



ICML
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EduMirror: Modeling Educational Social Dynamics with Value-driven Multi-agent Simulation



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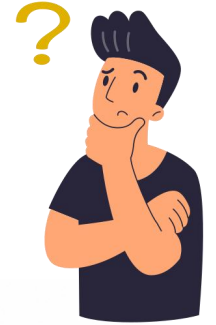
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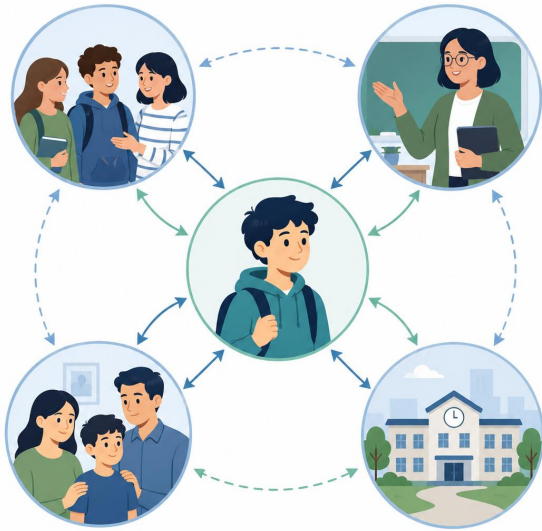
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Backgrounds



Why Educational Social Dynamics Are Hard to Study ?



