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# RIT

## **Intelligent Tutoring in a VR Classroom**

by

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Fine Arts in **Visual Communication Design**

School/Department of **Visual Communication Design**  
**College of Art and Design**

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## Abstract:

ITS(Intelligent Tutoring Systems) have played a significant role in today's smart learning educational technology environment, where students are given feedback instantly at scale. However, the current, more practically inclined approaches de-emphasize the reliance on the problematic student model, i.e. student's motivation, emotional state and interest instead put more effort into the construction of theory-based user interfaces. Although research in ITS has produced many interesting theoretical insights, there are relatively few ITS which are regularly and effectively used. Through research conducted into current practices in ITS, gaps within the system have been noted.

Specifically, the paper attempts to propose a solution to improvise an Intelligent Tutoring System called Merits-VR that makes students in the K12 learning domain facilitate deep learning.

Keywords: Ed-Tech, Intelligent Tutoring System, Adaptive Learning System, Learning, AI, Machine Learning.

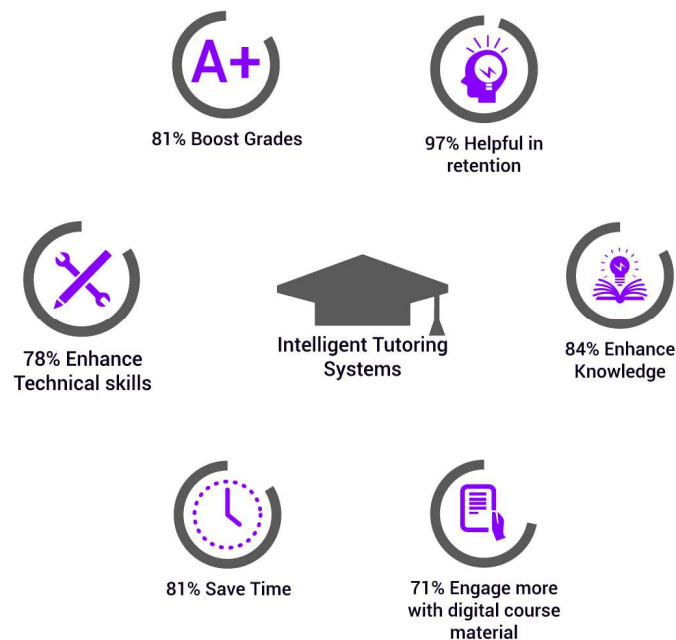


Figure 1: Students voice their digital preferences in education. Elearninginfographics.com. "Top 6 Reasons Why Students Prefer Digital Content." n.d. <https://elearninginfographics.com/students-prefer-digital-content-reasons-infographic/>.

## 1. Introduction

Given the rise in the Ed-Tech companies and the users all around the world we can say that Intelligent Tutoring Systems have transformed the mode of traditional classroom learning (Fig.1). Having been fortunate enough to experience and study in 8 different and one of the best schools around the country in India and now in the US, I have realized that students can be very different and diverse in a classroom. Some students may be very good at the subject, a large number of them might perform at a slightly lower level and then some students find it really challenging. Not only do they learn differently they learn different content differently. That's why I respect my teachers so much because they know how to bring out the best in most of them. However, the teaching style might not be effective in getting information across to each and every student. "The normal lecture and read-a-book format is a product of the industrial revolution, where industry wanted people to be trained faster and be able to execute procedures. They didn't need or even want people with deep knowledge. But now we're in a knowledge revolution where the workforce needs to have a deeper set of skills and more interdisciplinary and collaborative problem solving. Prior to the industrial revolution for millennia, learning occurred through an apprenticeship framework with conversations between the learner and a master, mentor, or tutor."<sup>2</sup> In 1984, Benjamin Bloom defined the "two-sigma problem," which states that students who receive one-on-one instruction perform two standard deviations better than students who receive traditional classroom instruction. An improvement of two standard deviations means that the average tutored student performed as well as the top 2 percent of those receiving classroom instruction. It's interesting how technology is allowing us to go back to that approach. Can today's technology help students control, create and learn in a learner centered environment?

## 2. Problem Statement

Current, more practically inclined approaches de-emphasize the reliance on the problematic student model instead they put more effort into the construction of theory-based user interfaces. Although research in ITS has produced

many interesting theoretical insights, there are relatively few ITS which are regularly and effectively used. The tutoring system today needs more than just good tutorial videos or infographics or a beautiful user interface. With the use of modern tools like AI and machine learning we are able to generate the best of the frameworks for a student's learning curve. But they lack in monitoring various other important factors in student's learning like motivation, emotional state, and interests. These factors are equally vital for students to get a wholesome experience of deep learning.

### 3. Literature Review

In the 1980s there was an upsurge of artificial intelligence. Most of these learning tutors were created during that time based on rule-based expert systems. These rule-based expert systems were based on the understanding of the knowledge paradigm and that's why they were domain-specific. For example, an intelligent chemical tutor had a domain of chemistry. There were very set rules for the domain based on the expert's understanding. So the expert's knowledge was converted into a set of rules which had to be followed to understand a subject matter. □ The problem with these intelligent tutoring systems was that as soon as you change the domain the intelligent tutor won't work. For example, poetry where there is no right or wrong answer. There is clearly a lack of intelligence in the framework of the learning structure offered to the learner. □ The content has to be presented in different pedagogical framework with a cognitive learning strategy that makes the learning process self-paced and personalized.

A typical ITS today has a framework divided into 4 parts. The knowledge base(domain knowledge), student model(student's current knowledge state), Pedagogical module(suitable instruction measures contingent on content of student model) and user interface(effective dialogue between ITS and student).

