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ASEE

Adaptive Virtual Assistant for Virtual Reality-based Remote Learning

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Introduction

- This paper discusses the development of an adaptive virtual assistant in an immersive virtual reality (VR) serious game
- VR opens new opportunities for teaching and learning manufacturing, and enables remote learning from any physical location
- We propose an adaptive virtual assistant in the game environment to support the student learning process
- Using reinforcement learning, the virtual assistant can learn and adapt to the student's preference in the types of assistance to provide

Serious Games

- Using games as a form of training and education has been a growing trend

- Video games have been used to teach
  - computer science
  - computational thinking
  - programming logic
  - biological engineering
  - sustainability
  - Biology
  - problem solving, etc.

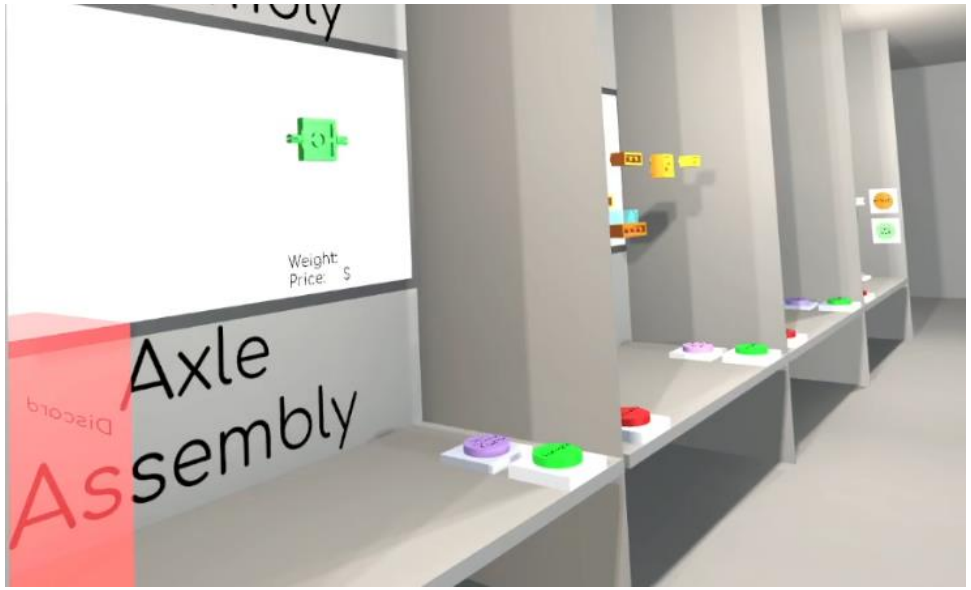
Virtual Reality (VR)

- VR provides a more immersive experience. Getting popular due to lightweight and affordable VR headsets
- Serious games for the purpose of education, training and military applications have started deploying VR technology
- Researchers examined different input schemes, such as head-tracking, or the effects of locomotion methods on the player's experience

Research Methodology

- The proposed research develops a gamified VR learning environment together with a virtual assistant to enhance student understanding of manufacturing concepts

- The task is toy car assembly on an assembly line



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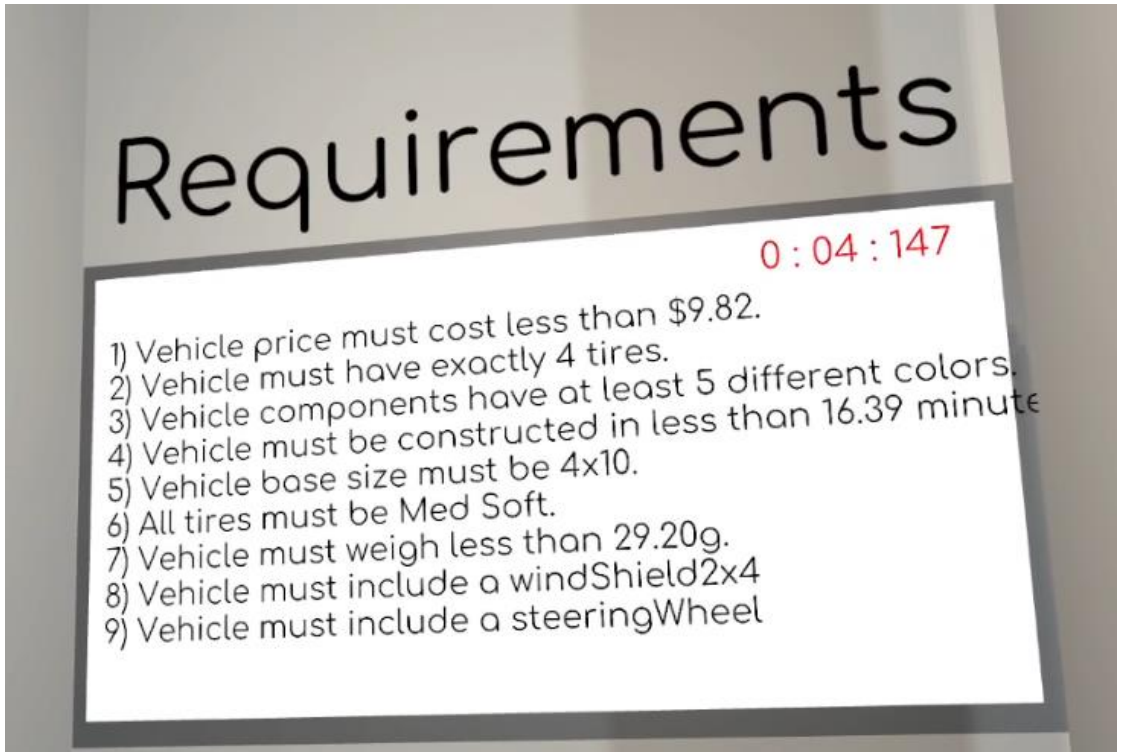

