CONTEMPORIZING THE CHILDREN'S E-READER

Submitted in partial fulfillment of the requirements for the degree of Bachelor of Arts Department of Computer Science Princeton University

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"The more that you read, the more things you will know. The more that you learn, the more places you'll go."

Dr. Seuss, I Can Read with My Eyes Shut!

ABSTRACT

Many students across the United States find books uninteresting, and as a result, reading rates have plummeted in recent years. This paper details the design, development, and testing of a contemporary e-reader that engages today's children with books. This project accomplishes its goal by making reading more collaborative between peers with reading groups and emoji reactions. It also adds enticing discovery functionality for students, such as interactive maps and word pronunciation.

ACKNOWLEDGEMENTS

There are many people I would like to thank, for without them, this thesis would not have been possible, and my time at Princeton would have been far less amusing.

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1. INTRODUCTION

"Scientists compare the shadow cast by the pandemic to the lifelong imprint left on the children of the Great Depression."

— The Wall Street Journal

Over the past several years, reading rates among grade school students have declined in the United States. Test scores are dropping, and reading for pleasure is on its way to becoming a thing of the past with America's youth. In 2019, American performance in reading on national and international exams decreased, and the gap between high and low performers widened [20]. This downward trend also extends to reading enjoyment. From 2017 to 2019, the number of eighth graders in US public schools who said they read for 30 minutes or more outside of homework declined by 4%. These same students also reported less favorable attitudes toward reading, saying they are less likely to talk about books or go to a library and less likely to agree that reading is one of their favorite activities [9]. In a study from 2018 by the American Psychological Association, less than 20% of all American teens read books, magazines, or newspapers for pleasure [49]. The Progress of International Reading Literacy Study concluded that American fourth-graders rank in

the lowest tier for their grade among other countries in deriving pleasure from reading. The study showed that although these students did not hate reading, they certainly did not enjoy it [28]. This results from the expansion of electronic media into our daily lives, which has undoubtedly contributed to young students reading less. The last year more people in America spent time reading books than surfing the internet and playing video games was 1996 [7].

1.1   What Are the Ramifiactions?

The COVID-19 pandemic has intensified reading problems in the United States. In 2022, the Education Department reported the most significant drop in reading scores in decades for students in the fourth grade, a leading indicator for educational and economic success [17]. In a 2022 Wall Street Journal article titled, *How the Covid Pandemic Will Follow Today's Kids Into Adulthood*, Belkin highlights the incredible learning loss that will take place for this generation of kids due to the pandemic. Belkin writes, "While some kids will become stronger and more resilient adults, many are at risk for increased struggles across their lifetime" [10]. The New York Times also published a piece in 2022, *It's Alarming: Children Are Severely Behind in Reading*, stressing the need to develop reading skills with students post-pandemic. The Times calls on the opinion of Dr. Tiffany Hogan, the director of Speech and Language Literacy for the Boston MGH Institute of Health Professions, who states, "we're in new territory" concerning elementary school reading results. She also points out that the risks are "pretty dramatic" if elementary-aged children cannot become competent readers before advancing to middle school [20].

The Organisation for Economic Co-Operation and Development (OECD)

reported in 2002 that reading for pleasure was the most critical indicator of a child's future success [28]. Mcoy, from the National Literacy Trust, also presents that poor literary proficiency can increase the chance of earning less money and experiencing poverty. Mcoy reasons that literacy skills are the "foundation stone for success in educational attainment, employability, community participation, individual confidence, and well-being" [34]. Baines contends that literacy leads to greater overall and lasting happiness than electronic forms of media [7]. Reading is crucial for success in modern society, and excelling at a young age can lead to greater earnings, increased effectiveness, and a healthier life.

Reading proficiency also has significant economic benefits for the United States. An article from Forbes estimates that low literacy levels in American adults could cost the United States $2.2 trillion a year [36]. The US Department of Education found that more than half of Americans (54%) read below a sixth-grade level [8]. The same article from Forbes points out that if all adults raised their reading to a sixth-grade level in large metropolitan areas like New York, Los Angeles, Chicago, and Dallas, each city could stand to increase their GDP by 10% [36].

