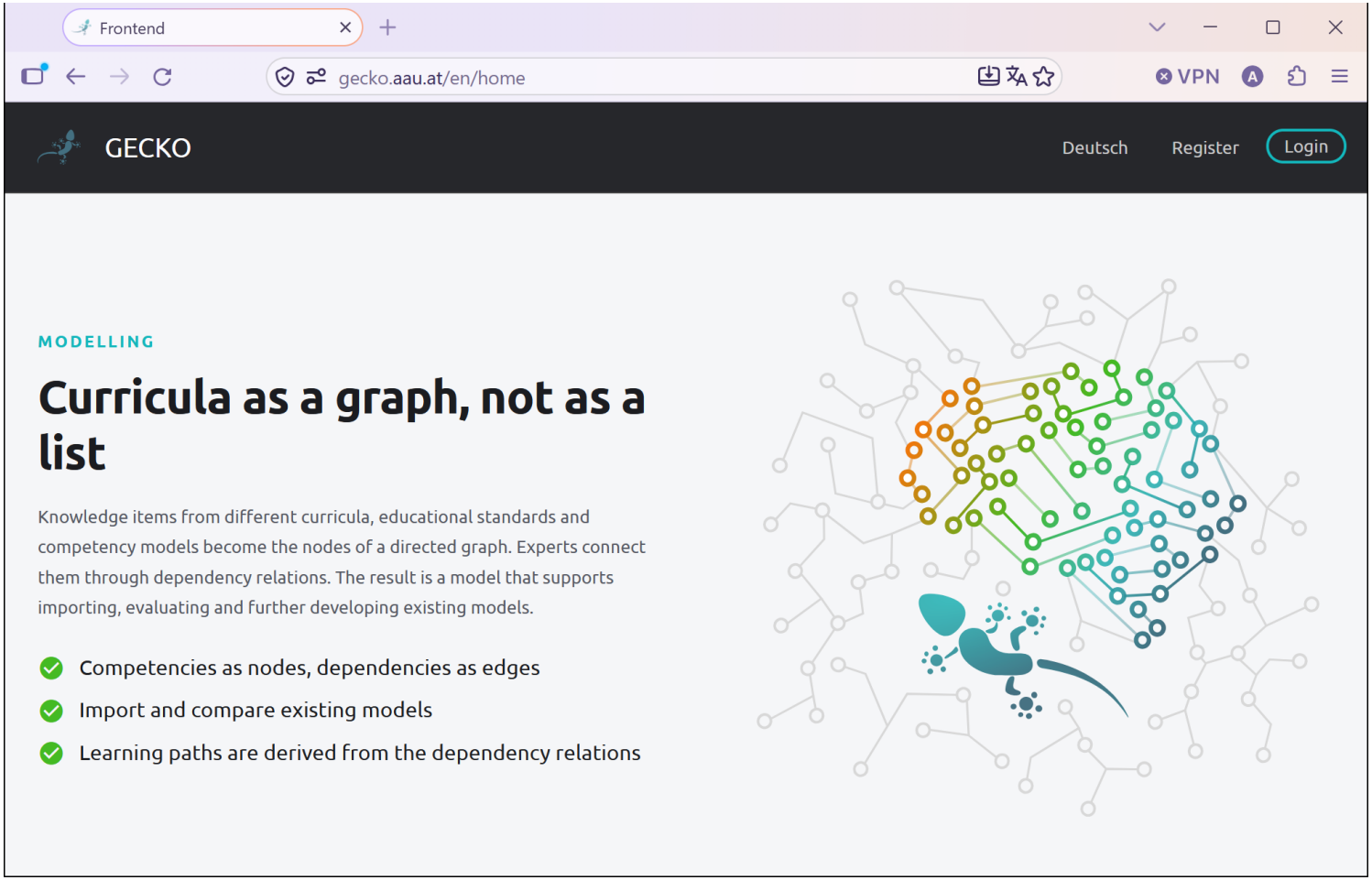
GECKO: A Graph-Based Approach to Competency Mapping and Curriculum Analysis

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ECSS 2026, Porto

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GECKO – A Graph-based Competency Tool



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What can a curriculum tell us about readiness?

- **Curricula describe intended learning outcomes — but their overall competency structure is difficult to see.**

COVERAGE	PROGRESSION	COHERENCE
Which competencies are addressed?	How do competencies build on each other?	Where might gaps or redundancies occur?