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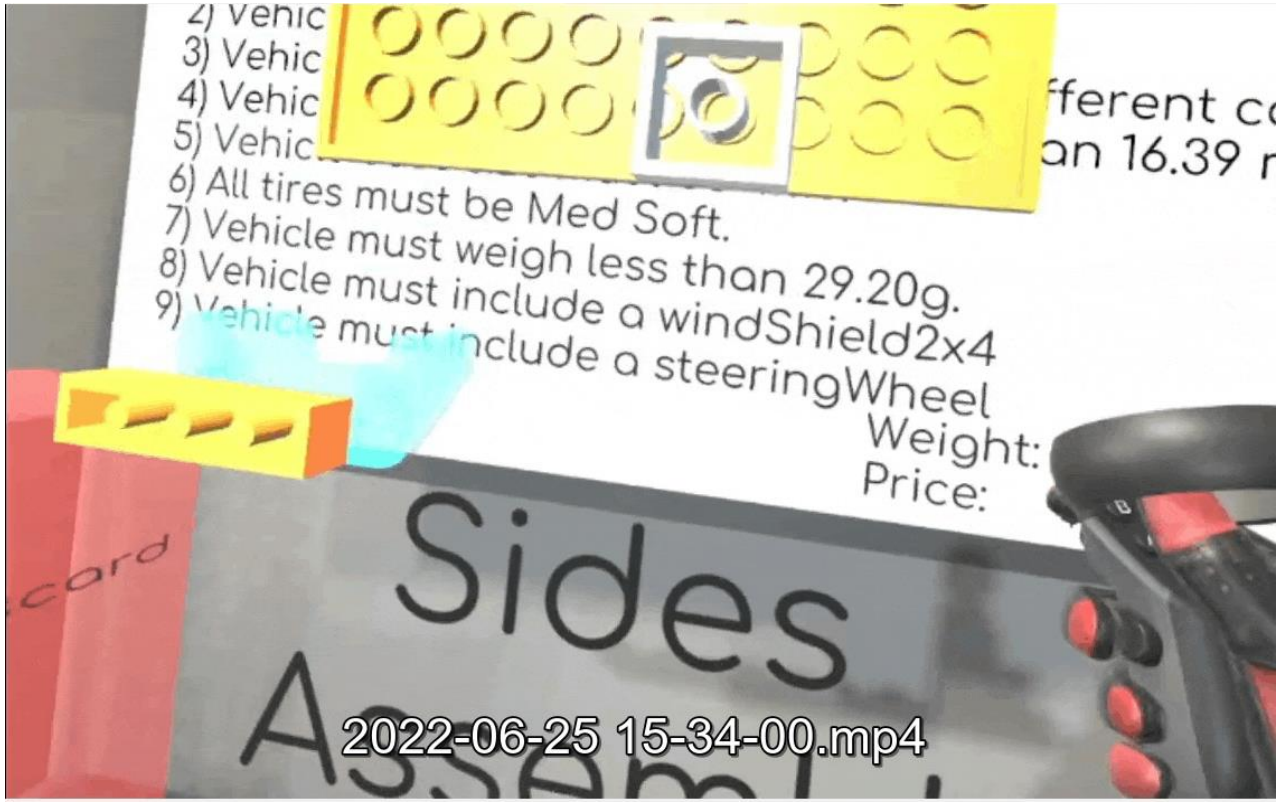

