# GPT Pedagogy

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**Abstract**

GPT-3 is a Large Language Model which, through overuse, is often used to deprive students of the opportunity to learn effectively. Our intended use case of GPT enables the transparent use of the technology between instructor and student. We aim to create a more active and participatory learning environment through the usage of the model in active learning. Our long-term goal for higher education is along the lines of the fourth UN SDG:

> Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

We view GPT as a way to create an adaptive learning experience which promotes the educational endeavor rather than detracts from it.

Our plan is to develop a GPT-3 based learning assistant for the *Introduction to Biology* course here at RPI. Through a partnership with the professor, we will gather sufficient amounts of course material to fine-tune a pre-trained GPT-3 model. This will create a knowledgeable and focused learning assistant, *Mathesis* (from the ancient greek work for learning). By creating this personalized AI tutor we can make it easier and more transparent for students to learn the material and reduce their stress.

One of our goals is for the model to maintain its conversational abilities while embedding additional knowledge about faculty defined key learning objectives. *Mathesis* will generate a series of topic-relevant questions, evaluate the answers of those questions, and give useful feedback or counter-examples to the student. The model benefits from human-in-the-loop reinforcement learning by storing previous chats from students and faculty alike.

We also aim for this model to be generalizable to other classes and disciplines in the future. The model will work especially well for courses where it is difficult to give personalized feedback to each learner in each class meeting time, such as in classes that have a high student to faculty ratio. It will also work well for courses with students interested in AI who cannot adequately engage with that interest through the course material.

# 1 Introduction

The idea for this project was conceived before the beginning of this project in the context of our Informatics class. It stemmed from observations about the current trend that large language models are heading in and how many educational institutions are not fully prepared to handle the fallout of this trend. Our primary motivation for this project is to remedy this issue. By providing students with an opportunity to use large language models, like GPT, as a learning tool, we allow students to gain valuable insight into the practical benefits and shortcomings of these models.

# 2 Project Use Case

## 2.1 Specifications

For the development of the use case for this project, it is important to detail several specifications that describe GPT Pedagogy in a more rigorous manner. One of these specifications is the list of the functional requirements of the project. To fulfil our objectives, the project needs to:

- Provide students with a knowledgeable teacher that can answer any course-relevant question
- Be able to automatically generate a series of evaluation questions for students and reference answers based on the core topics of the course
- Receive students' answers to evaluation questions and evaluate their correctness based off of the reference answers
- Provide useful feedback to students if their answers did not sufficiently match the reference answers
- Allow instructors to review and regenerate all questions generated by the model
- Allow instructors to evaluate a summary of student performance based off of the automatically generated questions

Another important specification to consider is that of the entropy/uncertainty of the project. Overall, we have worked to minimize the total uncertainty of the project. It is important to note, however, that the GPT model will always introduce some amount of extra uncertainty.

One of the areas where we worked to minimize the uncertainty in was the user interface. This is split into two parts, the student and administrator views. In both of these cases, our design was oriented towards a simple, straightforward interface. We worked to accomplish this through the use of a minimalist design. Users can choose to choose only a few tabs: the main chat and the lesson evaluations. The administrators have a similar view, with th addition of the ability to edit the questions that are displayed to students. In our design, buttons, animations, and images are kept to a minimum. This will hopefully allow users to focus more on working on evaluations or interacting with *Mathesis* to better learn specific topics.

Another way we worked to minimize uncertainty is through the fine-tuning of the model on our own, customized, training data. By feeding *Mathesis* significant amounts of course material, we have narrowed its focus down to the relevant topics of the course. While the model does not forget its previously learned knowledge, its ability to correctly interpret and recall information related to the course has increased. This lowers the uncertainty of the project by encouraging the trained model to generate responses that are targeted towards the course material. This will increase its helpfulness to students as unrelated responses may provide misinformation or serve to demotivate students from interacting with the system.

The use case that we developed addresses what we expect to be the basic low of the system, along with any reasonable alternate or exception flows. The goal of this system is the same as the project in general: to use an interface and pre-trained model to provide students with a flexible and helpful learning assistant for the *Introduction to Biology* course at RPI.

We have included the particular flows that we did in order to properly scope our use case. Our intention is to cover all relevant ways in which students and administrators, while not including flows that may bloat our design of this early use case. Examples of such flows would be deliberate adversarial attacks to the system. While these attacks are a near certainty in a deployed system, the time constraints on this project has not allowed us to account for them in our working prototype. Due to this reason, we have set this and similar edge cases to be outside our scope.

## 2.2 Implementation Considerations

As mentioned above, one of our primary design goals of this project was to minimize uncertainty. In addition to the previously mentioned methods, we also minimized uncertainty through our usage of semiotics, cognitive principles, and the project architecture.

One of the ways in which we minimize uncertainty is through our placement of our signs. Many of the elements in the user interface lack symbols or icons. This is by design. As this project is currently in a prototype form, it would be unwise to begin using signs in places where they do not need to be. In place of these signs we instead have text descriptions. While this may be less visually appealing, it offers a lower uncertainty as many elements have their descriptions written on them. An example of a sign that we do use can be found in the 'send' icon for the chat functionality. This sign is an icon, specifically as it does not physically resemble anything being sent. We chose this icon to be that of a paper airplane, as is standard across most massaging applications. Through the use of this, and other icons, we hope to make all functionality clear while maintaining familiarity.

We also use both semiotics and cognitive principles in the chat and feedback functionalities of the project. Our design of the chat and feedback interfaces mirrors that of more mundane chat-focused applications. By modeling our interface in a similar manner to SMS communications, we create a familiar environment to both students and teachers. This was likely the rationale of ChatGPT's interface design, which mirrors these communications as well. The lesson quiz submitting also mirrors familiar environments such as LMS. By creating a familiar environment, we hope that users will be able to immediately recognize the form and function of the interface, allowing for quicker acclimation.

# 3 Architectural Models

## 3.1 Conceptual Model

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## 3.2 Logical Model

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## 3.3 Implementation

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# 4 Conclusion

## 4.1 Future Work

In our future work in this project, we expect to both finalize the attributes of the project that we have included in its current scope and to expand the projects scope to cover more edge cases.

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Ways in which we would expand the scope of the project would to be to better handle reasonable edge cases. These could come in the form of students needing help with navigating the new system, handling adversarial attacks from students, or further automating the process of training models on new datasets. These possible additions would serve to help students better adapt to using the *Mathesis* assistant and its surrounding learning platform, deter students from using the model for unintended purposes, and creating encouraging environment for other professors who would like to include their courses into the learning system in future semesters respectively.

## 4.2 Closing Thoughts

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