Complex interactions



Ethical constraints

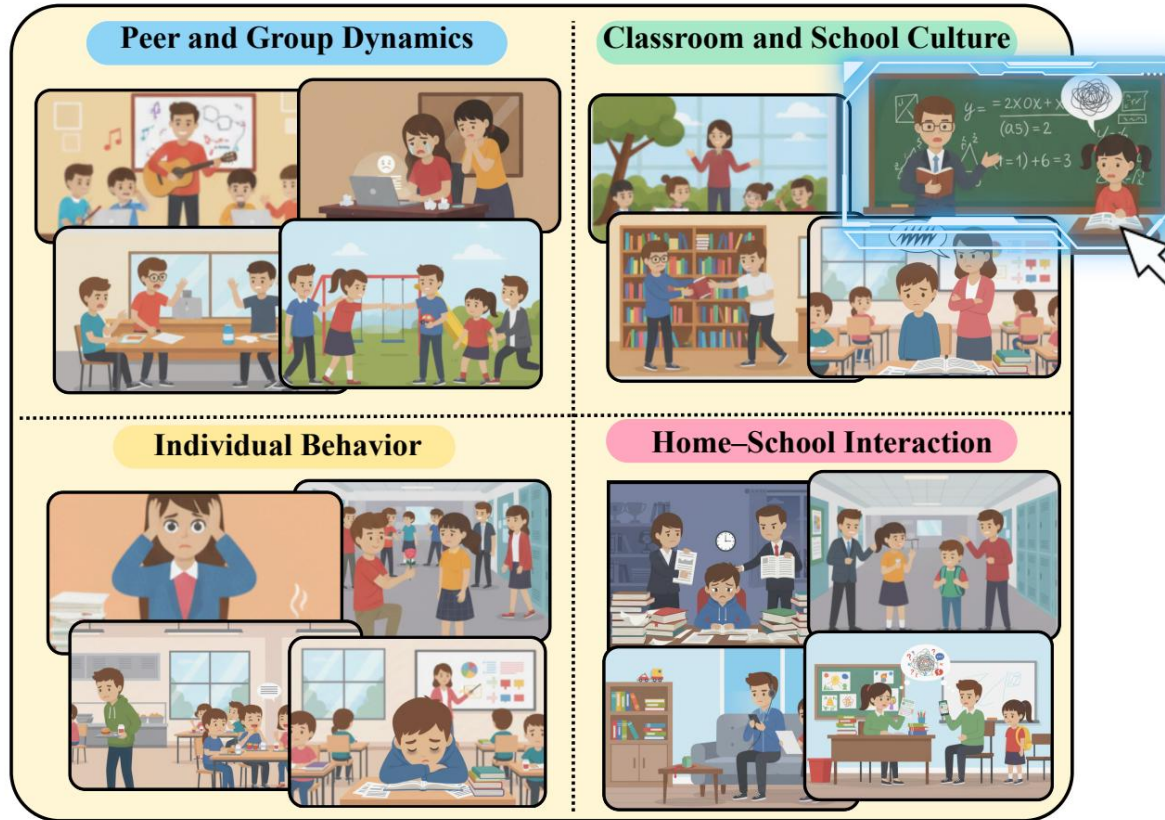


Hidden psychological states

We need an ethical way to run “what-if” experiments in education

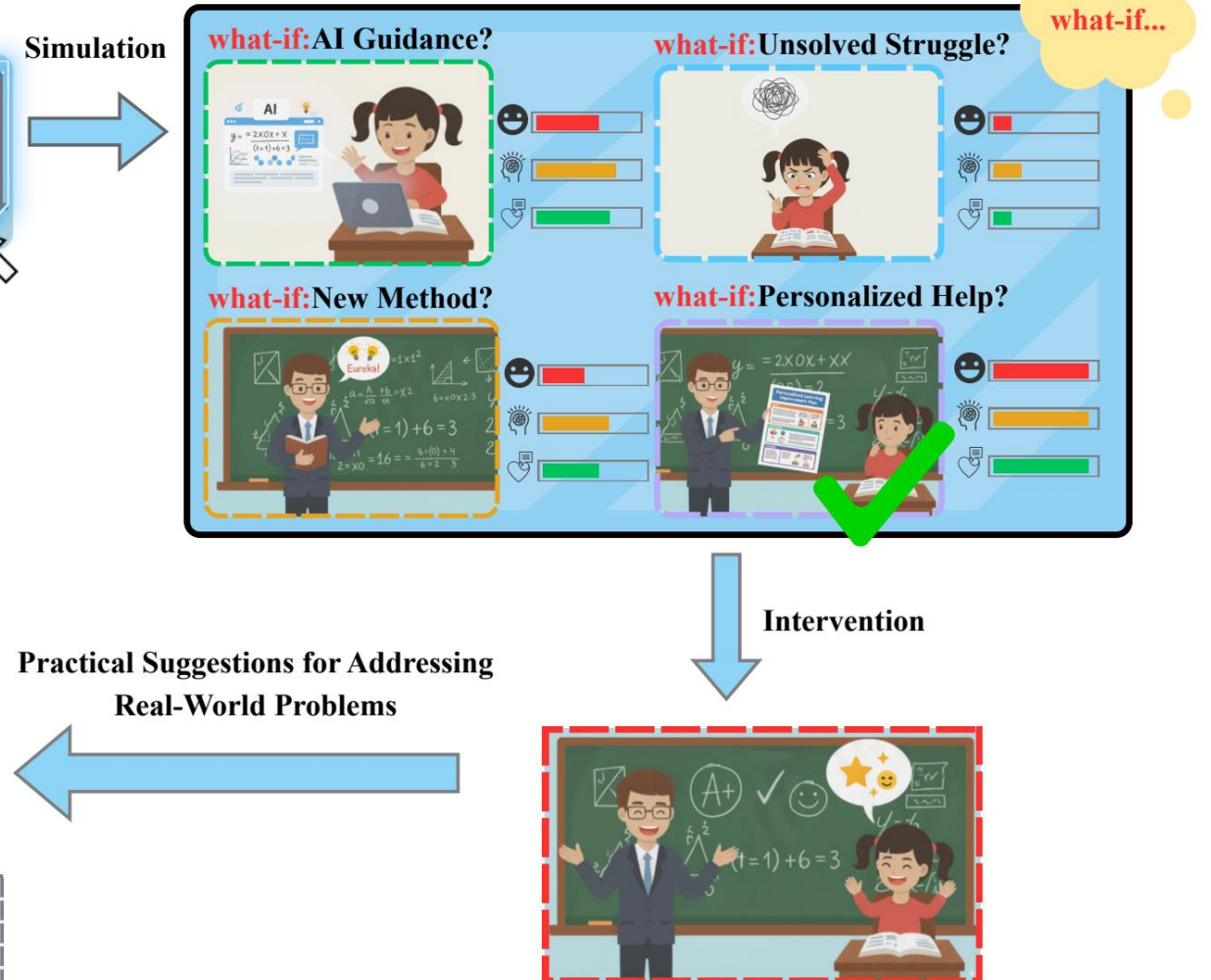
EduMirror

Diverse Real-World Educational Scenarios

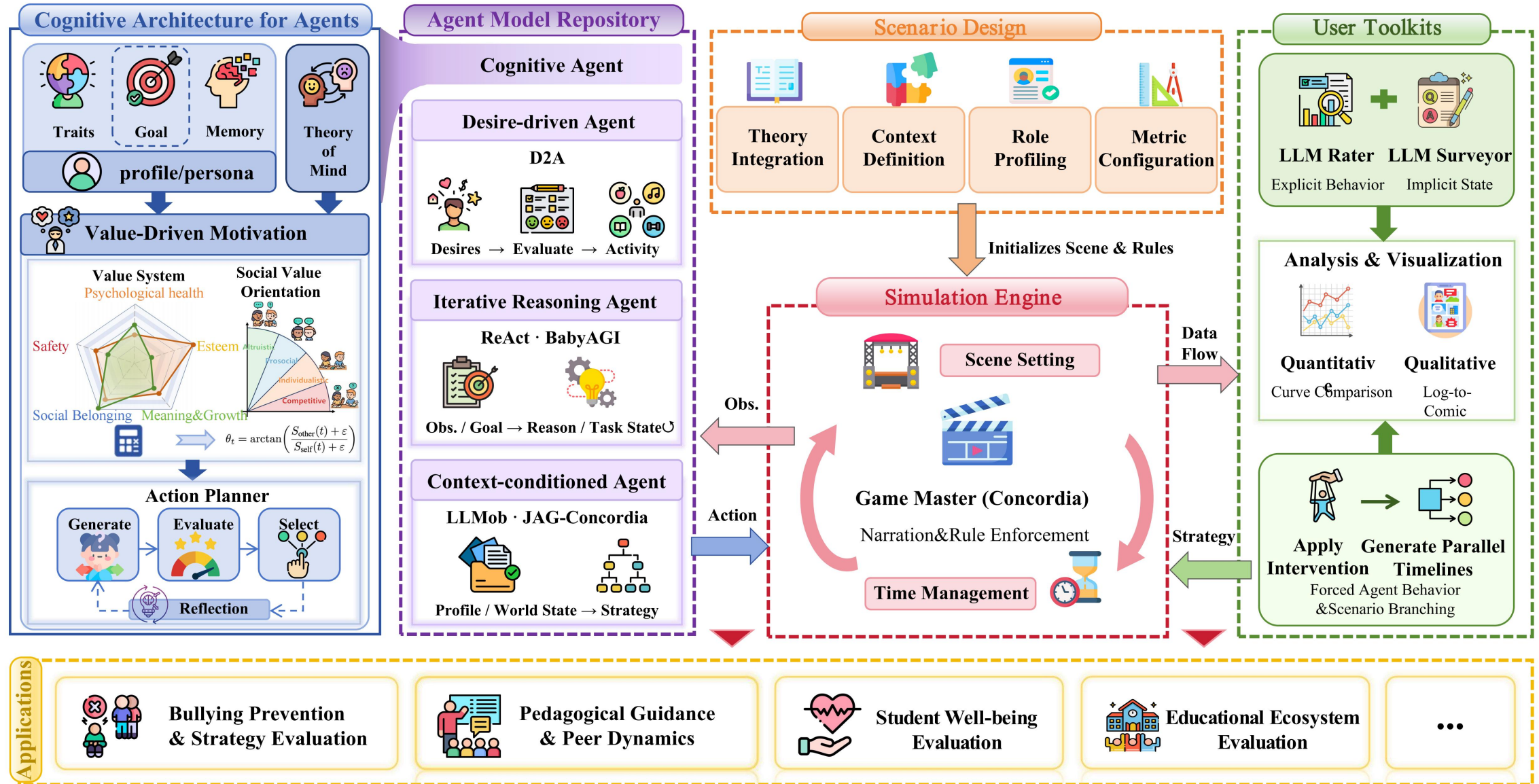


To address Alice's difficulties in understanding classroom content, designing and implementing a personalized improvement plan can best **fulfill her multidimensional value needs...**