➔ **Our starting point: make competencies and their relationships explicit.**

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From documents to structured competency data (1/9)

- **Curricula describe intended learning outcomes — but their overall competency structure is difficult to see.**

CURRICULUM	STRUCTURE	ANALYSE	REVIEW
Modules and learning outcomes	Competency extraction and relations	Rules, AI-assisted checks, graphs	Human judgement and revisions

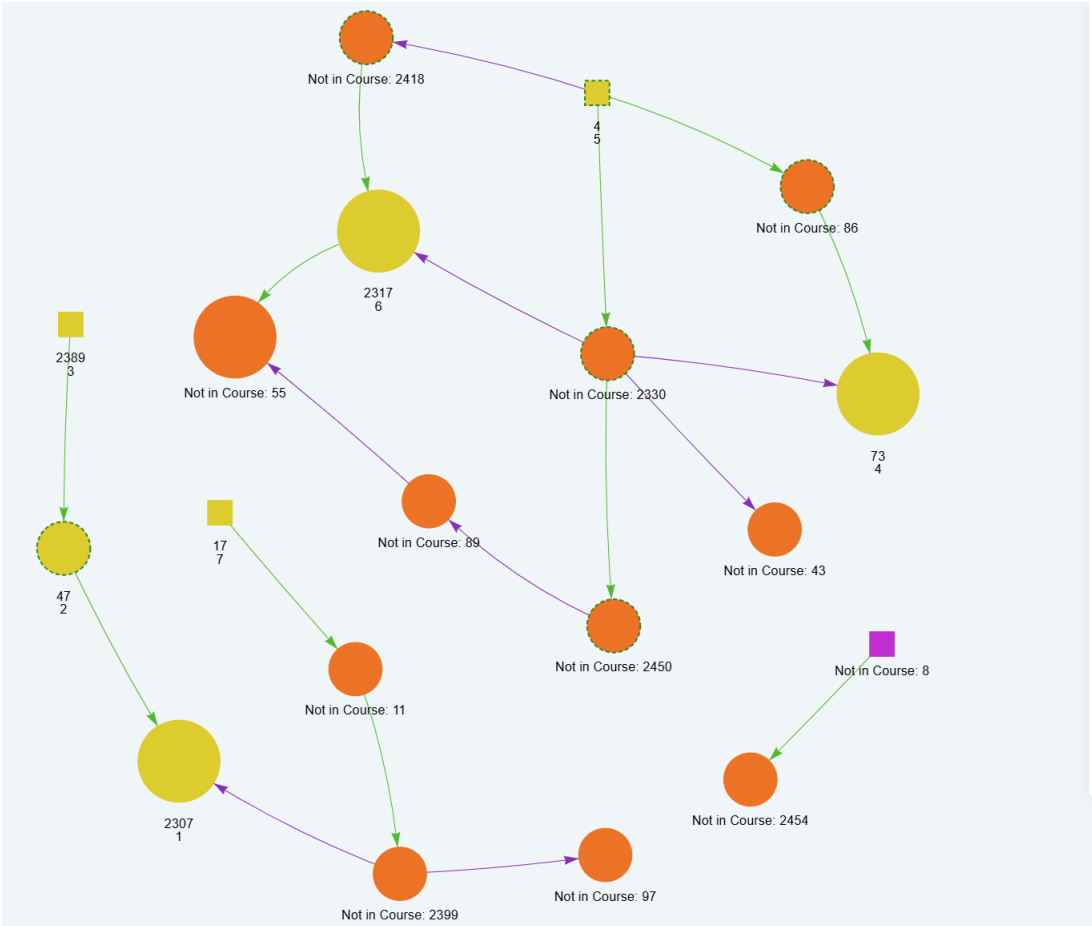
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maximum age: 7
level: 1

