<u>Project Proposal</u>

Description of the phenomenon to be investigated, including the research question to be answered.

Over the last few weeks, I have read about ITSs and how they can be used in enhancing a learning environment for students by personalizing feedback, method of providing information and other strategies. I have also looked into how ITSs can possibly be used for special needs students. With the feedback provided by my mentor, I have limited my scope into how AI can enhance learning especially for students with dyscalculia and students who have difficulty in learning mathematics in general. *Dyscalculia* stands for a brain-based condition that makes it hard to make sense of numbers and mathematical concepts [1]. While looking into research done so far, I have looked into some tools as well as studies that have been completed and though they provide some answers into developing a tool that could help, it is yet to be seen as what an ideal tool with AI modeling will look like? What should be some of the features within AI that will provide the most benefits? The goal of this project is to look into available tools, compare their strengths and shortcomings and lastly report on what the future products should accomplish with AI features specifically student modeling and interactive feedback. These are the questions I am looking to investigate using <u>research track</u>. This will be an individual project.

A description of background literature in the area that leads to your research question.

Initially just reading about Intelligent tutoring system piqued my interest into looking the tools that are available in the industry. Given the area of special needs is vast, there is no one size fits all approach that could be integrated into all the tools.

One of the initial studies that was very interesting and comprehensive was the article named 'Artificial Intelligence in Special Education: A Decade Review'. The article goes into different areas of special needs, challenges with the scope as well as the many studies that were conducted. It further talks about "a model called Perceptron based Learning Disability Detector (PLEDDOR). It is an artificial neural network model for identifying difficulties in reading (dyslexia), in writing (dysgraphia) and in mathematics (dyscalculia) using curriculum based test

conducted by special educators." [2] The paper states that this system was tested on 240 students in India and provided great results.

I particularly wanted to choose dyscalculia and students with difficulty in learning mathematics, because mathematics is a subject that is essential to everyone and overtime is needed in day to day life and job. As the conference paper, 'A brief look into Dyscalculia and supportive tools' mentions, "Either counting cookies or telling the hours, for someone with dyscalculia, these simple tasks become difficult to perform." [4] That to me was enough to look further into what will an ideal tool consist of? What has been the success rate of the existing tools? And, more importantly what are the challenges still remain.

The article mentioned previously further talks about a tool called ActiveMath which is a web-based ITS that allows students to learn in their own environment. It uses a bunch of AI techniques such as adaptive course generation, student modeling, feedback and interactive exercises. The student can create their own model via self assessment and following that can also choose their learning goal. The paper claims that this application has reported many positive outcomes by a large number of studies [2].

One of the phenomenon, that I studied in my personal question was what really motivates students? This is something touched on in the paper on ActiveMath by Erica Melis and J˙org Siekmann as they mention the future of the product "We are now working on cognitively motivated extensions of ActiveMath by new types of examples and exercises that have shown their merit for learning. In particular, the student model will be enhanced by information about the learner's motivation such that the system can properly react to excitement, boredom and other motivational states." [3] This is something I am also interested in exploring while focusing on AI and dyscalculia and how can the applications distinguish between learning behavior vs just moods or "motivational states"

A description of the research methodology that will be used, including the independent and dependent variables, internal and external validity, and the connection between these details and the research question.

I will be using quantitative approach to research and investigate the phenomenon. More specifically, I will be taking the descriptive research route.

The goal is to describe the existing applications that specifically target dyscalculia and teaching mathematics to students who have difficulty with numbers. The variables that I will be using are the relationship improvement in student performance compared to the features in the application such as interactive feedback and adaptation of user model based on the feedback produced. Questions to be answered here is what is the most effective way to use AI to provide feedback and generate adaptive student model to benefits students with dyscalculia?

A description of the data that will be needed or obtained, including spring-back plans if the data cannot be obtained. (For example, if the Registrar refuses to provide complete student information necessary for some research, you could instead plan for how to research only a subset of that data.)

The initial set of data that needs to obtained –

- Comprehensive list of existing tools
- Evaluation of such tools and details of their features
- Comparison of features from the evaluation.
- Studies that look into these tools in details.
- Student performance metrics such as success rate, better exam scores etc.
- Student and teacher surveys, if available

In case the surveys are not available, I will be heavily looking into metrics available by existing studies to provide an answer to my question. I will also be looking into conducting my own survey but it may present with its own challenges in terms of finding the students or teachers that might have used these products.

Project Plan and deliverables

Milestone 1
For my first milestone, I will be gathering the list of all the existing tools to evaluate. I will be submitting my findings in form of a power point and a report summarizing list, their features, and the comparisons. I will be also focusing on looking into the studies that go into detail of these tools, their architecture of AI based user models as well as how the feedback is formulated. I will look into

formulating a survey that correlates users who used these tools and what features kept them motivated to learn. The survey would look into what made the students opt for the tool, why they did not opt for the tool, what improvements and features they would like to see for future that will change their mind into opting for the tool and lastly the students who opted for the tool, did their test scores improved.

I will be presenting this to my mentor and collecting feedback. Based on the feedback, I will work on changing the approach if needed.

Milestone 2

For my second milestone, I will be looking into existing studies that describe the performance metrics and success rate of these tools. I will also be looking at the data that was collected via my survey. The fallback plan if no data is available via survey to base my conclusion on existing studies and metrics.

Weekly Schedule

Week	Task
Week of June 17	Research existing tools
Week of June 25	• Write report and ppt describing the findings • Weekly Status Check 1
Week of July 2	• Submit the report as the deliverable for Intermediate Milestone 1 • Weekly Status Check 2
Week of July 9	• Research existing studies and look into the possibility of formulating survey • Weekly Status Check 3

Week of July 16	• Collect data from survey and report for intermediate milestone 2 • If enough data is not available from the survey, look into existing data to formulate conclusion. • Weekly Status Check 4
Week of July 23	• Finalize research report with the findings. • Work on project paper • Work on the video presentation
July 30	Submit all deliverables

References:

[1]https://link.springer.com/chapter/10.1007/978-981-10-1409-3_23

[2]http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.497.203&rep=rep1&type=pdf

[3]https://s3.amazonaws.com/academia.edu.documents/34614264/An_Intelligent_Tutoring_System_for_math.pdf?AWSAccessKeyId=AKIAIWOWYYGZ2Y53UL3A&Expires=1529281573&Signature=M25ohUpmgNWwUz85tNhV9ifdUY0%3D&response-content-disposition=inline%3B%20filename%3DActiveMath_An_Intelligent_Tutoring_Syste.pdf

[4]https://www.researchgate.net/publication/303048479_A_Brief_Look_Into_Dyscalculia_And_Supportive_Tools