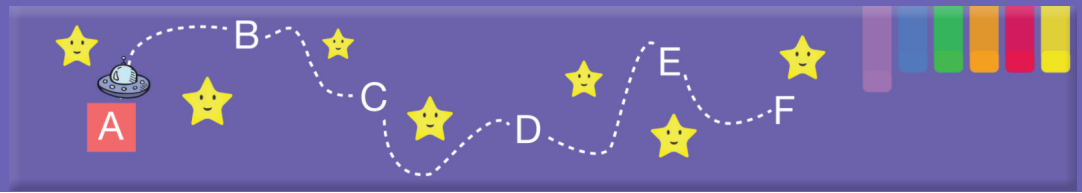# As Complex as ABC

Engineering and education experts marry instruction and technology to develop handwriting skills

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Technology has created new avenues for learning, exploring, and connecting with the world. Still, parents and educators alike sometimes bemoan the shift away from traditional learning opportunities.

One topic that has garnered particular interest—and sometimes disagreement—among educators is the role of handwriting in the digital age. With the prevalence of technology in homes and schools, is the 5,000-year-old tradition of writing by hand obsolete?

Most educators say "no."

Handwriting and typing simply are not the same to the human brain. For example, research suggests that taking notes by hand leads to greater memory for material than taking notes digitally. Similarly, functional magnetic resonance imaging of five-year-old children has revealed that writing by hand activates the same areas of the brain activated during reading—areas not activated when a child types letters on a keyboard. Learning letters by writing them also involves fine-motor skills and coordination that children need to develop.

What if technology supported handwriting instead of replacing it?
Education professor Nell K. Duke and engineering professor Elliot Soloway, along with SOE postdoc Crystal Wise, occupational therapist Tracy Mistry, and a team of three U-M engineering students are working on "MakeMyLetters," an app that would support children learning how to form letters and free up teachers to better focus their efforts, particularly with large class sizes.
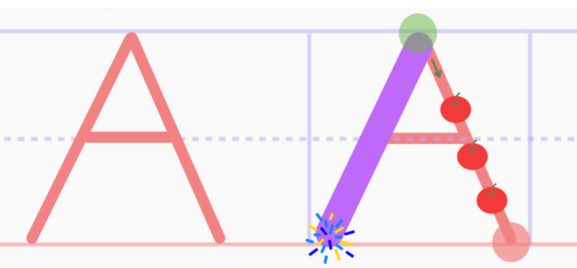
Writing researchers recommend regular handwriting instruction and practice, but many classrooms simply can't meet that goal. As teachers will tell you, there are just not enough hours in the school day for everything that needs to be taught these days. That's where a handwriting app comes in.

A well-designed handwriting app can provide a lot of the instruction and practice children need, allowing teachers to focus their instructional time on things that are harder to teach, such as how to decode words, engage in higher-order discussion of text, or compose compelling arguments. While the teacher is working with small groups on these challenging instructional targets, children can spend their time independently working with the app.
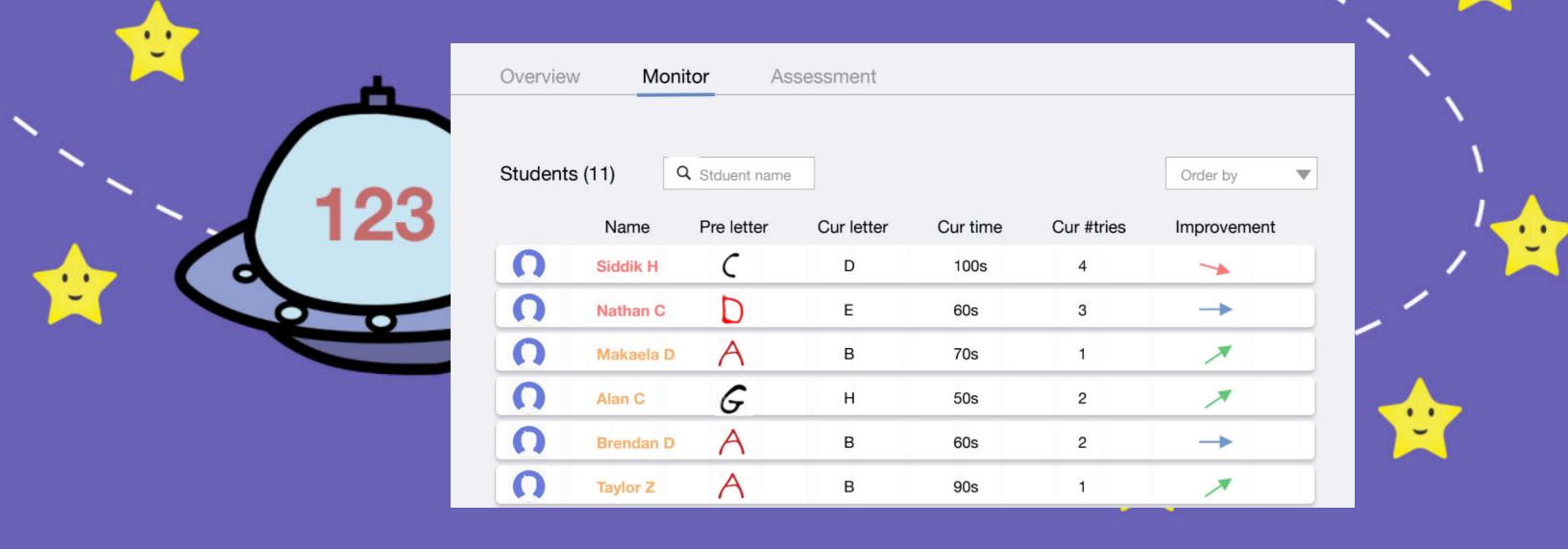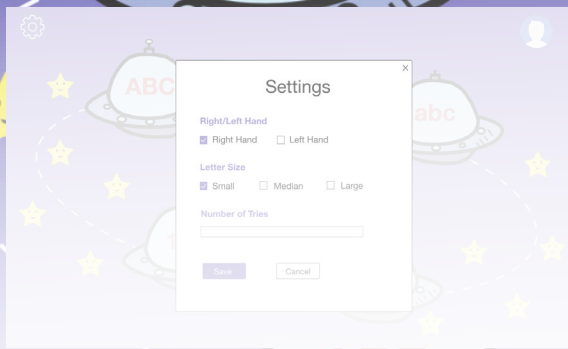
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The handwriting app will also support alphabet knowledge. While children are working on letter formation, the app will play audio that repeats the sound or sounds commonly associated with the letter as well as words that begin with the sound or sounds (for example, A apple acorn). For some letters, the team plans to use hip-hop-style songs they commissioned from a hip-hop artist, Draetown, for a related curriculum development project.