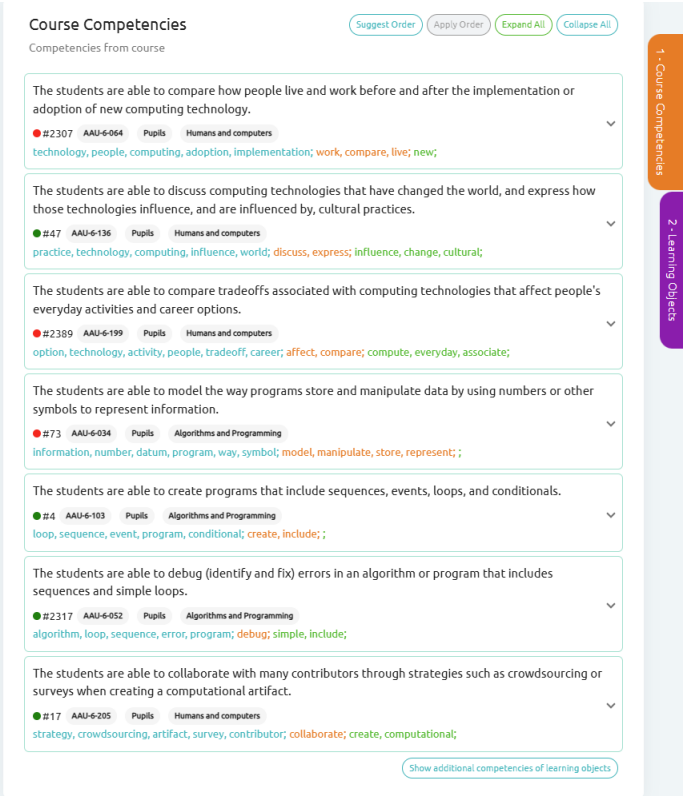
Concept	Subconcept	Level 1A (Ages 5-7) *By the end of Grade 2, students will be able to...*	Level 1B (Ages 8-11) *By the end of Grade 5, students will be able to...*
Computing Systems	Devices	**1A-CS-01** Select and operate appropriate software to perform a variety of tasks, and recognize that users have different needs and preferences for the technology they use. *(P1.1)*	**1B-CS-01** Describe how internal and external parts of computing devices function to form a system. *(P7.2)*
	Hardware & Software	**1A-CS-02** Use appropriate terminology in identifying components of computing systems (hardware). *(P7.2)*	**1B-CS-02** Model how computer hardware and software work together as a system to accomplish tasks. *(P4.4)*
	Troubleshooting	**1A-CS-03** Describe basic hardware and software problems using accurate terminology. *(P6.2, P7.2)*	**1B-CS-03** Determine potential solutions to solve simple hardware and software problems using common troubleshooting strategies. *(P6.2)*
Networks & The Internet	Network Communication & Organization		**1B-NI-04** Model how information is broken down into smaller pieces, transmitted as packets through multiple devices over networks and the Internet, and reassembled at the destination. *(P4.4)*
	Cybersecurity	**1A-NI-04** Explain what passwords are and why we use them, and use strong passwords to protect devices and information from unauthorized access. *(P7.3)*	**1B-NI-05** Discuss real-world cybersecurity problems and how personal information can be protected. *(P3.1)*

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From documents to structured competency data (2/9)