Reading can have profound effects on an individual and an entire economy. With the current reading dilemma in the United States, it is now more critical than ever that we bring innovative solutions that combat learning challenges to the forefront. We must quickly take steps to help students maximize their full potential as it pertains to reading, and encourage them to build a solid foundation for future success.

1.2   Our Mission

As technology continues to advance, students will continue to consume digital media over physical books. In response to this trend, my project seeks to introduce exciting features to an electronic book that make reading more engaging in this increasingly digital age without losing the feel of a traditional book experience.

This project seeks to design, develop, and test a new e-reader emphasizing collaboration with peers, emoji integration, and geographical awareness to better engage young readers with text. With our e-reader, students can read books together, an innovative concept against the grain of conventional reading practice. Students will also be able to react with emojis to passages and view their reading partners' reactions, aiming to engage students in a simple visual form rather than solely through text. Lastly, this project builds upon independent work completed in 2021 by myself that used natural language processing to find geo locations from a novel's text and display them to users on interactive maps as they read along. Developing an interactive e-book reader with a higher level of engagement seeks to turn around the current trend of the American youth becoming less interested in books.

2. BACKGROUND & RELATED WORK

"Had a chance to check out Bookji today and it was fantastic! Hope this makes its way into our school libraries soon. Check it out."

— District Technology Teacher on Twitter

As a student in grade school, I was a reluctant reader and continually struggled to find books I enjoyed. Like many of today's children, I found reading boring, and technologies like TV and web browsing more enticing. I first saw reading in a different light when, through a recommendation from a friend, I discovered Rick Riordan's *Percy Jackson and the Olympians* and could not put the series down. From this positive experience with reading during my youth, I continued to find other books I have enjoyed from a wide array of genres. My hesitant past with books as a young reader fueled my desire to create a solution for students today who feel like I did.

2.1   Bookji

This solution came about in the form of Bookji, a reading platform I designed and developed over the last two-and-a-half years to encourage students to

discuss, share, and engage with books among their peers [40]. Traditional methods of getting students to read, like gamification and other incentive-based approaches, contrast with how students use Bookji. Instead of providing a superficial reward for reading, Bookji encourages students to find books that match their interests and facilitates discussions about books with peers — helping students to find real interests in the books themselves, not superficial prizes. Overall, Bookji seeks to make reading more interesting for the uninterested reader and emphasizes collaboration over individualistic learning. It is essential to mention the purpose behind Bookji because it runs parallel to the approach I will take in developing an e-reading device.

Bookji started as an idea in ENG 385: Children's Literature, the Princeton English course, during my sophomore year. The initial web application was designed and developed in 2021 during the first semester of my junior year with Dr. Robert Fish of the Princeton University Computer Science Department as my independent work advisor [40]. The original premise of the application was simple: to connect students with books they might be interested in through a short, interactive quiz about their reading preferences. Since many students also need help finding the right book and getting started, this project aimed to provide an easy, fun way of selecting a book.

After the fall of 2021, I took a gap year from Princeton and expanded Bookji significantly. During this time, I grew the application from a single-page reading quiz into a fully-fledged social reading platform with numerous book discovery tools. I added new features to address a broader array of problems young readers face today. The reading platform has three key elements that distinguish it from other online reading tools and help it carry out its mission.

The areas are social media-like content-sharing capabilities, emoji reactions and search, and interactive book maps.
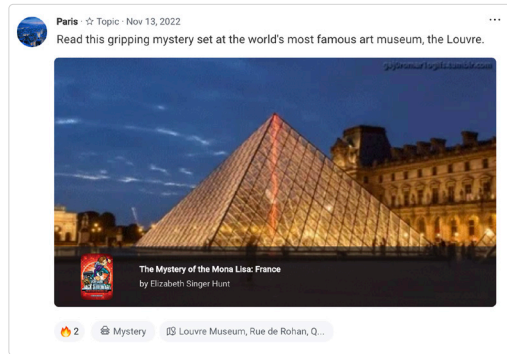