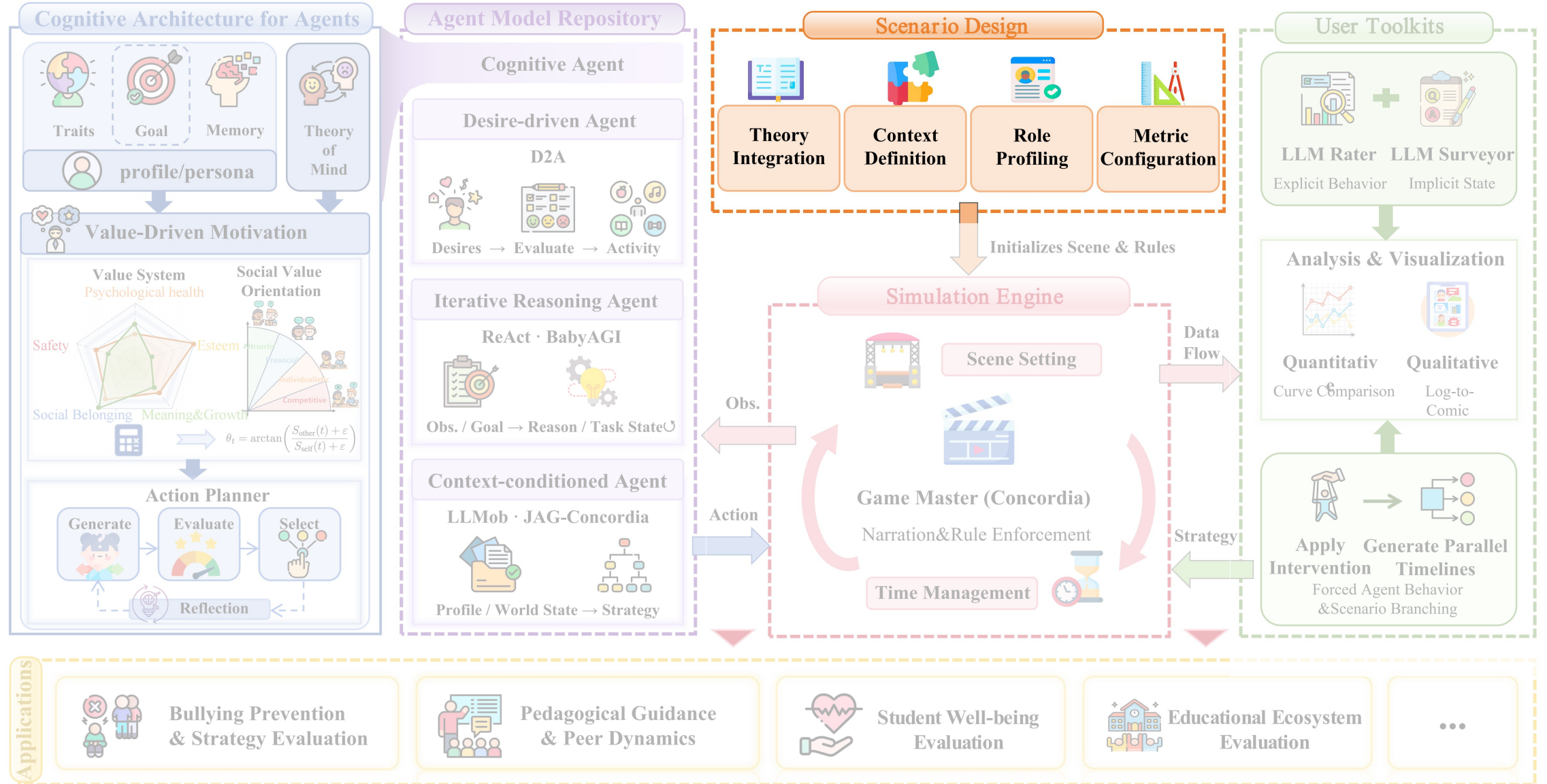
EduMirror



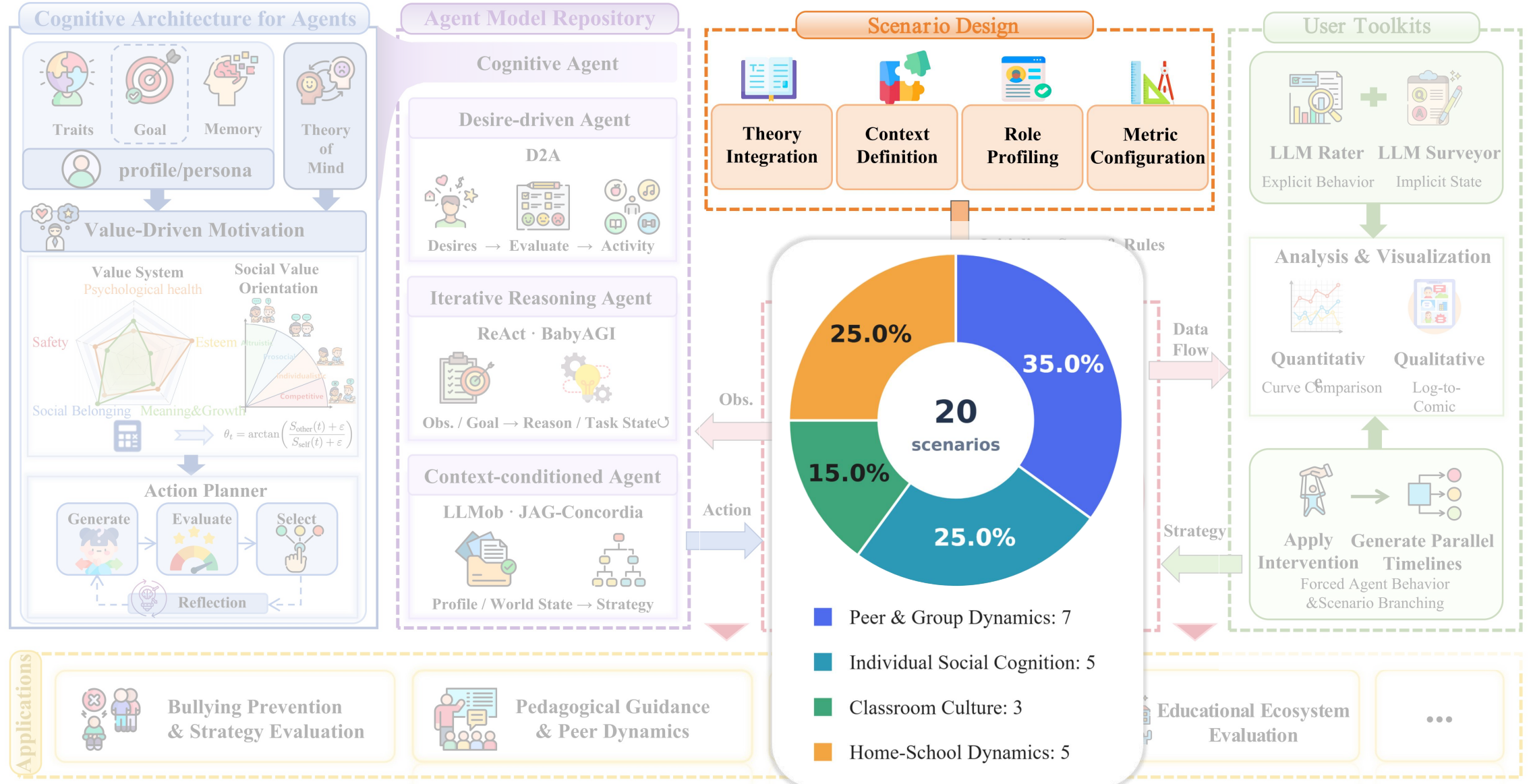
Overall Framework of EduMirror