- **Analyzing Curricula (CSTA and TEWI-GECKO)**





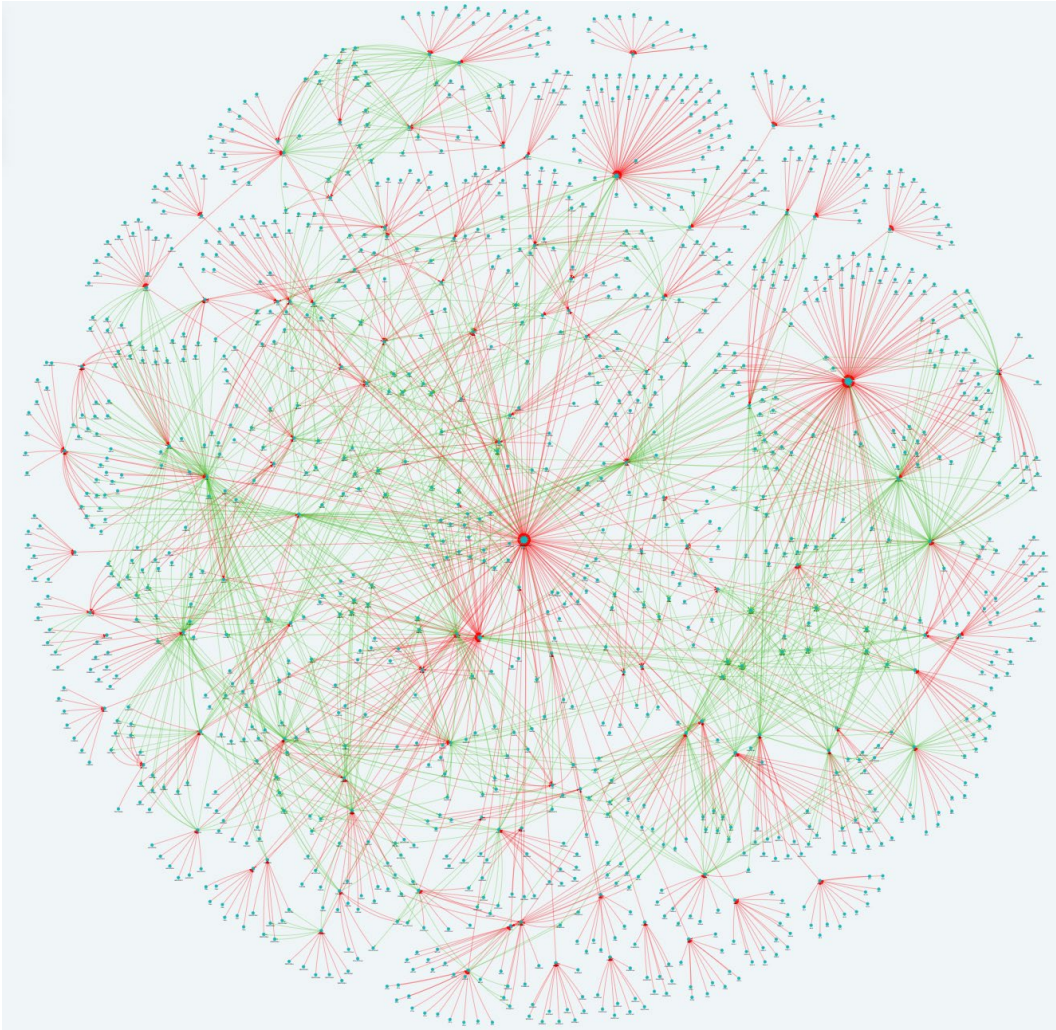
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From documents to structured competency data (3/9)

- **Making competency dependencies visible @TEWI / Univ. KLU**

  Red: … is part of …
  Green: … requires …

- Central nodes:
  - Introduction to Informatics
  - Introduction to Informatics Education
  - Microelectronics
- Node size:
  Number of relations



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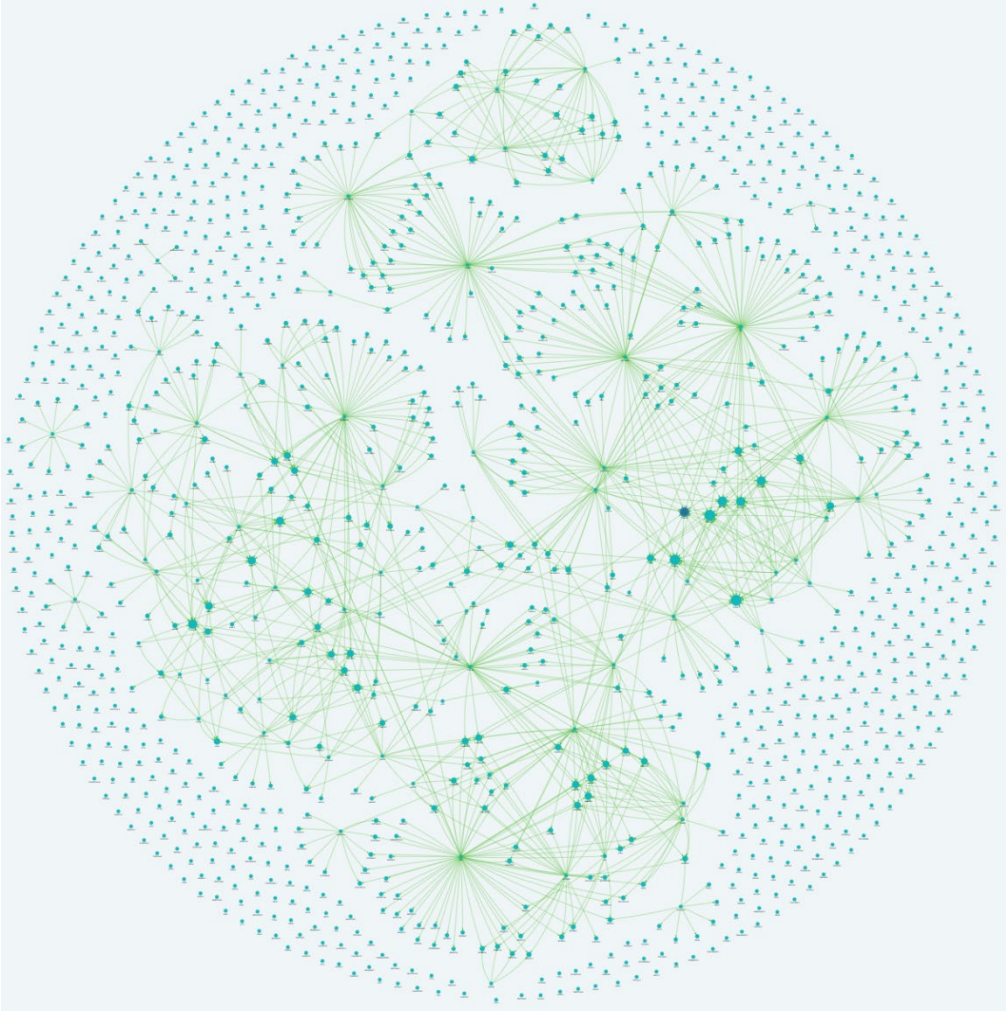
From documents to structured competency data (4/9)