Figure 1: Bookji GIF Post with Trevor Noah

Figure 2: Bookji GIF Post Louvre

Figure 3: Bookji Book Post

Figure 4: Bookji Post with YouTube Video

Bookji is, at heart, a social media website for children's books. It allows students to share posts and discover book-related content. Figures 1- 4 show examples of posts students can view, share, and create on Bookji. Students can interact with GIFs, YouTube videos, and images. To take it one step further, students can set up profiles like the one displayed in Figure 5 and follow profiles like the one shown in Figure 6. This feature allows classmates to follow one another and stay in touch with what friends are reading. Integrating these familiar and modern technology components into the application facilitates an effortless
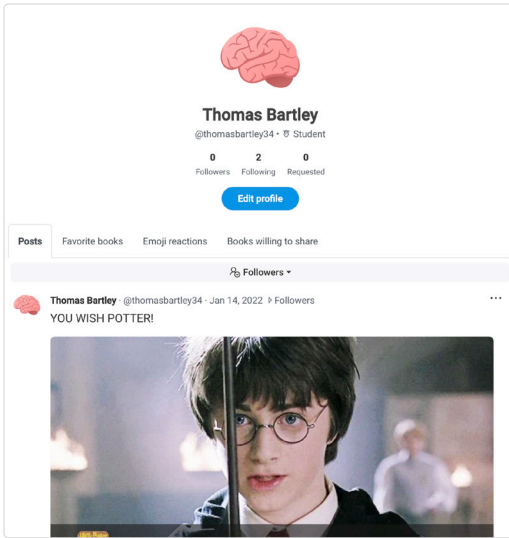
discussion about books.
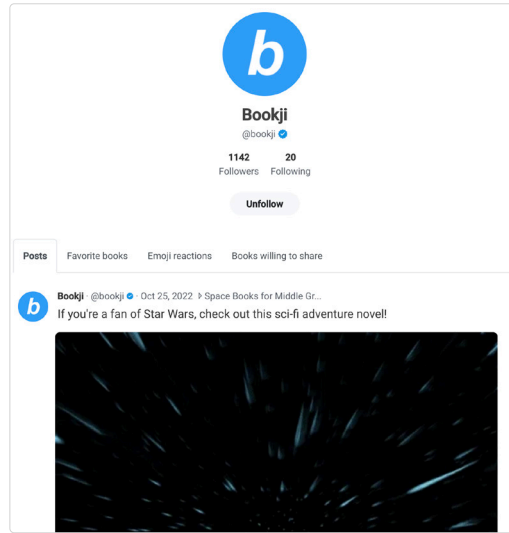

Figure 5: Bookji Student Profile

Figure 6: Bookji Profile

Emojis are utilized throughout Bookji allowing users to react to books in an expressive manner. Students can also search for the top books in the United States by students' emoji reactions, as seen in Figure 7. Reacting to a book with an emoji is a concise, expressive way of rating a text and allows students to search for books apart from traditional book categories like the genre. This feature encourages young readers to branch out from typically chosen books. Suppose a student usually reads fantasy novels but finds books labeled as "mind-blowing" intriguing. In this case, they could be more inclined to begin reading a historical novel, for example, that another student said was "mind-blowing." Emoji integration with Bookji also enhances social-emotional learning, emphasizing the development of students' ability to cope with and understand emotions.

The platform leverages the power of physical maps, adding another dimension to the standard book discovery process. With this feature students can view

