

A Comprehensive Exploration of Personalized Learning in Smart Education: From Student Modeling to Personalized Recommendations

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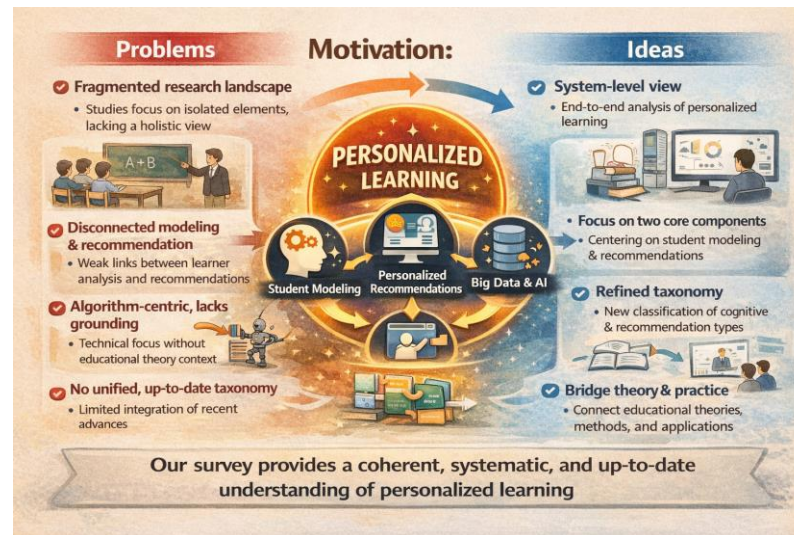
Problems & Ideas

Problems:

- **Fragmented research on personalized learning:** Existing studies focus on isolated components (e.g., recommendation algorithms or cognitive diagnosis), lacking a holistic view.
- **Algorithm-driven reviews overlook educational theories:** Educational theories are often mentioned but not systematically connected to modeling and recommendation designs.
- **Lack of a unified and up-to-date taxonomy:** Existing surveys are limited in scope or outdated, failing to reflect recent advances (2017–2025).

Ideas:

- **Adopt a system-level perspective:** This study systematically encompasses the entire chain from educational theory to technical methodologies and practical applications, effectively bridging the latest advances in core theory with cutting-edge practice.
- **Focus on two core components:** Student modeling and personalized recommendation are identified as the backbone of personalized learning systems.

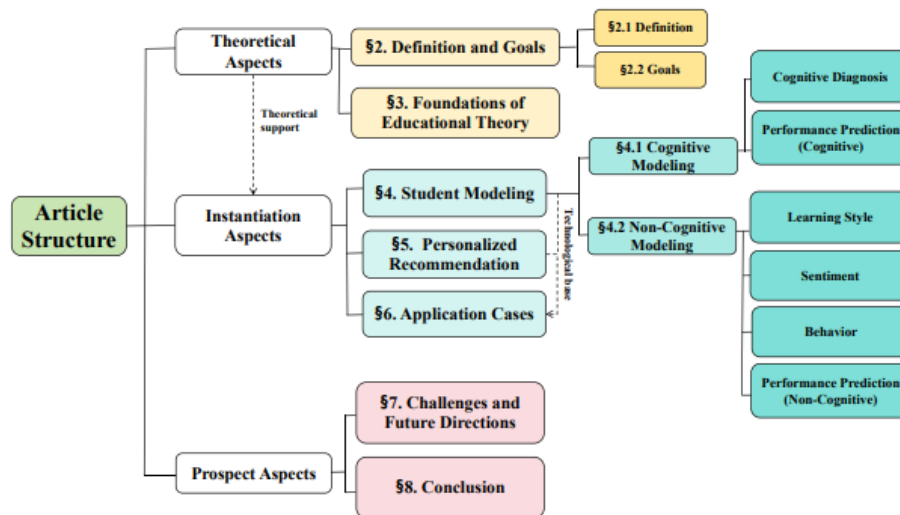


The figure illustrates the construction process of this review. It summarizes core issues in current personalized learning research, such as fragmentation and the disconnect between models and theory, while demonstrating how this study addresses these challenges by proposing a new classification system and systematic perspective to build a review framework that bridges theory, methodology, and practice.

Main Contributions

- **Contributions:**

- **A Novel Taxonomy:** We introduce a refined classification framework that divides student modeling into cognitive and non-cognitive categories and further classifies recommendation tasks into learning path, course, and exercise recommendations;
- **A Systematic Survey:** We provide a comprehensive, multidimensional review of 238 publications (2017-2025), connecting educational theories with technical methodologies across the entire pipeline from student modeling to personalized recommendations;
- **Connecting Theory and Practice:** Validating the effectiveness of personalized learning through real-world case studies, while identifying future research directions across four dimensions: data quality, assessment systems, technological limitations, and ethical considerations.



An overview framework of the survey.