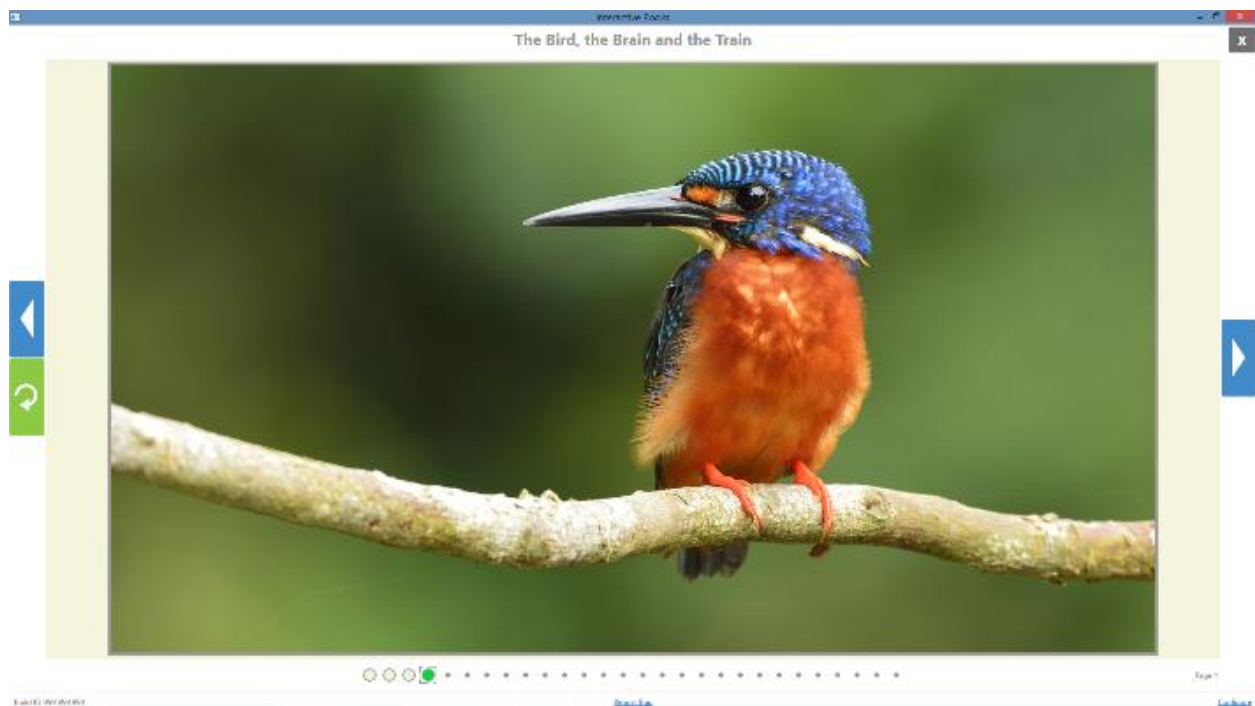
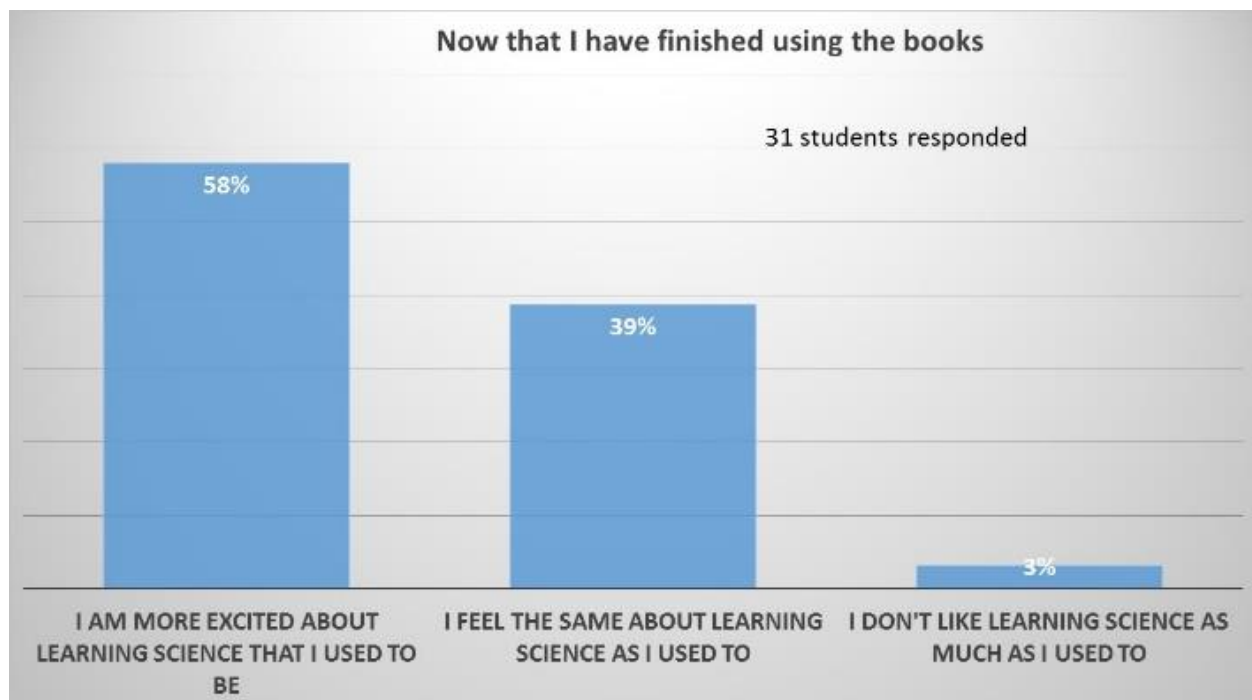
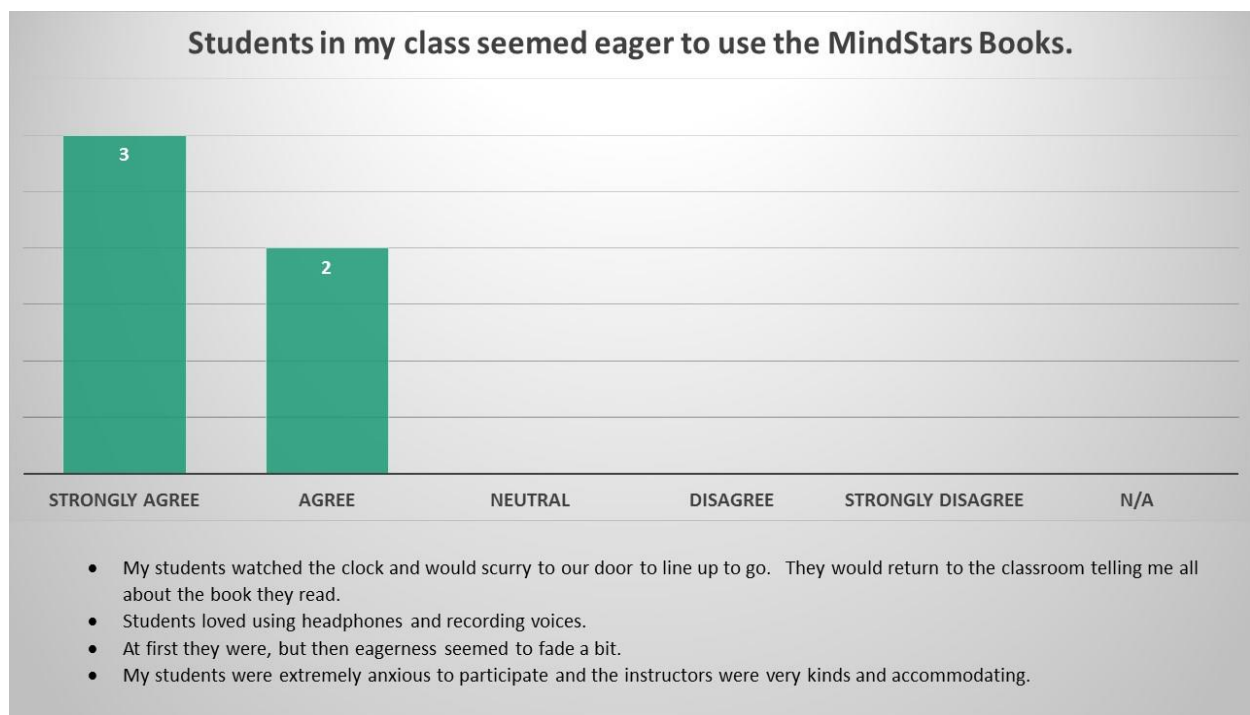
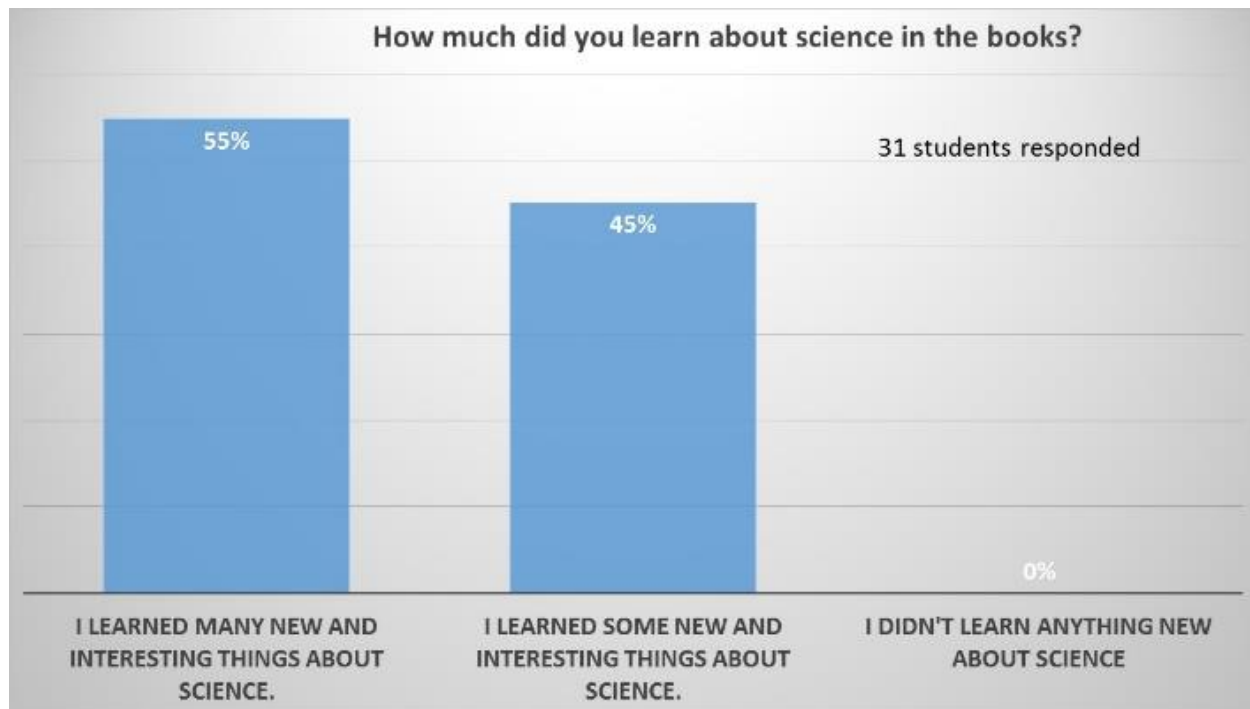


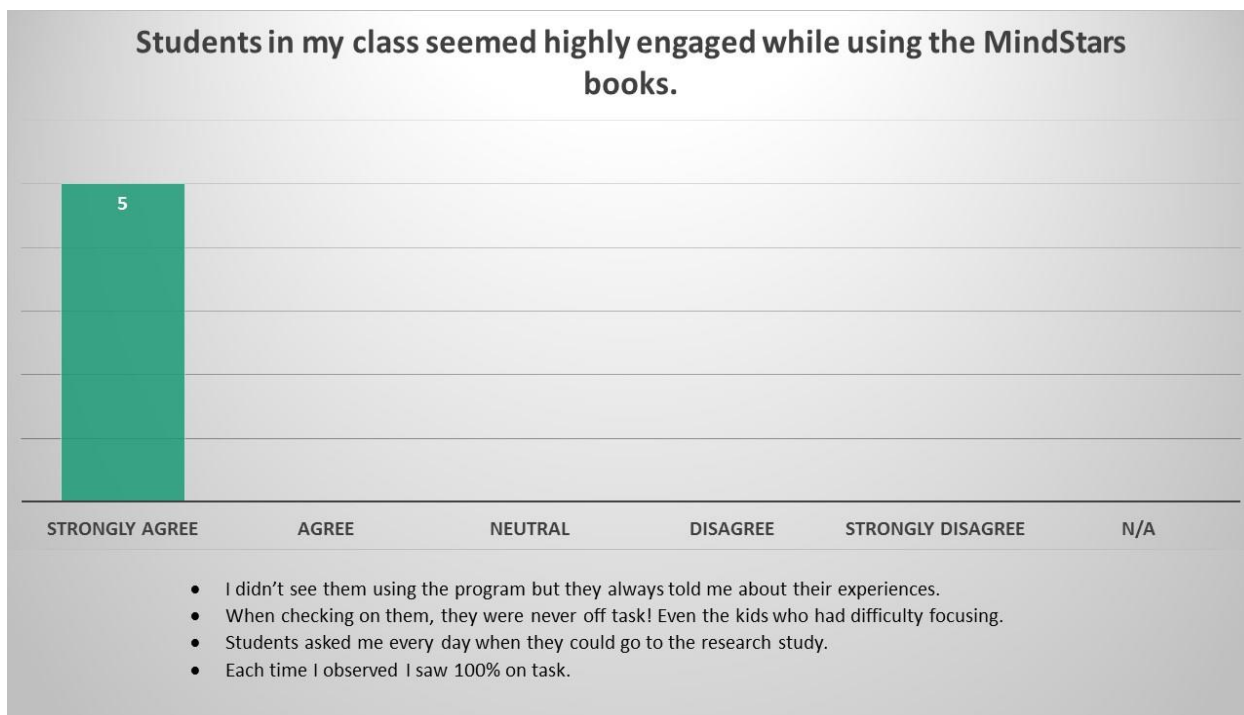
The goal of the SBIR Phase I project was to demonstrate the feasibility and promise of MindStars Books. A MindStars Book is an intelligent tutoring system in which children interact with a virtual agent that explains science using multimedia presentations. At logical stopping points within the book, the agent presents multiple choice questions to assess students' understanding of the vocabulary and concepts presented thus far. Students receive immediate formative feedback on their answer choices. Correct answers are reinforced and expanded. Incorrect first choices are followed by a hint and a second try. If the second choice is incorrect, the question is repeated, and the correct answer is given, along with its expansion. Students then practice reading short text passage about the science. During reading practice, students can listen to the agent read sentences