an interactive world map modified to display book locations. Pin-pointing exactly where books take place on a map allows students to search for books in a new way. For example, a student might be interested in reading books that take place in their home state of California. This student could search the map to find which books occur in what parts of California, as shown in Figure 8. Integrating maps into teaching literature also benefits a student's geographical knowledge.
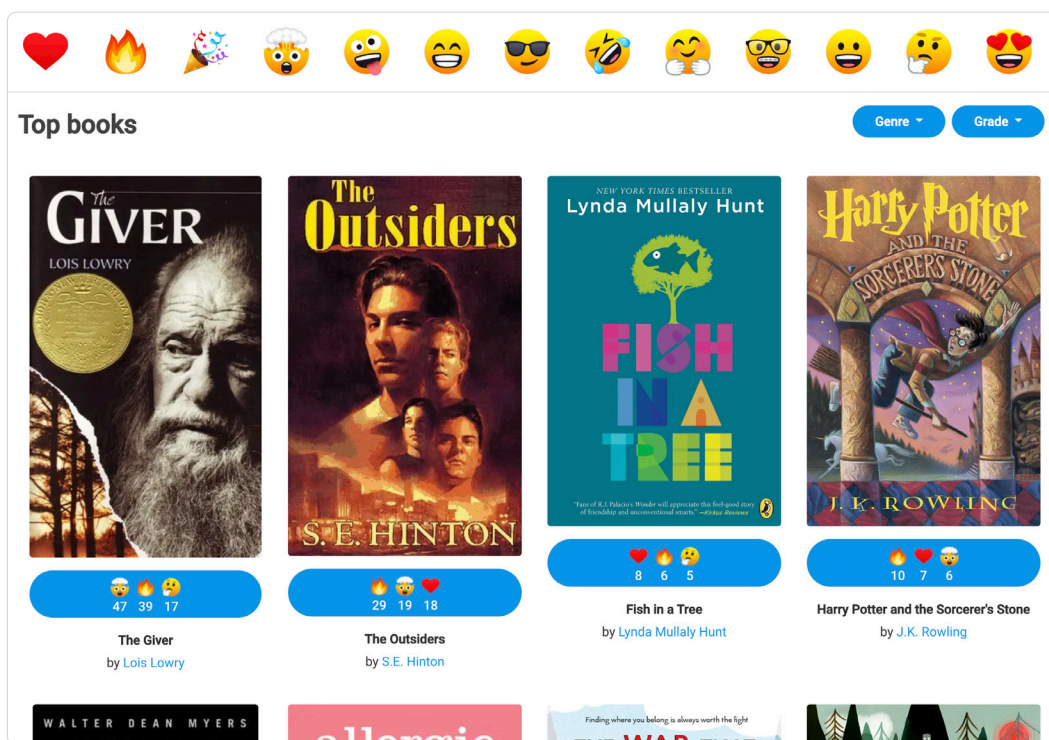

Figure 7: Bookji Emoji Search

Bookji has also garnered feedback from librarians and other educators through its roll-out in public elementary schools. On Twitter, one K-12 technology teacher with over sixteen thousand followers from New York wrote, "Had a chance to check out Bookji today and it was fantastic! Hope this makes its way into our school libraries soon. Check it out" [16]. Another librarian from New Jersey wrote on Twitter, "Hmm. @gobookji has some interesting features. It's

sort of like a souped-up reading journal - students can access maps that let them track the locations in their books. And it gives educators a look at kids' reading progress. \#njasl2" [47]. More reactions to Bookji from other librarians are included in Figure 9, Reactions to Bookji on Twitter.
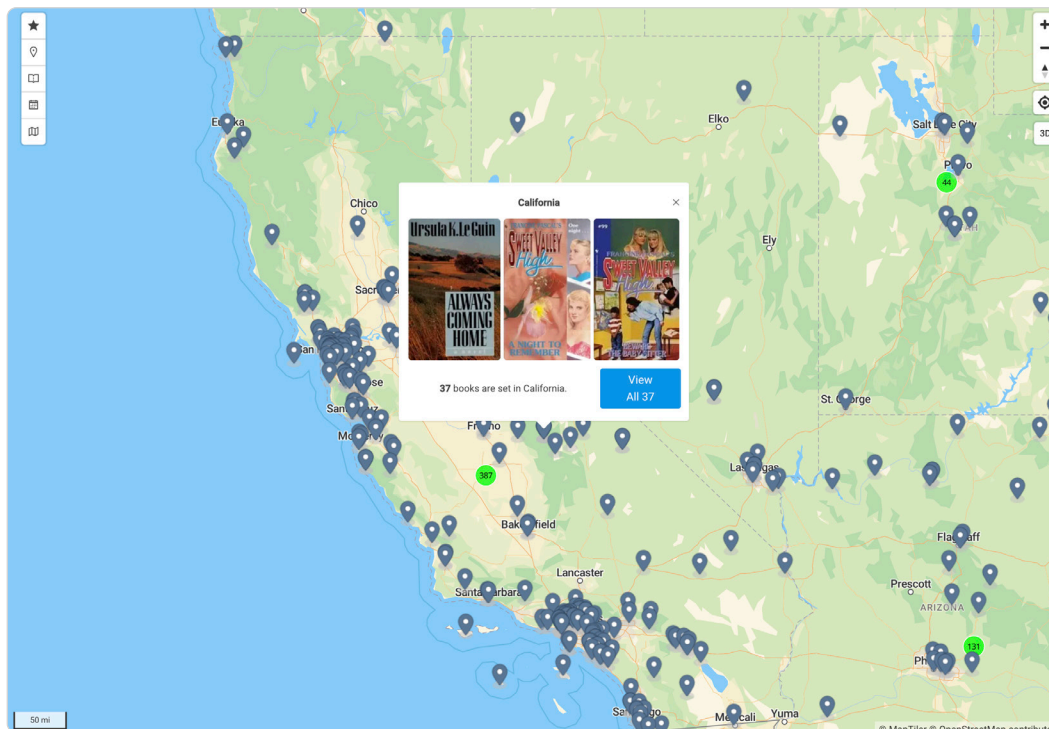