Dr. N Sonwalkar former principle educational architect at the hypermedia teaching facility at MIT talks about changing the interface of education with brain-wave adaptive learning. Specifically, he discusses the challenges faced by MOOC's (Massive open online course), which are not efficient enough for a personalized learning experience for a student. His purpose is to enhance the possibility of a framework to enhance brain-wave adaptive learning using more than just statistical inference. □ He focuses on enhancing the interaction of the learner and the

ITS using EEG(Electro Encephalo Gram) technology to record brain waves. The recorded brain waves will decipher the learner's current state of mind while interacting with the content to get him to the competence instantly.

Dr. Arthur C. Graesser, “Professor in the Department of Psychology and the Institute of Intelligent Systems at the University of Memphis” and winner of McGraw prize in education 2018, focuses on some attempts to promote deep learning through principles of learning science and adaptive learning technologies with computer agents. He describes some agent-based learning environments like “AutoTutor” that have been developed to improve deep learning in reading comprehension, use of hypermedia, conversational interaction, instructional games, academic arguments, and collaborative problem-solving. Agent-based learning environments also have been developed to improve writing, scientific inquiry, and guidance on career counseling and lifelong learning, all of which are known to improve the acquisition of deep knowledge.<sup>2</sup> He argues that emotions play an important role in learning which is often neglected in the framework of a modern day ITS.

The current more practically inclined systems give less importance to a student's motivation, emotional state, and interests while they are learning. “When you get ratings from classes, Students tend to like easier classes with less challenging material because they are not motivated enough. Hence it is important for us to track their emotions and reinforce them with feedback or channels that motivates them.”<sup>2</sup>

Processing the full range of information that we as humans can, is challenging for an ITS. For example, reading the student, understanding their background, the context in which they are working. With advances in educational data mining, we can infer learner’s emotions from their natural language interaction with systems. Lou Pugliese, “senior innovation fellow, and managing director at the Arizona State University (ASU) action lab” talks about Intelligent adaptive learning systems. Specifically, he focuses on “the effective implementation and use of adaptive learning systems” with the help of institutions, vendors and other stakeholders and its impact on next-generation personalized learning. The purpose of this article seems to be to explain why it is important for adaptive learning systems to leverage content using modern approaches like machine learning, advanced algorithms, decision tree, content scaffolding, social interaction, and metadata. The next generation data intensive ITS requires a rich amount of data about users actions, behavior, and content interaction so that it can optimally map a learning path for learners. Most learning systems focus solely on data derived from functionality inside the ITS framework. □ Even though we have

identified learning centred emotions, facial expressions and body language remain to be incorporated effectively in a modern-day ITS.

## 4. Design Concept

As we understand the importance of learner's affect state in learning for an ITS, I propose to design an Effective Intelligent Tutoring concept tool called Merits-VR for students in the K12 learning domain (Students from grade 1 to 12), that addresses learner's motivation, emotional state, and interests through a well thought out user interface that will foster deep learning. K12 students want a solid foundation of the knowledge they gain in school in a personalized and engaging way. For example, AutoTutor; an ITS that can detect the student's emotions by virtue of the way the people interact in natural language. Natural language tends to be more coherent when you are having a flow experience whereas when people are confused, there are often more interruptions and pauses.<sup>2</sup> Similarly from my research, my design methodology involves a case study on understanding students emotions by:

- a) Natural language interaction processing
- b) Micro facial expressions and body language
- c) Analyzing voice patterns and eye movements

The interface deciphering learner's emotions by the above-mentioned ways will help me design an effective ITS that can engage in a personalized and wholesome learning experience for a student.

## 5. Proposed Method and Evaluation

Probably the most effective method of achieving the concept is to incorporate the data derived from the student's current emotional state in the already existing online ITS platforms like Knewton, Khan Academy, Byjus, Coursera etc. Moreover, I will develop a *Virtual Reality Classroom* tool called Merits-VR that learns to recognize human facial keypoints and eye movements using a machine learning model called "Convolutional Neural Networks" to analyze the expressions of the student. The current emotional state of mind data can access the pain points in the learning curve and what works best for the student. To evaluate the feasibility of the improvised student model, this



data can then be sent to the systems adaptive learning framework to restructure the course accordingly. The evaluation of the student's performance can be done by comparing data from learning gains before and after applying the improvised student model in the ITS framework. How might we make the classroom more engaging with the web VR technology? How might we increase the engagement rate of the students? How might we incorporate kinesthetic learning in the learning process? Merits-VR allows students to engage in the learning process by getting hands on experience with difficult concepts. For example, assembling a personal computer, fixing a bike or perhaps building a drone. The stylus along with the HMD allows us to gauge the natural language processing of the learner's affect state instantly. It can also analyze the voice patterns, eye movements and facial expressions. This data can be used to analyze learner's affect state at the moment. Instant feedback can be given to the students if they feel overwhelmed or if they are not understanding something along their learning journey.

## **6. Conclusion**

I believe our education system needs to go beyond just the transfer of knowledge. We need smarter ways of learning systems that foster deep learning. The use of ITS's understanding of human emotions might help alleviate some of the stress and frustration a student feels during the learning process and motivate them as well, to make them a better learner. The proposed method is more interactive and attempts to pick up emotions rather than standard delivery of text and multiple-choice questions. The ITS of the future might not just monitor the learner and give feedback that it already knows about. But ITS that itself can learn. It can learn what teaching strategies or feedback are most useful based on the strategies that lead to future improvement, from a database of millions of students' data. It can potentially unlock some principles of learning that we are not even aware of yet.

## Foot Notes

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