacher digital skills		●				●	●	●

Checks indicate that the corresponding school factor is present in the configuration, crossed-out white circles indicate absence of a factor, blank cells indicate a "don't-care-condition"

Supporting school leadership decision making with actionable insights using holistic School Analytics

Research Significance

- The proposed School Analytics method can support **school leaders** to:
  - Create a transparent **holistic school profile** of factors that affect students' learning (in our case study: **digital skills**), and
  - Highlight which of these factors need to change and in what way, to create better conditions for cultivating students' digital skills

- The outcomes of this research project so far include:
  - S. Sergis, D. Sampson and M. Giannakos, "Supporting school leadership decision making with actionable insights: A holistic School Analytics approach based on fuzzy-set Qualitative Comparative Analysis", Computers in Human Behavior, Elsevier, 2018
  - S. Sergis, D. Sampson and M. Giannakos, "Enhancing student digital skills: Adopting an ecosystemic school analytics approach", 17th IEEE International Conference on Advanced Learning Technologies (ICALT 2017), July 2017

Thank you for your attention

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