Figure 8: Bookji California Book Places

Upon returning to Princeton in the Spring of 2022, I expanded on engaging students with reading through interactive maps in my second junior independent work paper. I worked with Princeton Computer Science Professor Dr. Alan Kaplan as my advisor to extend an open source e-reader to have functionality that interactively displays the location mentioned in the text on a map. With this enhancement, readers are able to quickly understand the geographical context of the text [41]. This paper will improve on the work done with Professor Kaplan and gather results on its effectiveness.

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Figure 9: Reactions to Bookji on Twitter

2.4   Categorizing E-Book Readers

I will now focus our discussion on e-readers, diving into the different types, models, benefits, and shortcomings. This section will explain the difference between a basic, enhanced, and interactive e-reader and look at relevant examples and studies.

In his paper, *Interactive eBook Apps: The Reinvention of Reading and Interactivity*, Itzkovitch describes three categories for e-readers: basic, enhanced, and interactive. A basic e-reader is one in which there are limited bells and whistles. This type of e-reader is similar to a traditional book and offers simple features like searching for content, highlighting words, and dictionary definitions [26]. Examples of this e-reader include Apple's iBooks and Amazon's Kindle. These e-reading tablets were the pioneers of a new digital publishing market and revolutionized the way that people gained access to books. In a recent survey from 2014, *Digital Media and Student Learning: Impact of Electronic Books on Motivation and Achievement*, Hess evaluates the engagement and enjoyment levels of a group of fourth graders reading a book on a basic e-reader vs. a traditional paperback. The students completed their e-readings on a 1st generation NOOK. The results showed that students were excited to read electronically, and the experience was favorable to a paperback [22].

The enhanced e-reader differs from the basic e-reader in that it raises the levels of interactivity. Itzkovitch describes the enhanced e-reader as "a new digital publication standard that allows easy integration of video, audio, and interactivity" [26]. Enhanced e-readers can also include puzzles, quizzes, and

other interactive games. Enhanced e-reading devices provide supplementary content to a book designed to engage the audience better.

Lastly, the interactive e-reader is a device or piece of software that allows students to engage with the storyline of a book with sight, touch, and sound [26]. An interactive e-reader is less book-like than both basic and enhanced e-readers. This technology completely redefines what it means to be a book.

Let us now look at some examples of enhanced and interactive e-readers. Some of these e-readers are more interactive than others and provide different levels of supplemental content. SpoonRead is a company focused on creating gamified e-books students can use on mobile devices. The app's premise is to give students questions after they have read and provide rewards in the form of coins for each question they answer correctly [46]. Testimonials from children on the site's website say they like earning coins to win prizes [46]. SpoonRead is a true example of gamifying the reading process and shifts the primary focus from purely reading to getting questions correct on a quiz.