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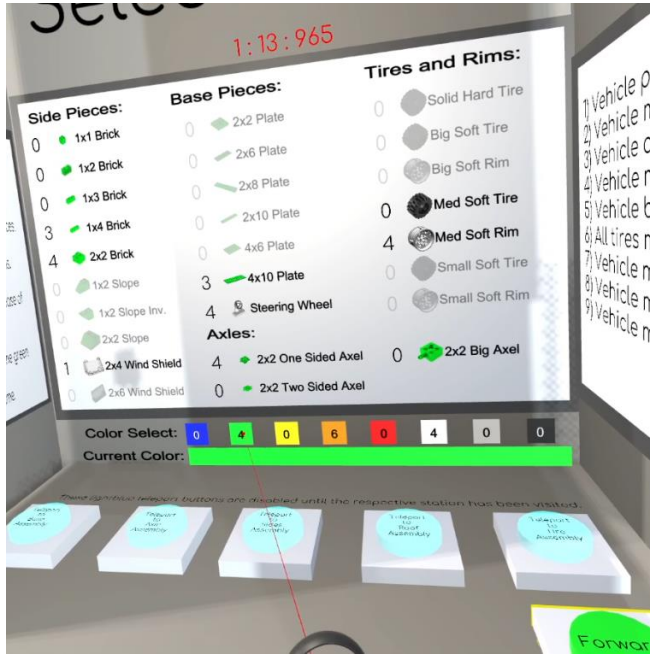
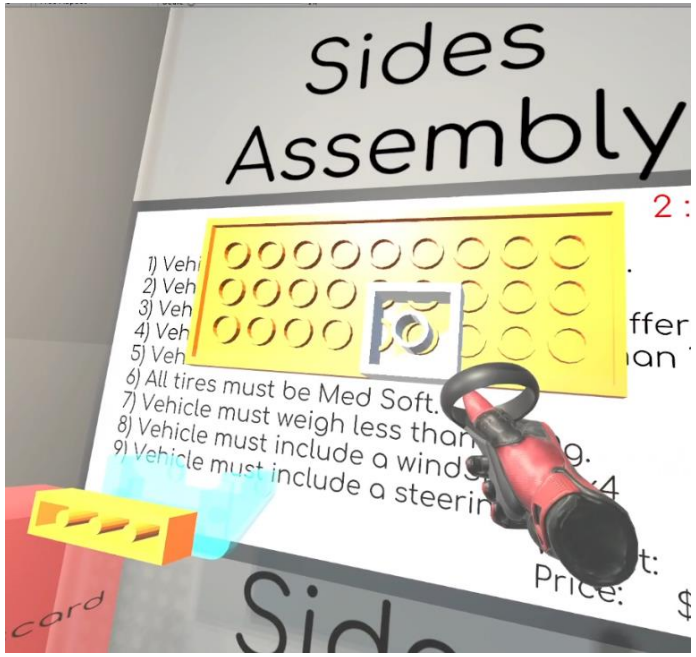
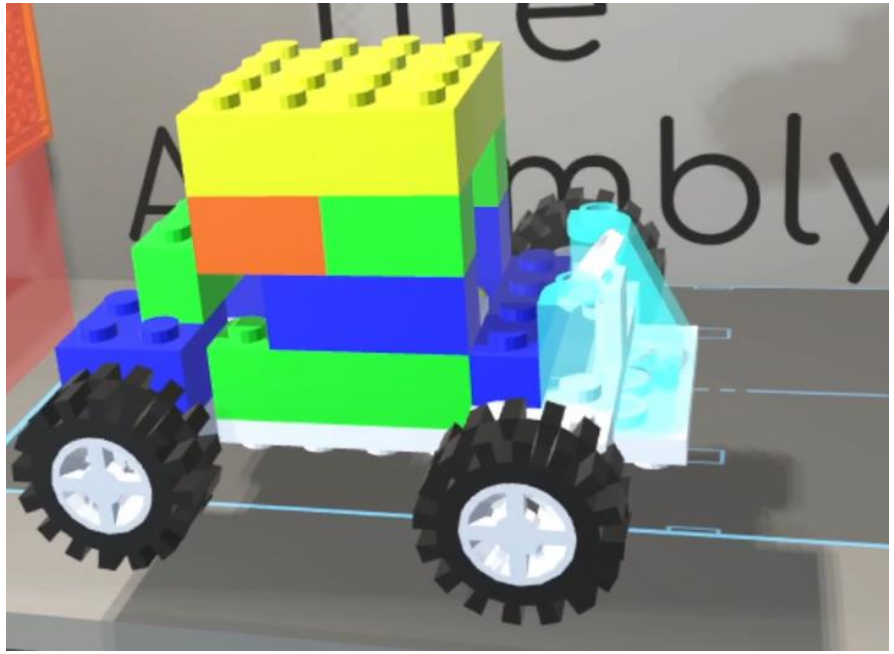
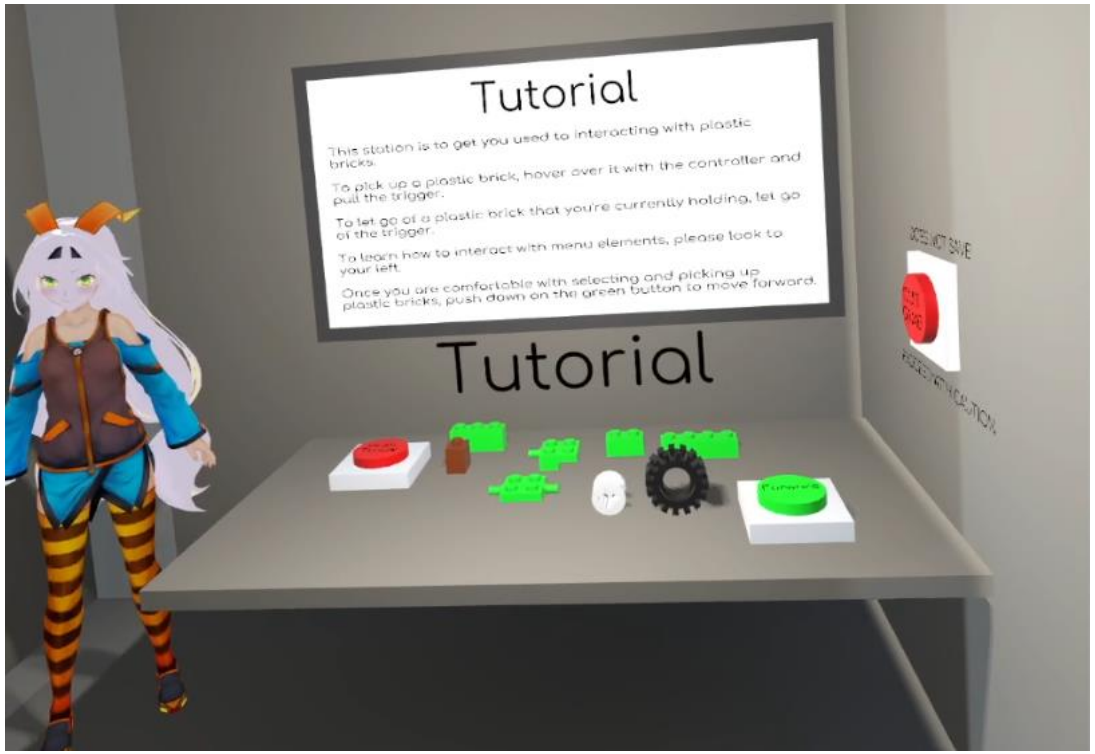