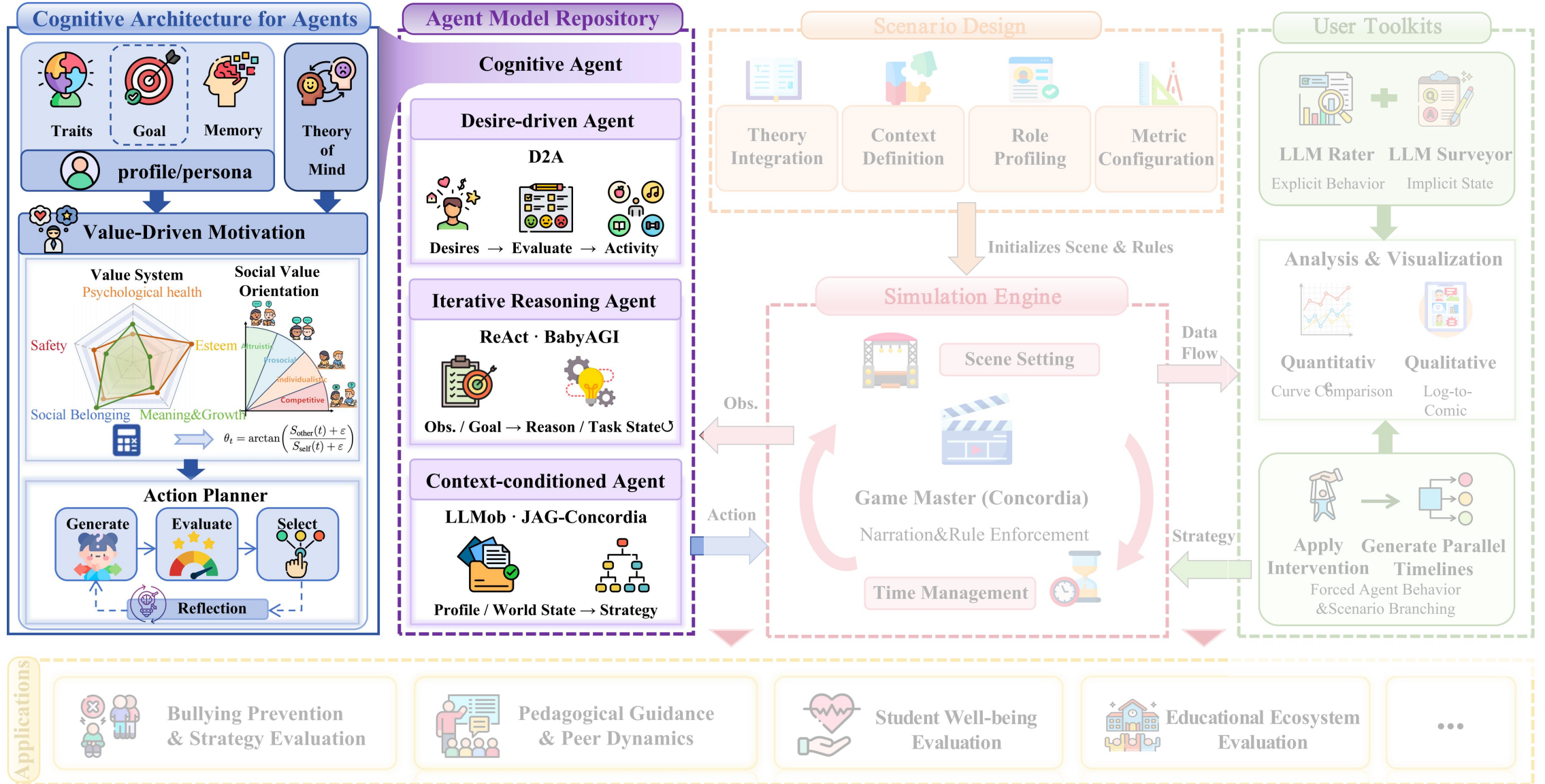
Framework of EduMirror



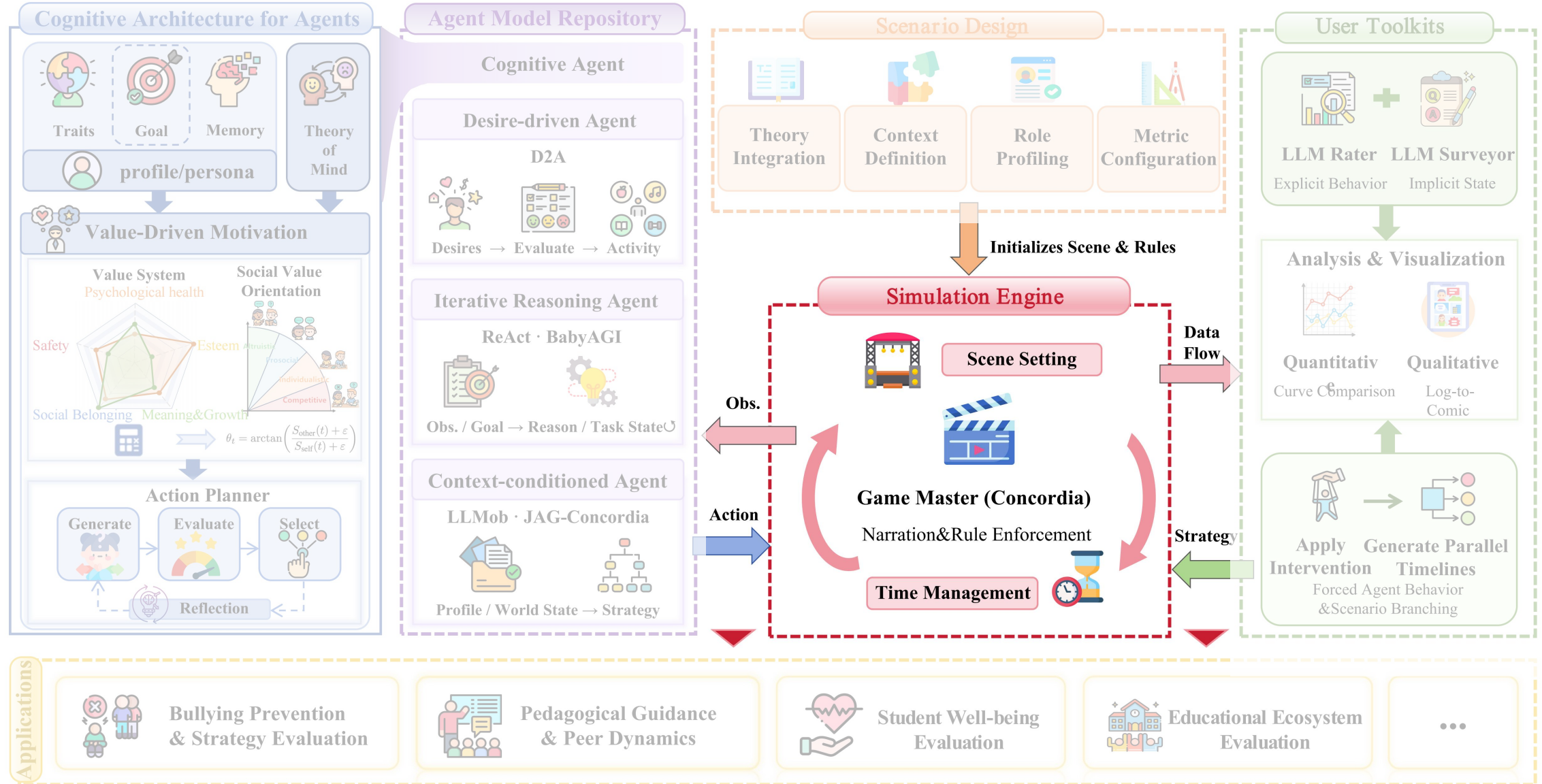