Red Shelf is a collaborative e-reader that makes it simple for users to highlight text and share notes [30]. The application allows users to form a group and view the messages of all group members. This app is less interactive than SpoonRead since the focus is still on reading, but there are still additional elements added to the functionality. Another e-reader similar to Red Shelf is Monocle. This application is called the "social e-reader" on their website [4]. Like Red Shelf, this app features annotation and note-sharing features for friends to compare thoughts on their favorite books easily. These two e-readers are still considered enhanced under Itzkovitchs definition but contain fewer

interactive features than a product like SpoonRead.

A research study on the effects of gamifying reading, *A Collaborative Reading Annotation System with Gamification Mechanisms to Improve Reading Performance* by Chen et al, studied 55 fifth-grade students in an elementary school in Taiwan. The study asked students to read an article while annotating and sharing their text comprehension. The results showed that gamification did not necessarily improve reading comprehension [14]. In this study, one group was part of the gamification process, and the other was not. The study concludes, "It is possible that students merely 'played' the annotations to achieve game levels and less attention was given to comprehend the article itself" [14]. Numerous other studies have surveyed lower-level readers, including Frye's *The Implications of Interactive eBooks on Comprehension* and De Jong and Bus's *Quality of Book-Reading Matters for Emergent Readers: An Experiment With the Same Book in a Regular or Electronic Format*, have shown that e-books with two-way action of interactive multimedia content may help children engage more with a text [15, 18]. Two-way action refers to a process similar to gamification, where students engage with the text directly after reading through questions, animations, etc. The study from Frye also found that lower-level readers found it helpful when the stories added narration [18].

The studies from Frye, and De Jong and Bus found some promising results for interactive e-readers. It is important to note that the students were a few grades younger than the fifth-graders survey in the study conducted by Hess and Chen et al. Similarly, my study will survey older students in grades five through seven.

2.3   The Children's E-Reader

In a 2012 report from the Association of American Publishers (AAP), the children's e-book market share exceeded that of adult e-books in the publishing space [23]. This statistic was no surprise to many due to the rise in popularity amongst children with the e-reader. In an article from 2011, The New York Times highlights one parent of an 11-year-old child from New York who exclaimed, "the kids have taken over the e-readers." The article lists relevant child experiences with e-readers like 12-year-old Mia Garcia, who cried after reading *Little Women* and *The Hunger Games* on her Sony Reader, and 11-year-old Eliana Litos, who hadn't watched TV in two weeks after receiving her e-reading device [11]. Another article from The Telegraph in 2012, titled, *E-books Could Become the Norm for Children as Sales Soar*, comments on the growing popularity of e-readers amongst children [21].

The rise in the popularity of e-readers among children is the ability of electronic devices to support features like videos, games, puzzles, etc. [44]. For reluctant readers, these added features can be exciting and serve as a way to get students interested in books. However, with this drastic change in technology, criticism followed. An article from The Washington Post argues that "most children need and crave the tactile interaction that real books provide" [12]. A study by BookTrust surveyed approximately 1,500 parents who expressed concerns over their children using e-readers. The survey found 35% of parents worried that their children could lose interest in traditional books, and 45% feared an increase in overall screen time [43]. As seen in the study by Chen et al., there was no apparent benefit to reading comprehension when using a gamified e-reader, and this project will take a different approach.

3. APPROACH

"In the future, as the world becomes increasingly digital and increasingly globalized, emoji will become important tools for translation and communication—a lingua franca for the digital age."

— *Wired Magazine*

The numerous examples and studies on e-books in Section 2, Background & Related Work, showed mixed results when testing their effectiveness on children. Lower-level readers in early grades benefited from the read-aloud and gamification features, while some older students in a different survey were distracted. This project does not seek to change the underlying medium for which a story is told (i.e., narration, animations, and games); instead, we aim to preserve the conventional medium of a book while changing how grade school students discuss a story they have read and encourage students to share their diverse opinions with their peers.