Gamified VR

- Tutorial and score board

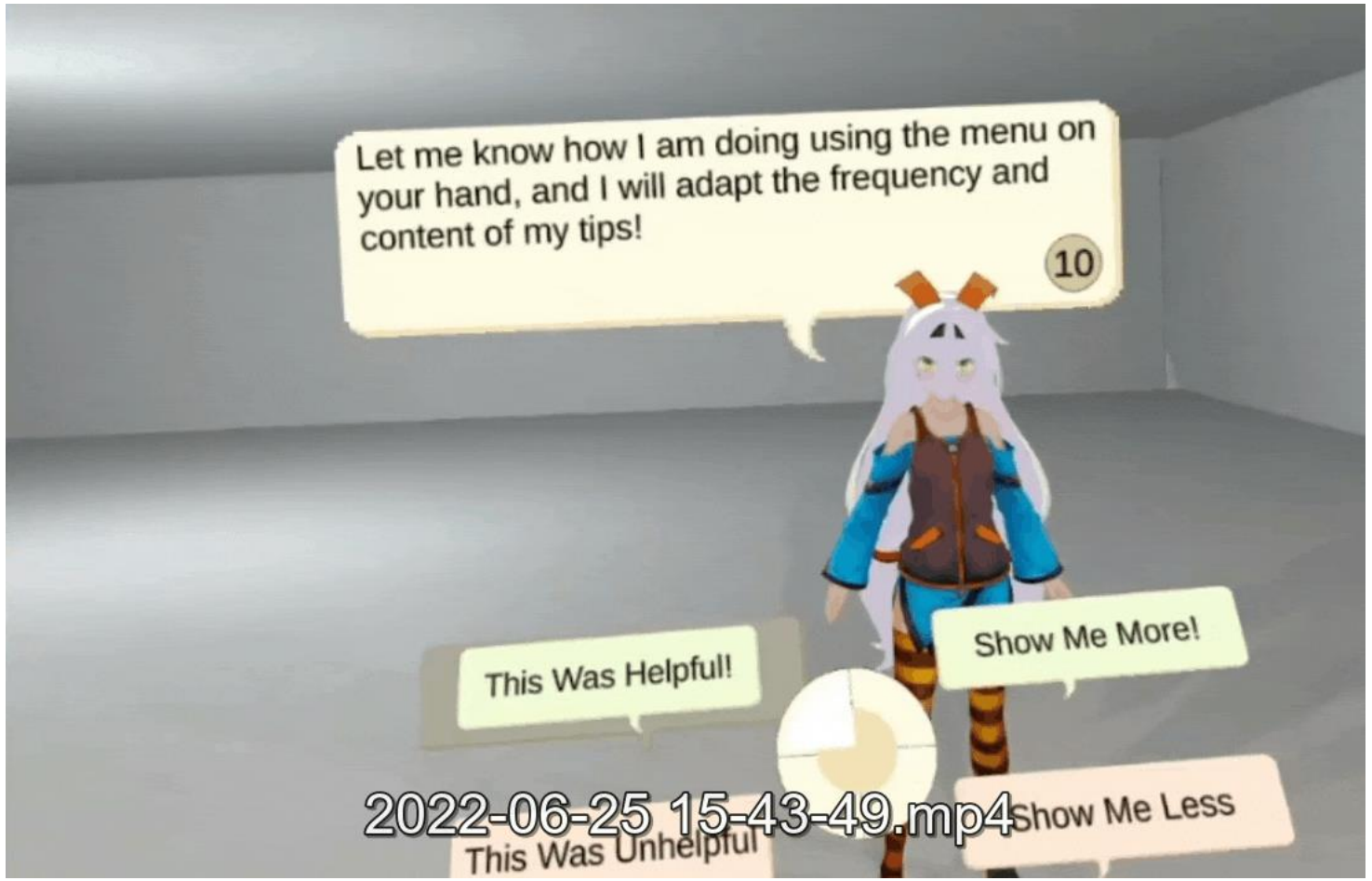


Gamified VR

- Leader board
- Level selection

Adaptive Virtual Assistant

- The purpose of the virtual assistant is to help the student as the student completes the problem-solving task



Adaptive Virtual Assistant

- The purpose of the virtual assistant is to help the student as the student completes the problem-solving task

- Support from the virtual assistant can be categorized into two categories, hints and reminders.