The app reflects current understandings of effective handwriting instruction. The emphasis is not on the beauty or precision of strokes, as was the case in traditional penmanship education. Instead, the emphasis is on legibility, efficiency, and automaticity. Duke says, "We want to get children to the point where they can handwrite legible letters quickly and without having to think about it, so they can devote their attention to other aspects of writing, such as the content of what they are writing."

MakeMyLetters is being designed with both students and teachers in mind. For students, the app models the letter, guides the child through the strokes, and provides feedback to help the child improve. The team has also begun to create fun "worlds" to engage kids visually; each child could choose how they want the virtual environment of the app to appear. Additionally, the team is interested in adding "gamification" to the program. The gamification of learning has become a popular area for researchers and app developers because it may enhance motivation for some students by providing them with goals and a greater sense of accomplishment.

For teachers, the app will provide actionable feedback about each student either through a teacher dashboard or via real-time messaging when the app identifies a student who is struggling or when a student taps the "help" button. The data collection possibilities excite the researchers because computers have the unique ability to discover patterns that might otherwise be lost. Data collection opens new opportunities for teachers to anticipate where students will struggle so they can make corrections earlier. Additionally, teachers could replay student sessions for parents to help them understand where their child is struggling.

| Students (11) | 🔍 Stduent name | | | | | Order by ▼ |

	Name	Pre letter	Cur letter	Cur time	Cur #tries	Improvement
⋂	Siddik H	C	D	100s	4	↘
⋂	Nathan C	D	E	60s	3	→
⋂	Makaela D	A	B	70s	1	↗
⋂	Alan C	G	H	50s	2	↗
⋂	Brendan D	A	B	60s	2	→
⋂	Taylor Z	A	B	90s	1	↗

Without grant support, the team has developed a "minimally viable product," which they have tested with a small group of kindergarteners. For each letter, there are three frames:

1. The child traces the letter.

2. The child traces a dotted representation of the letter.

3. The child writes the letter without any letter template.

Some feedback is provided to the student directly by the app. For example, the program stops showing the mark if the student makes an incorrect stroke and presents a short, voice-annotated video on how to correctly form the letter they are attempting. Upon completion of each letter, there is a visual and auditory "reward."

The team is using agile development principles. The idea is to build an early version of the app, test it with students and teachers, and iterate based on the findings. This cycle occurs continuously to improve the product. "Software is a living thing. It is an ongoing process of maintenance and improvement," says Soloway.

Undergraduate engineering students Joan Liu, Anupe Diwakar, and Connor Beard recently observed children using the first version of the app that they had built. Beard says, "We noticed how the students were using the tool and it changed the way we thought about how much direction we should give the child while they are learning." Soloway adds, "That is why you have to go and test it." With larger sample sizes, the team is eager to test different variations of the product.

One determination the team must make is how and when the app can best support the child's development. When a child makes an error, what is the most effective way for the app to interrupt and help the child get on track? Both pedagogically and technically, this is a fascinating question because it involves perceiving when a child is struggling, identifying what they are struggling with, and providing feedback in a productive format.

It is crucial that the app is accessible on a wide variety of devices with touchscreens so the team has designed an in-browser app to work on any of the common web browsers. The technology must also be highly reliable and easy to use. It will be of no use to teachers if they can't feel confident that the technology will work when they need it and without distracting them from their classes. And, finally, it must be free or available at a very low price.

In addition to these usability requirements, the team plans to work with teachers to discover how they integrate the app into their teaching, which data they find helpful, and what support they need to successfully use the app. The team is fortunate to have a partnership with the Wayne Westland School District, including three kindergarten teachers in the district, Christie Brewster, Lindsay Dugan, and Alexis Finger, who will be pioneering the use of the app.

The team plans to have the next version of the product ready for additional testing this summer. The team began work on MakeMyLetters before the advent of COVID-19, but the work has become much more pressing in the wake of the pandemic. Teachers will have a lot of instructional catching up to do when children return to school, so it will be helpful to have a tool children can use independently to support their development. The team is hopeful that children will soon have access to the tool from home should distance learning need to happen again in the coming academic year.