- **Making competency dependencies visible @TEWI / Univ. KLU**

- Key competencies:
  - Loops
  - Methods
  - Arrays
  - Conditional Statements

- Node size: Number of prerequisite relations

- Isolated nodes: No cross-course dependencies



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From documents to structured competency data (5/9)

- **Recent Work: three complementary quality perspectives**

RULE-BASED	AI-ASSISTED	GRAPH-BASED
Formal structure, missing information, assignments	Wording, taxonomy levels, possible inconsistencies	Dependencies, progression, structural patterns

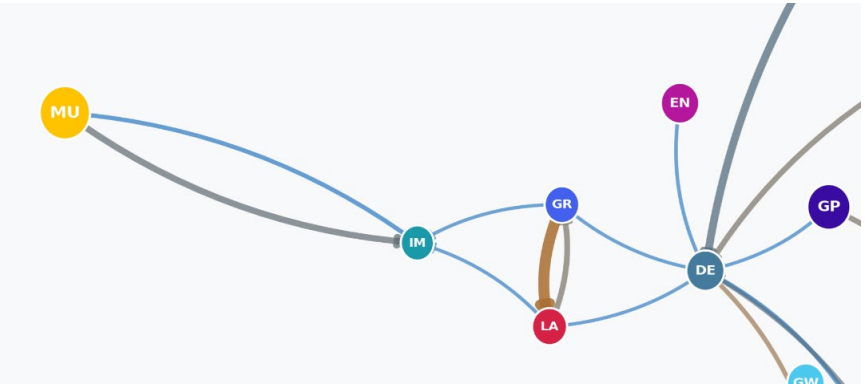
- **All three provide diagnostic evidence — none replaces expert evaluation.**

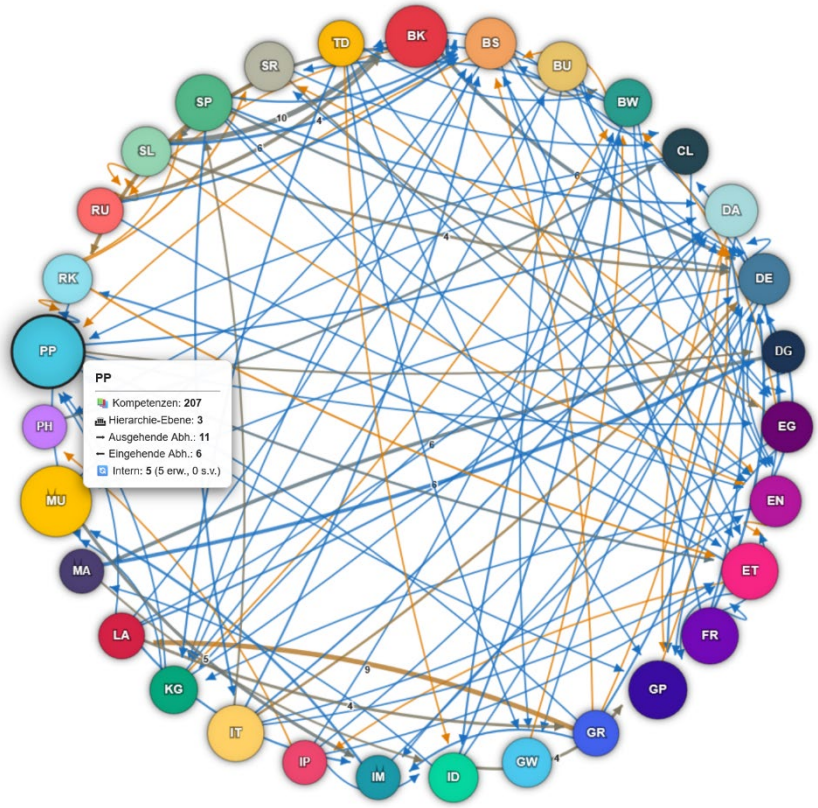
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From documents to structured competency data (6/9)