  - Hints can be generated when students make mistakes in the tasks, such as when an obvious wrong plastic component was chosen for a task
  - Reminders can be generated when a student is at risk of failing to achieve a requirement, such as when the toy car being assembled is getting close to the maximum weight allowed

Adaptive Virtual Assistant

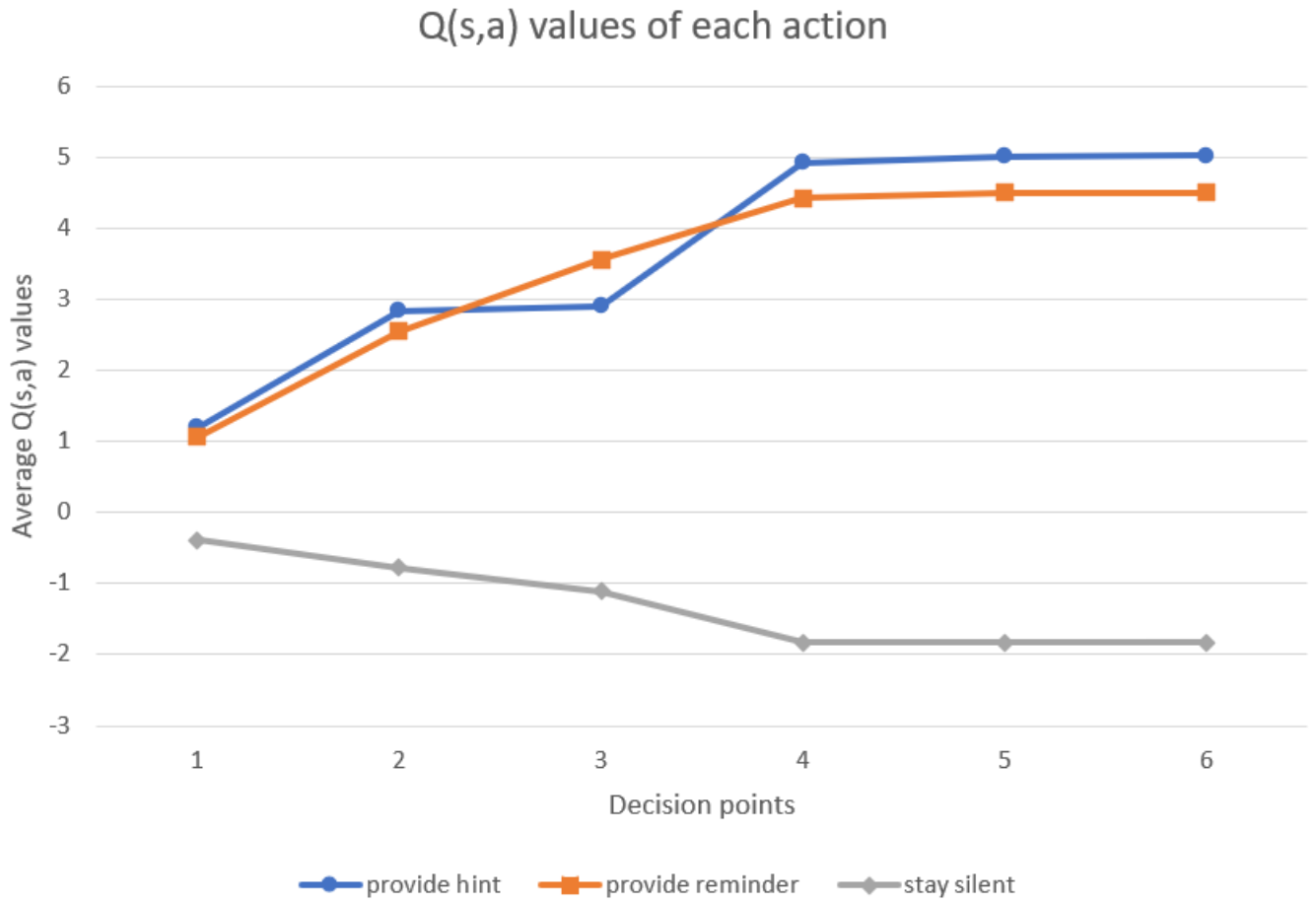
- Adaptation through Reinforcement Learning

