

Supporting Student Engagement in K-12 AI Education with a Card Game Construction Toolkit

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ABSTRACT

With the growing prevalence of AI, the need for K-12 AI education is becoming more crucial, which is prompting active research in developing engaging AI learning activities. In this paper, we present our work on a game construction toolkit for middle school students and educators that enables them to tailor an AI-focused unplugged card game activity. In our prior work, we designed, developed, and piloted an unplugged card game activity where players predict the identity of a person based on hand-drawn features extracted from a set of facial cards. The activity aims to teach AI concepts aligned with one of the big ideas in AI utilizing techniques from facial recognition. During our pilot testing of the activity, we discovered that creating face cards that capture students' interest is a crucial factor in promoting student engagement. As a result, we designed a card game construction toolkit that allows students and educators to craft their own face card decks using photos that are personally interesting to them, looking to foster engagement and improve replayability of the activity. The toolkit's design is focused on ensuring easy accessibility and features a simple web-based interface that allows users to download and print their customized cards. We expect this toolkit will enhance the usability and educational effectiveness of our unplugged K-12 AI education activity.

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1 INTRODUCTION

Preparing today's K-12 learners for an AI-centric future is both essential and immediate [6]. As the need for K-12 AI education becomes more crucial, initiatives have been undertaken to design, develop, and evaluate unplugged activities for teaching AI concepts

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[1, 5]. Unplugged activities can support the development of student interest and engagement, while teaching a wide range of AI concepts [4]. For example, Ma et al. [5] introduced two unplugged activities, "The Pasta Land-Decision Tree" and "The k -NN-Penguin," which incorporate decision tree and k -nearest neighbors algorithms tailored for middle school students. These activities use familiar animals and objects to help students grasp AI concepts in a relatable and age-appropriate way.

In our prior work, we designed, developed, and piloted an unplugged AI learning activity, "Guess Whose Face" [3]. We implemented the activity with 10 rural middle school students during an AI-focused summer camp. Results from exit tickets taken at the end of the activity indicated that the students scored an average of 4.625 out of 5 for enjoyment and engagement and 4.375 out of 5 for conceptual knowledge about *Representation and Reasoning*. Furthermore, we noted that letting students and educators participate in creating and designing part of the unplugged activity could offer promise for further promoting students' engagement. Previous work has explored a variety of toolkits that are available as a means of providing customization opportunities for students [2]. Drawing on the significant potential of unplugged activities for K-12 AI education and informed by our prior findings, we present our work on a game construction toolkit, *Card Craft Studio*, which enables students and educators to customize our "Guess Whose Face" unplugged AI learning activity.

2 MOTIVATION

Prior to designing our toolkit, we developed an unplugged activity called "Guess Whose Face" aligned with one of AI4K12's Big Ideas in AI, *Representation and Reasoning*. Unlike the popular board game "Guess Who?" wherein players ask questions to guess the identity of a person, our game requires students to use features represented as dots extracted from a facial image to guess the person.

The game is designed to be played as a team of two or more students to compete against other teams. There is one *Drawer* and one or more *Guessers* on each team. The role of the *Drawer* is extracting facial features onto tracing paper from a randomly chosen face card without revealing the target face (Figure 1). *Guessers* use a spinner to determine the team's next action and have to recognize the target face from the facial features drawn on the tracing paper. The face card deck serves as a dataset of target faces that the *Guessers* attempt to identify. For the summer camp, we created



Figure 1: Students playing “Guess Whose Face.” Student on the left is the *Guesser* and student on the right is the *Drawer*.

a face card deck with cartoon characters, Disney princesses, and celebrities that represented different difficulty levels.