- **Making competency dependencies visible**

EVSO Austria (Teacher Education Curricula in south-eastern Austria)





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From documents to structured competency data (7/9)

- **A real application: teacher education curricula**

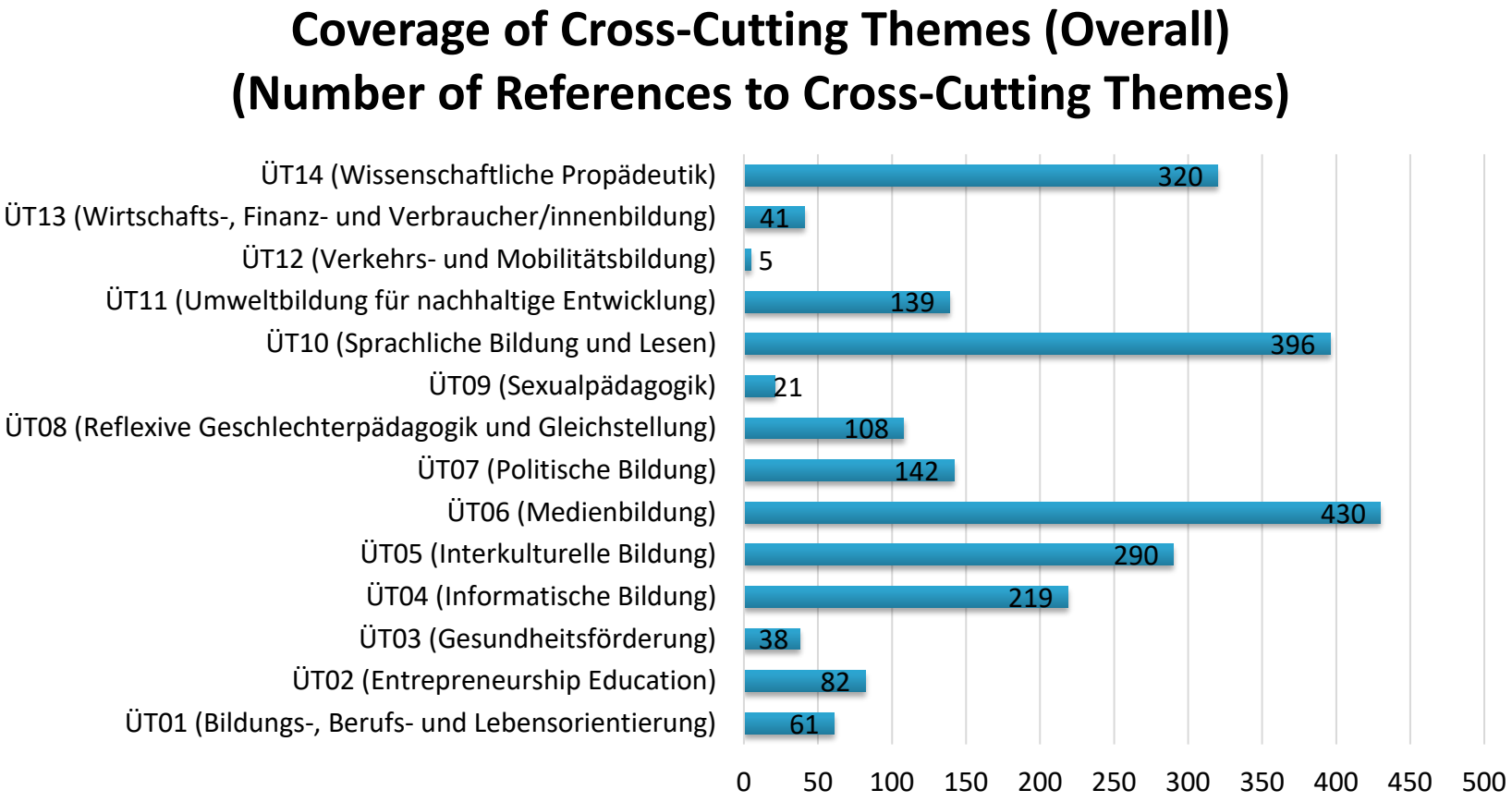
64	3,623	11,390
Curriculum files	BA+MAcompetencies	Dependencies