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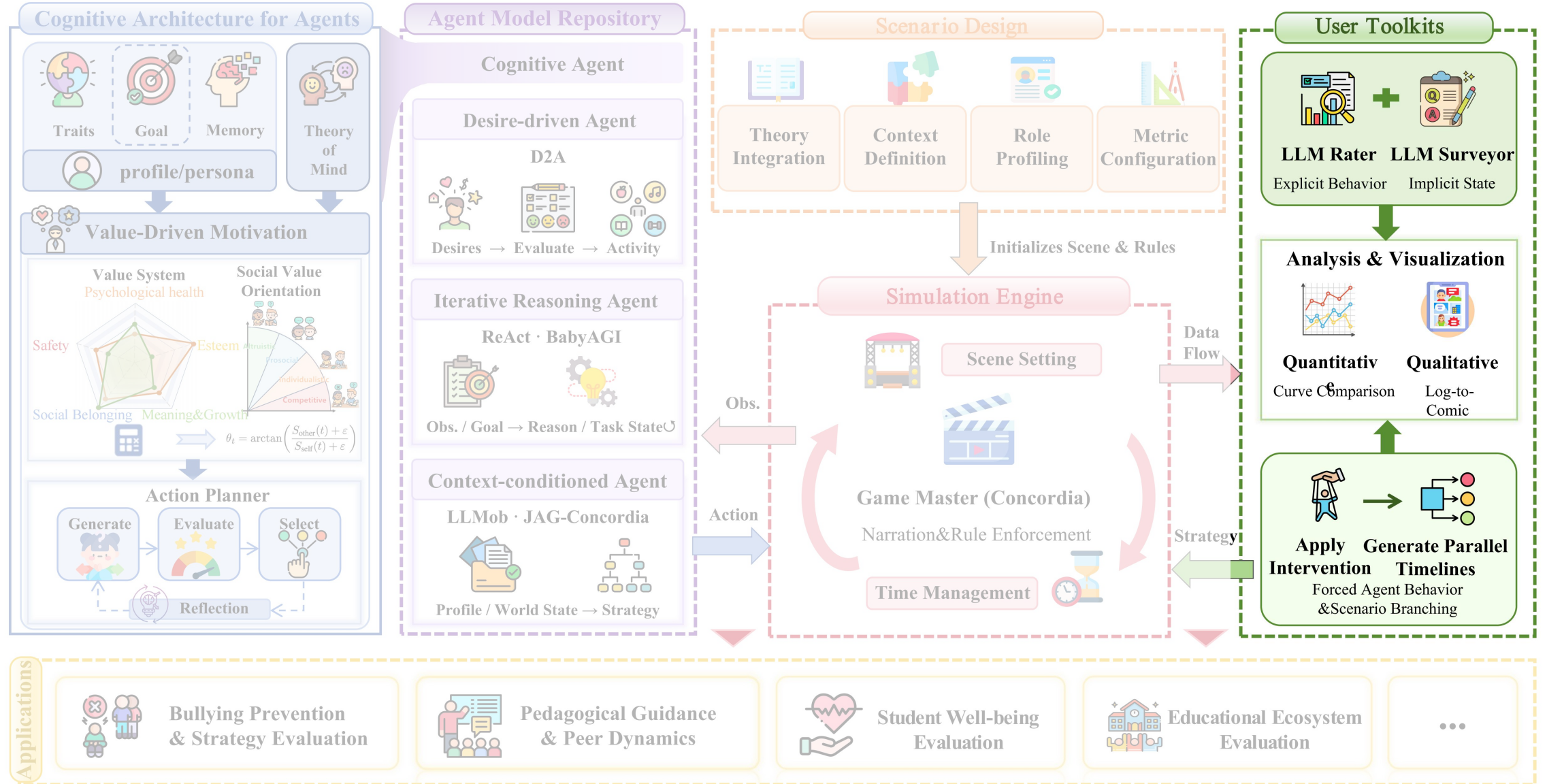
