**Senior Project Final Report**

**Department of Computer Science**

**Calvin University**

**Title**: Cognitive model of Introverted Students in class

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## Background and Problem

Our project seeks to tackle the significant issue of untapped potential in classroom discussions caused by the hesitation of introverted students to participate using a computational modeling strategy. Introversion, while a natural personality trait, can lead to a loss of valuable insights and perspectives that would otherwise contribute to a richer learning environment. By examining why introverts tend to shy away from answering questions and how this impacts overall classroom dynamics, we aim to understand the root causes of their reluctance.

Failing to hear from half the class limits the diversity of thought, which negatively affects the quality of education for everyone. Our goal is to identify strategies to encourage introverts to share their thoughts more freely, recognizing that their unique viewpoints are crucial for well-rounded discussions. By understanding the interaction patterns of introverted students, we can develop solutions to help them engage more effectively, thus unlocking the full potential of every student and enhancing the collective learning experience.

## A diagram of a model AI-generated content may be incorrect.Project design

 Our solution is running simulation of cognitive model of student learning using NetLog. Through simulation, we identified alternative approaches to support introverted students in classroom environments. Based on research of academic literatures, we identified crucial features and relationships that significantly influence students' cognitive processes. We defined the relationships between each feature, node, in our model and determined appropriate weights for each formula to represent the strength of these relationships. To optimize these weights, we applied a gradient descent method for fine-tuning. This process generated a set of refined formulas that accurately represent students' cognitive processes. Using these formulas, we constructed an artificial classroom model for simulation.

***Summary of design norms***

\* Transparency: Our Agent-Based Model provides transparency in the cognitive processes of students. Unlike hidden layer approaches in neural networks, our model reveals the internal mechanisms and relationships between different cognitive factors, by specifying crucial nodes and features.

\* Social: Our project is designed for mediate social interaction for introverted students, face in classroom engagement. The model identifies the barriers to classroom engagement.​

\* Caring: The purpose of our project is to care for introverted students who often struggle in traditional classroom environments. By simulating agent-based model, we can find better solutions to care and support students in classroom.

***Problems***

Our model was fine-tuned based on artificially generated data, raising concerns about reliability. We consulted with Professor Crystal Bruxvoort from the education department to validate our model structure. After several meetings, we restructured our model based on professional experience. Additionally, our initial plan to use simulated annealing which is based on randomization approaches. And we found that this optimization is time-consuming and potentially inaccurate for models with complicated parameters. We used gradient descent based on differential calculus, which provided more efficient optimization with high accuracy for our complex parameter space.

**Results, analysis, and discussion**

## Our simulation successfully demonstrated the correlation between introversion, academic performance, and classroom response rates. However, the results showed the critical importance of additional factors, particularly self-efficacy and teacher engagement, in students’ cognitive process. The findings indicate that while introversion is a significant factor in classroom dynamics, it is not the only factor which determines classroom interactions. Other variables in our model showed substantial influence on learning outcomes.

## Future works

## To enhance the reliability and accuracy of our model, generating real-world data through experiments would be crucial. Additionally, teacher engagement and self-efficacy are currently represented as single nodes in our model. However, these nodes could be expanded into more comprehensive sub-models. These expansions would require further research to accurately capture the complexity of these factors in classroom settings.

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## Publication

AAMAS 2025 workshop paper.

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