- **What Did We Learn from the EVSO Case Study?**
  - Precision: Ambiguous and difficult-to-assess competency statements
  - Coverage: Missing links and underrepresented competency areas
  - Progression: Unexpected changes in cognitive demand
  - Coherence: Redundancies, inconsistencies and structural dependencies
  - Scalability: Automated feedback across multiple curricula

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From documents to structured competency data (8/9)

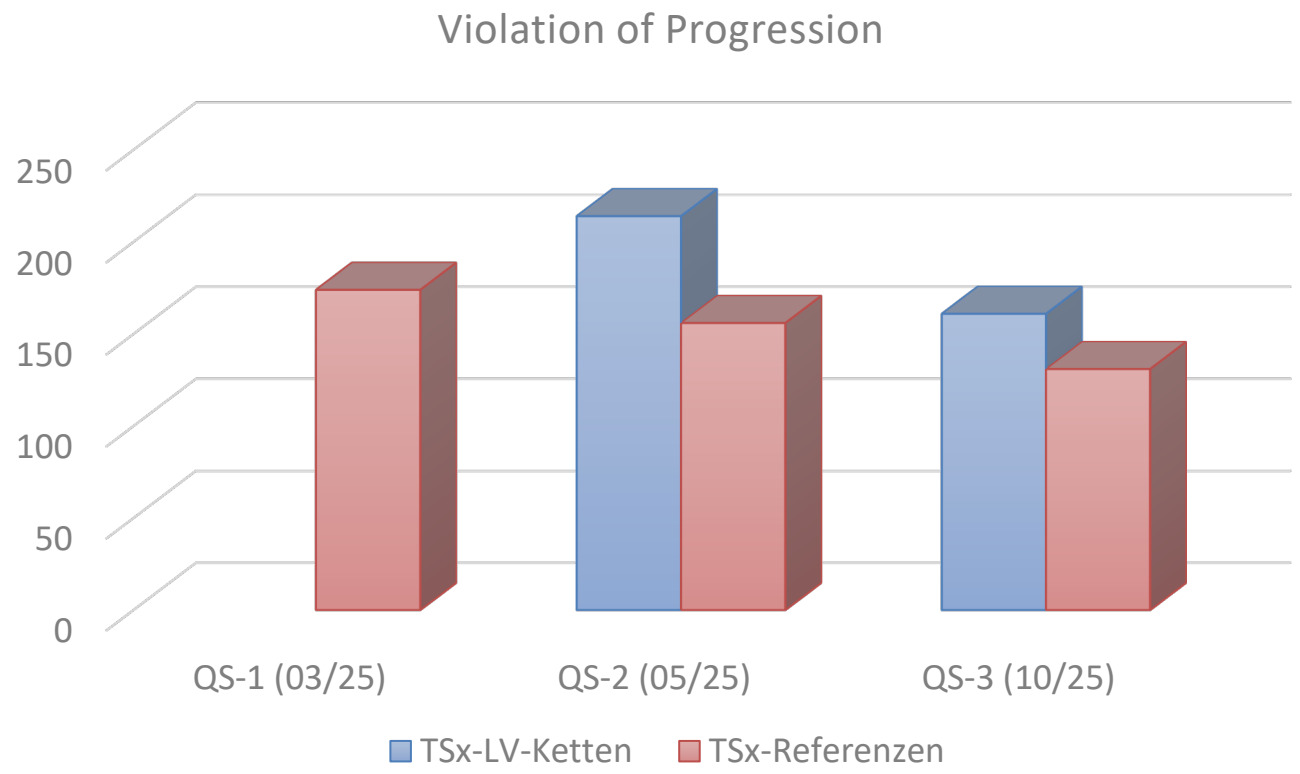
- **Wording, Topics, …**



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From documents to structured competency data (9/9)