- Reinforcement learning is an area of machine learning where an AI agent is not told what to do and has to discover the appropriate actions to maximize a notion of a numerical reward.
- In RL
  - a set of world states $s \in S$
  - a set of actions $a \in A$
  - an unknown reward function $R(s,a) \rightarrow r$ that outputs a reward r for each state s and action a
  - an unknown state transition function $T(s,a) \rightarrow s'$ that takes a state s into the next state s'.
  - a Q(s,a) value represents how good an action a is, in the state s

Student action	Reward given	Rationale
Student responds to the hint/reminder by selecting “Show me more!”	+5	Explicit responses result in the largest positive reward
Student responds to the hint/reminder by selecting “Show me less”	-5	Explicit responses result in the largest negative reward
Student looks at the hint/reminder for more than 2 seconds and turns away without a response	+3	No explicit response, but student reads what the assistant provides
Student looks at the hint/reminder for less than 2 seconds and turns away without a response	-3	No explicit response, and student did not read what the assistant provides
Student ignores the provided help	-2	Student does not want to interact with assistant
Student does not look for help when the assistant remains silent	+3	Student does not want to interact with assistant and assistant correctly remains non-intrusive
Student looks for help when the assistant remains silent	-3	Student wants to interact with assistant

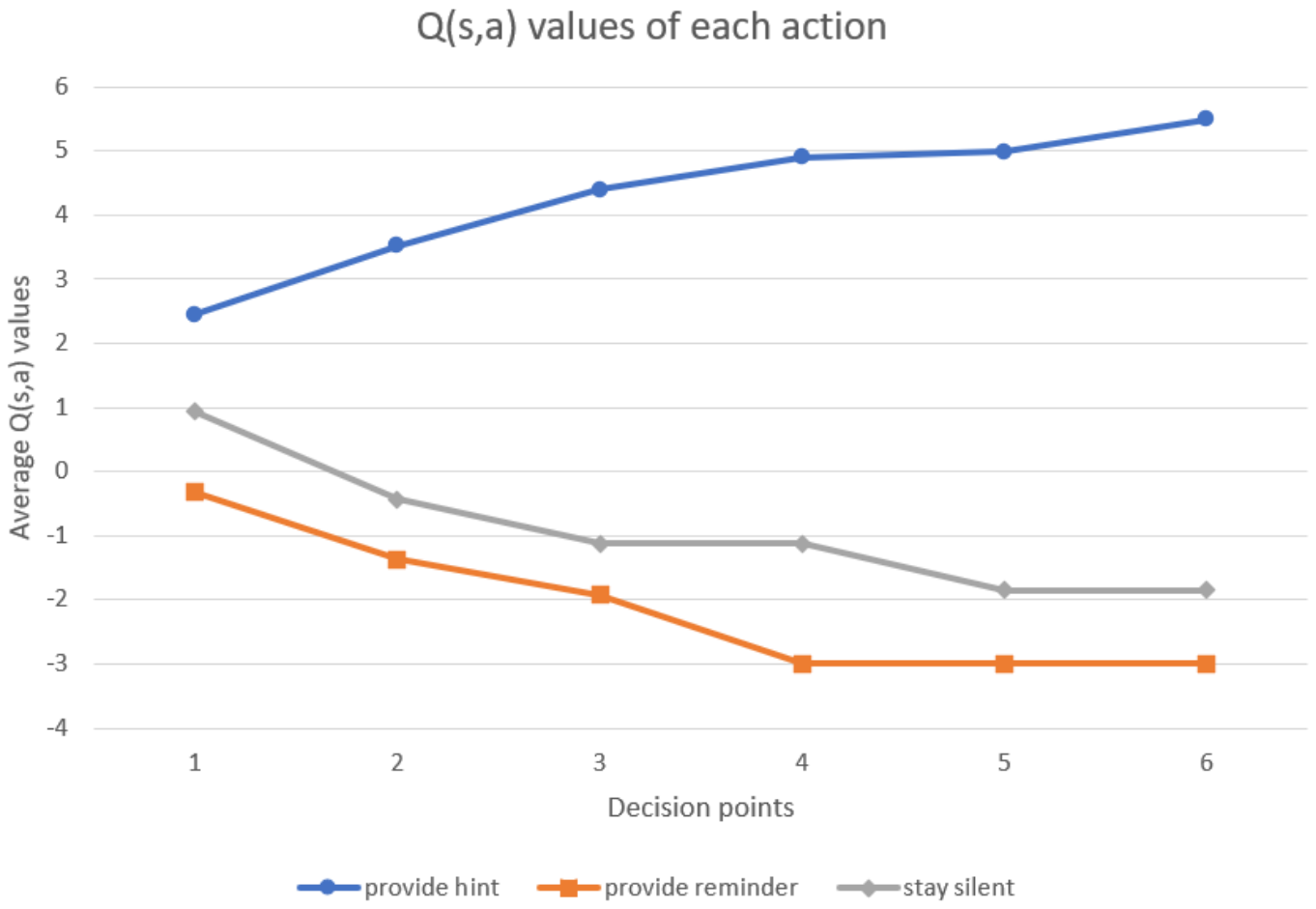
Experimental Results

- Learned Q(s,a) values of each action over 6 decision points where the simulated student is receptive to help.



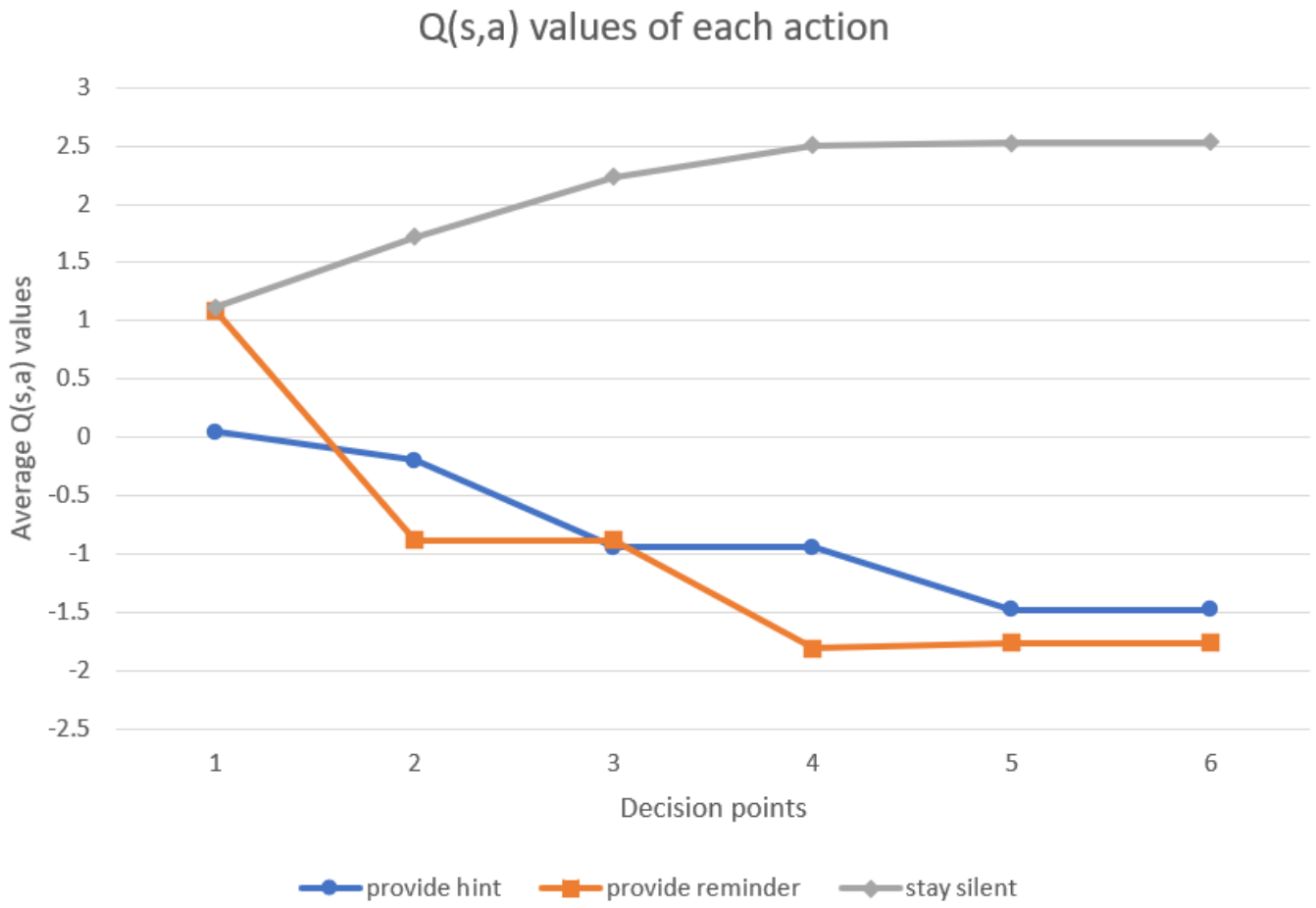
Experimental Results

- Learned Q(s,a) values of each action over 6 decision points where the simulated student is receptive to hints, not reminders.