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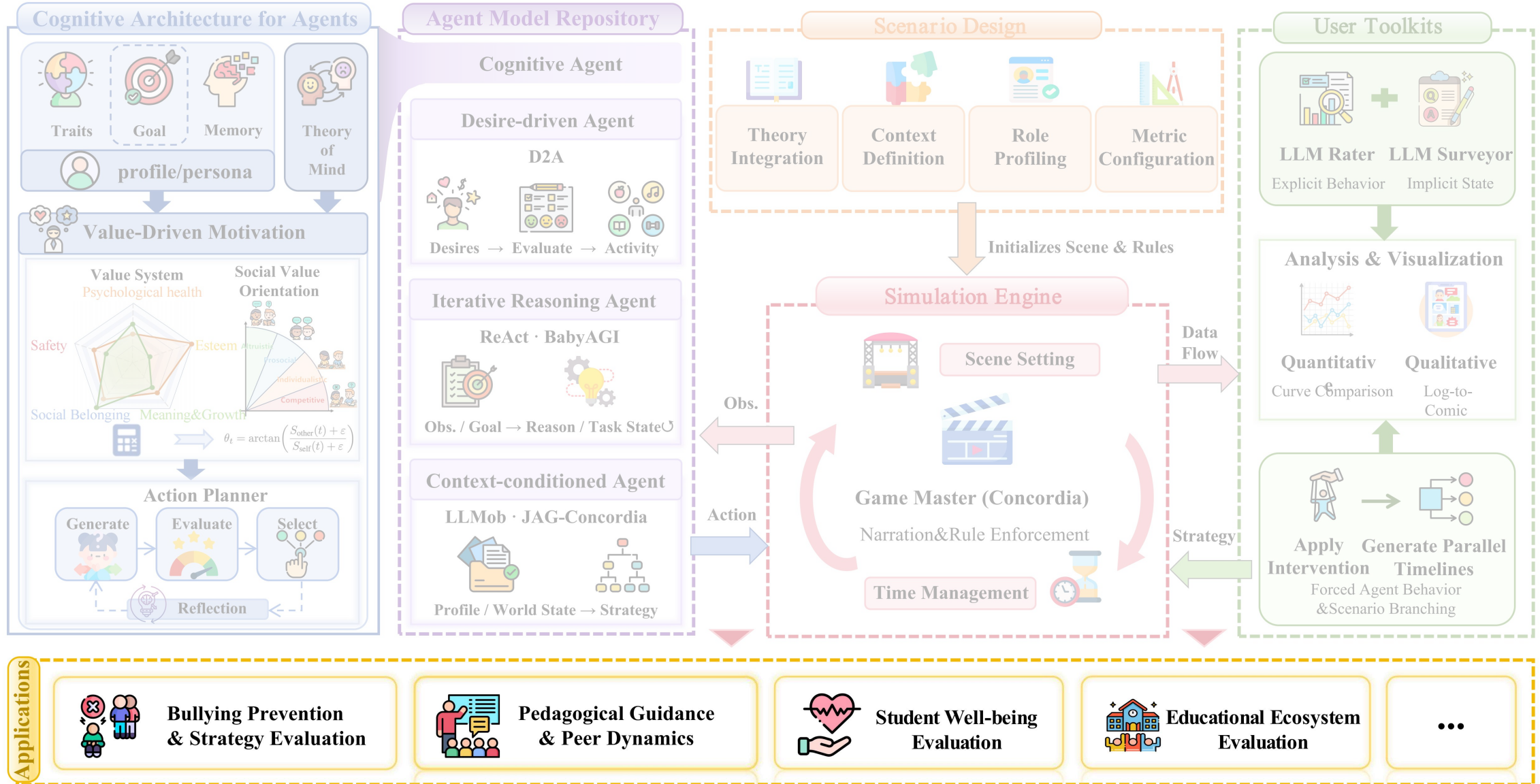
Framework of EduMirror