Through our pilot study with summer camp attendees, we noted diverse student behaviors and collected insightful suggestions that can aid in refining the activity. We observed that students’ participation in the activity appeared more enthusiastic when they chose a card of a person or character they knew or were familiar with. Conversely, students seemed to be less enthusiastic when choosing an unknown or unfamiliar card. We collected information about celebrities and characters middle school students prefer through a post-camp survey. The survey suggested that there was a limitation in the original design of the unplugged activity that we could not meet the preferences of all students due to the fixed deck of face cards we provided. One possible solution is to provide a printable DIY (do it yourself) template. This is a well-known method among people who play “Guess Who?” with customized card decks. Using a template supports placing an image file in a fixed number of empty squares that players can print out after mapping all of their own images. Although this method is fairly straightforward, it has the disadvantage of requiring labor-intensive effort to place the images manually. To address this problem, we designed a web-based toolkit allowing students and educators to choose the desired images and automatically arrange them to print their unique face card deck.

3 TOOLKIT DESIGN

The toolkit is designed with simplicity and intuitiveness in mind, aiming to allow first-time users to use it effortlessly (Figure 2). The design of the toolkit emphasized four core functionalities.

Card Configuration. Users can designate a color for the card based on the intended game difficulty levels (Easy, Medium, or Hard). They can also freely select any number of cards to create, ranging from 1 to 20, for customized gameplay.

Card Image Upload. This step facilitates the uploading of facial images for creating cards. Users can either ‘drag and drop’ an image file or choose one from an existing set of images. By default, the title of the uploaded file will be displayed as the name of the individual shown on the card; however, this can be edited.

Card Production. This feature automatically lays out the uploaded images into a card template, generating a personalized face card deck, and users have the option to print their crafted cards.



Figure 2: Design of the ‘Card Craft Studio’ toolkit.

Card Sharing and Editing. Users can save their facial images as a project file so that they can later reload it to modify, share with peers, and print it out for future usage.

4 CONCLUSION

Fostering student engagement in K-12 AI educational activities is critical. We have presented our work on a toolkit to enable students and educators to create customized versions of an AI-focused unplugged card game activity to help promote student interest in the activity. The toolkit is being developed as an open-source web-based application that will be available to educators and students interested in using our unplugged activity for K-12 AI education. In the future, it will be important to gather feedback on the toolkit usage from students and educators for future refinements. We aim to collaborate with local communities passionate about AI education, guiding them on how to use the toolkit and card game as we evaluate its effectiveness in practice.

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REFERENCES

- [1] Safinali Ali, Vishesh Kumar, and Cynthia Breazeal. 2023. AI Audit: A Card Game to Reflect on Everyday AI Systems. *arXiv preprint arXiv:2305.17910* (2023).
- [2] Pedro Beça, Mónica Aresta, Cláudia Ortet, Rita Santos, Ana Isabel Veloso, and Sofia Ribeiro. 2020. Promoting student engagement in the design of digital games: The creation of games using a Toolkit for Game Design. In *2020 IEEE 20th international conference on Advanced Learning Technologies (ICALT)*. IEEE, 98–102.
- [3] Hansol Lim, Wookhee Min, Jessica Vandenberg, Veronica Cateté, and Bradford Mott. 2024. Unplugged K-12 AI Learning: Exploring Representation and Reasoning with a Facial Recognition Game. In *Proceedings of the Symposium on Educational Advances in Artificial Intelligence*. AAAI.
- [4] Annabel Lindner, Stefan Seegerer, and Ralf Romeike. 2019. Unplugged Activities in the Context of AI. In *Informatics in Schools. New Ideas in School Informatics*, Sergei N. Pozdnjakov and Valentina Dagiéne (Eds.). Springer International Publishing, 123–135.
- [5] Ruizhe Ma, Ismaila Temitayo Sanusi, Vaishali Mahipal, Joseph E Gonzales, and Fred G Martin. 2023. Developing machine learning algorithm literacy with novel plugged and unplugged approaches. In *Proceedings of the 54th ACM Technical Symposium on Computer Science Education V*. 1. 298–304.
- [6] Ning Wang and James Lester. 2023. K-12 Education in the Age of AI: A Call to Action for K-12 AI Literacy. *International Journal of Artificial Intelligence in Education* 33, 2 (2023), 228–232.