aloud as the words are highlighted, or click on individual words to hear them pronounced. When ready, students read each sentence independently, and then listen to their recording as each word they spoke is highlighted on the screen. All three activities within the MindStars Book are self-paced, and thus under student control. Figures 1-3, respectively, show screenshots of a narrated multimedia science presentation, a multiple choice question, and reading practice.



The key outcomes of the project were: a) Highly positive experiences by students who used the MindStars Books; approximately 70% of students reported that the books were fun, that they learned many new and interesting things about science, and that they were more excited about science after using them, b) Evidence that students learned key vocabulary and concepts based on their responses to the multiple choice questions (75% first choice correct, 96% correct after receiving a hint and making a second choice), c) Reports by over 70% of students that they could read sentences better after using the books, and d) Highly positive reviews by all teachers, who said they would like to use the program in the future. The teachers reported that their students were always eager to use the books and were consistently “on task” while using them. Teachers also reported that the integration of science learning and reading practice was their most important feature, as the activities reinforced each other, and made it easy for them to schedule students to use the books during science, reading or language arts instruction. Histograms of Students and Teachers responses to questions in the second pilot study are shown in Figures 4-7.







In addition to developing and measuring the feasibility of MindStars Books to improve student engagement and learning in science and reading, we also investigated the feasibility of using existing open-source or commercial eye gaze tracking systems to measure students' attention during each of the MindStars Books activities. Our investigation identified one commercially available gaze tracking system, The Eye Tribe (<https://theeyetribe.com/>), that was sufficiently robust, accurate, and inexpensive (\$99) to merit further investigation of possible benefits of tracking students' eye gaze while using MSBs to gain insights into their cognition and improve student experiences and learning in the future.

In sum, the main outcomes resulting from the Phase 1 R&D effort included: 1) Development of the **MindStars Books authoring tool** (the MSB Editor), a stable and flexible authoring environment used to design, test, and publish 14 MindStars Books for use in schools, and the associated **MindStars Books Reader** to allow access to the library of MindStars books that students used in schools in two pilot studies, 2) Evaluating the feasibility and promise of the MindStars books for deployment in real world educational contexts to improve science learning and reading, based on first and second grade children's experiences and performance during and following use of the books, and 3) Evaluating the feasibility of tracking students' eye gaze for improving engagement and learning in future versions of the MindStars Books.