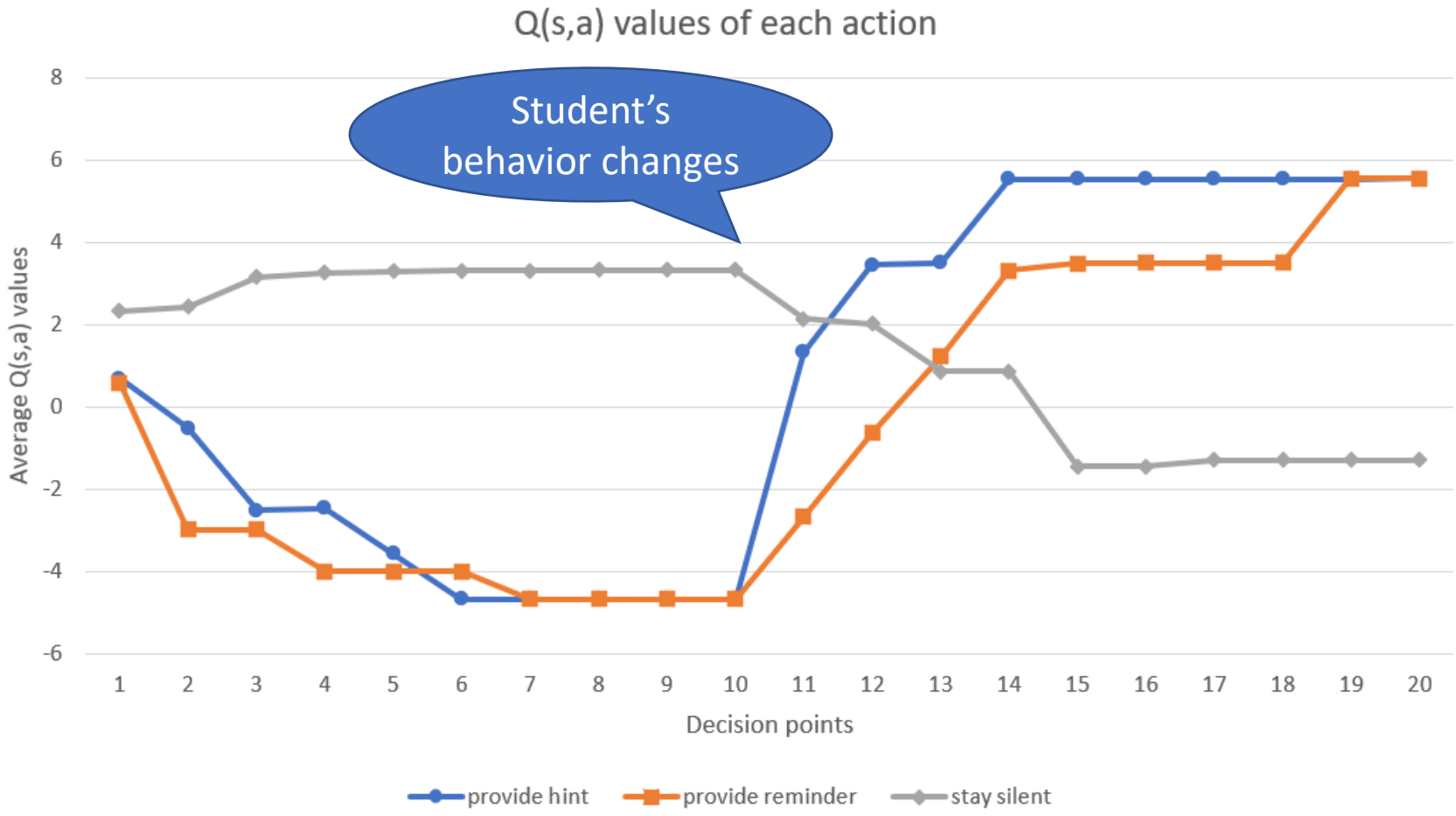
Experimental Results

- Learned Q(s,a) values of each action over 6 decision points where the simulated student is not receptive to help



Experimental Results

- student is not receptive to help during the first 10 decision points, but changes mind to ask for help



Conclusions

- We integrated gamification with reinforcement learning-based adaptive virtual assistant who can provide help as students complete the problem-solving tasks
- Using reinforcement learning, the virtual assistant can learn and adapt to the student's preference in the types of assistance to provide
- Adaptive virtual assistants can be deployed in many types of learning environments for different subject areas
- Thank you!