Framework of EduMirror



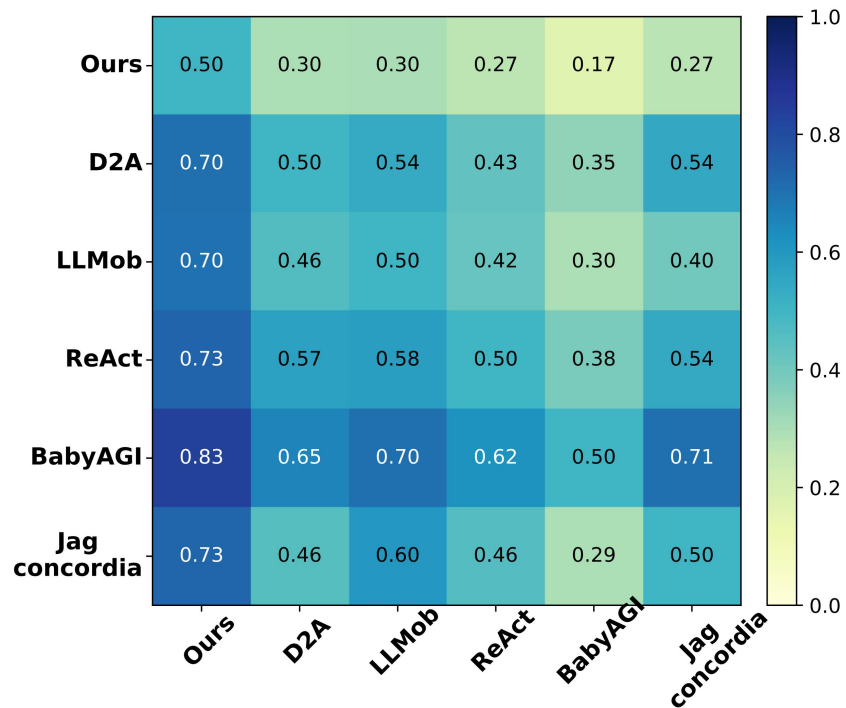
Framework of EduMirror



Experiments

System-level Validation:

Can EduMirror generate realistic simulations across diverse educational scenarios?



(a) Pairwise win-rate across 17 educational scenarios. EduMirror shows stronger overall realism than five baselines.

Agents	EduMirror	LLMob	BabyAGI	D2A	ReAct
5	4.80	4.25	4.10	3.35	2.35
15	4.18	3.60	3.57	3.53	2.93
30	4.03	3.83	3.86	3.12	2.41

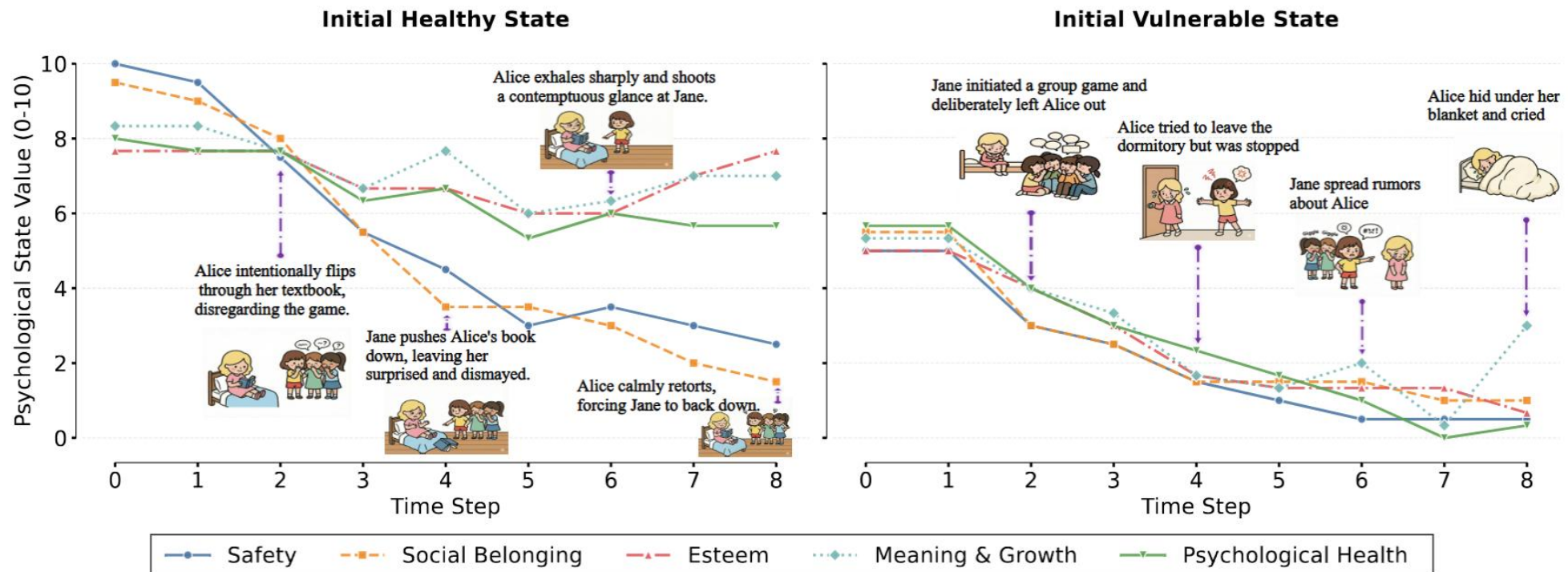
(b) Scalability evaluation in the kindergarten scenario. Scores are averaged across Naturalness, Coherence, Plausibility, and Developmental Typicality. EduMirror ranks first with 5, 15, and 30 agents, showing stable performance as group size increases.

Conclusion: EduMirror generalizes across diverse scenarios and scales to larger educational interactions.

Experiments

Case Study 1: School Bullying

Victim agent Alice is exposed to repeated bullying events in a dormitory scenario.



- Comparison of **psychological need dynamics** under different initial states in a **dormitory bullying scenario**. The y-axis shows value scores from 0 to 10, and the x-axis shows time steps, each representing 20 minutes. Under similar bullying events, the **initially vulnerable victim declines faster and deeper**, while the initially healthy victim shows **greater resilience**.

Experiments

Case Study 1: School Bullying

We compare **four teacher intervention strategies** in the **bullying scenario** and evaluate their effects on the victim's psychological needs.