- **Progression**



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Summary and Outlook (1/2)

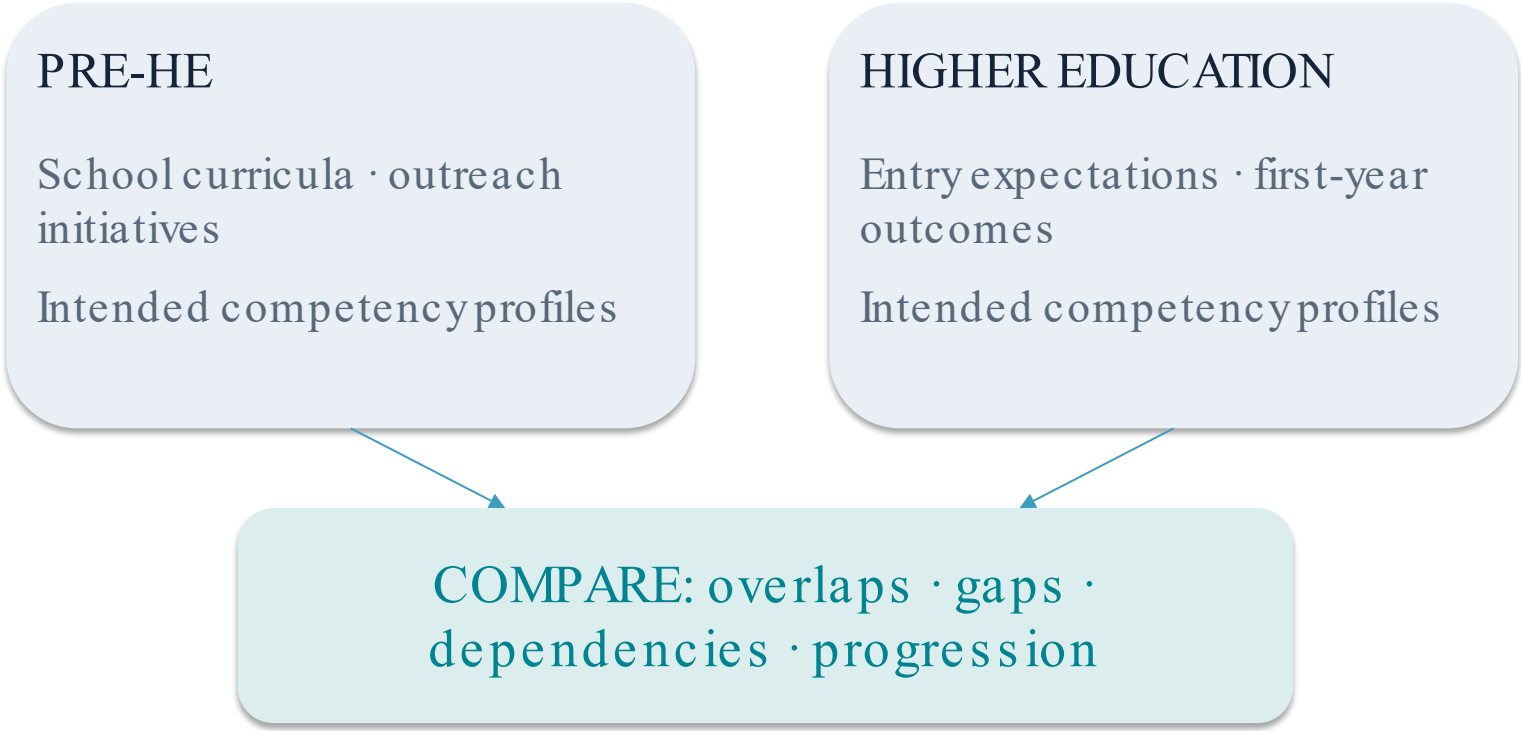
What Did We Learn and What Can GECKO (or similar approaches) Offer?

- **Transparency**: Reveal hidden competency structures and dependencies
- **Quality Assurance**: Detect unclear formulations, missing coverage and progression issues
- **Curriculum Improvement**: Support targeted revisions through rule-based, AI-assisted and graph-based analyses
- **Scalability**: Analyse thousands of competencies across multiple curricula

BTW: More Information on GECKO – Graph-based Educational Competence and Knowledge Observatory: Stefan.Pasterk@aau.at

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Summary and Outlook (2/2)



Which entry competencies do we perceive as most often missing?