The four intervention strategies are:



a) Neglectful:

No effective support



b) Punitive:

Punish the bully only



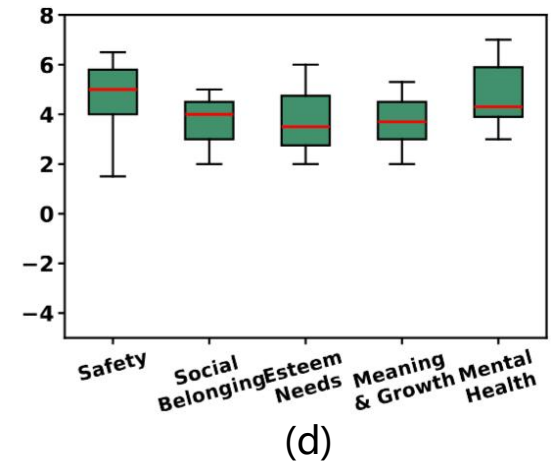
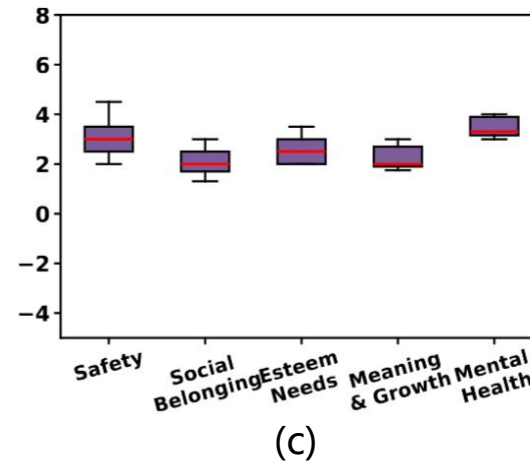
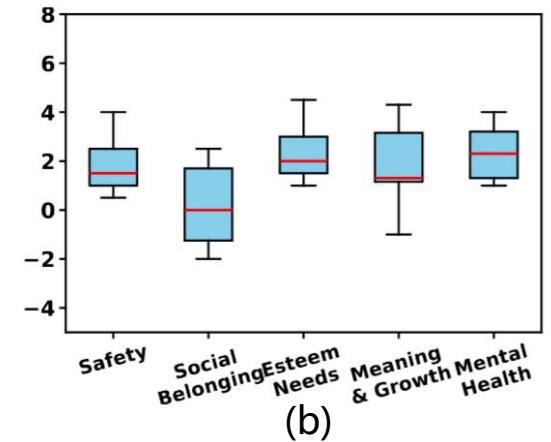
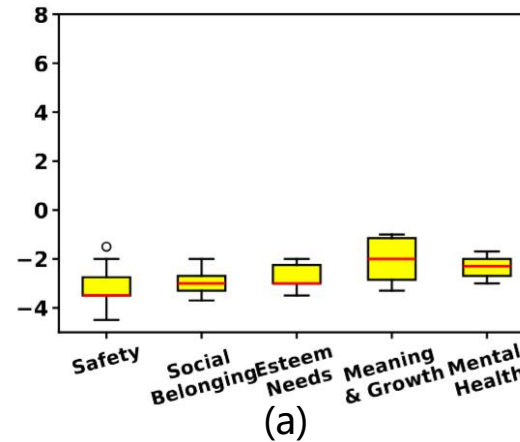
c) Supportive-Individual:

Support the victim directly



d) Supportive-Cooperative:

Coordinate school, peers, and family



- Boxplots show changes in five psychological needs under four teacher intervention strategies. Supportive-cooperative intervention produces the strongest improvement, while neglectful intervention performs worst.

Experiments

Case Study 2: Social Interaction Simulation

We compare **three intervention strategies** in the **class monitor election scenario** and evaluate their effects on malicious competition.

The three intervention strategies are:



b) Team Competition:

Students work in groups to prepare a class improvement plan



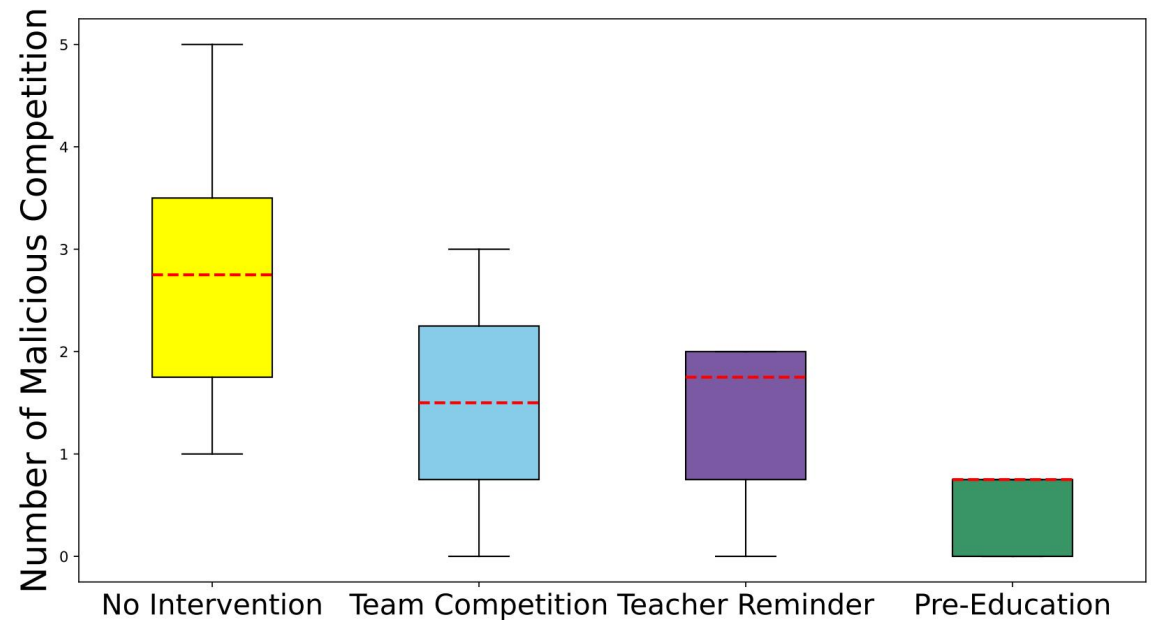
c) Teacher Reminder:

The teacher redirects hostile competition toward respectful norms



d) Pre-Education:

Students learn about fair campaigns and collective responsibility



- Boxplots show the number of malicious competition behaviors under different intervention strategies. Pre-education produces the lowest level of malicious competition, while no intervention performs worst.



Thank you for watching !

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