3.1   How Interactive?

When creating an e-reader with additional features, it is crucial to consider whether these added components are too distracting and take away from a

book. My e-reader aims to strike a balance between a traditional book experience and an interactive environment that helps children engage with text better. So how interactive is too interactive? Our e-reader does not contain animations, puzzles, games, etc. We hypothesize that these features can distract readers in our age range from fully immersing themselves in the text and challenge the notion of what it means for a book to be a book. Since the mission of this project is to get kids interested and engaged with reading, providing students with a book that contains games and animations could be more of a quick trick than a real solution.
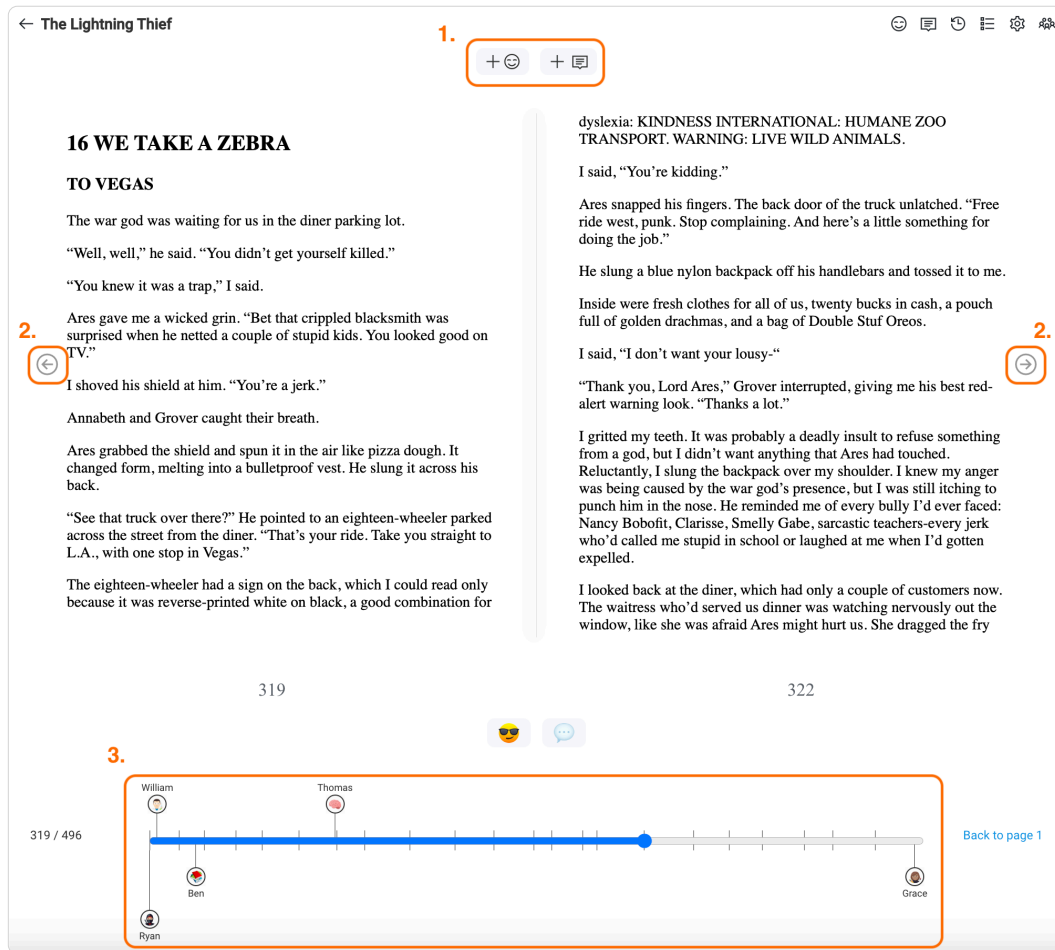

Figure 10: E-Reader Interface Overview

The interface builds on the design of a basic e-reader. Figure 10 shows a screenshot of the layout for *Percy Jackson & The Olympians: The Lightning Thief*. The top of the screen features the title of the book and a few icons to help the user navigate the e-book. Below are two icons that allow the user to add a reaction and a comment to a specific page, called out in the figure by an orange 1. The center contains the main pages of the e-book, with arrow icons to flip between pages, shown by the orange 2. This design layout is intentionally analogous to basic e-readers to give the reader a similar experience to an actual book. Finally, the bottom of the screen features a progress bar so the user can quickly scroll to different novel sections, shown by the orange 3. This progress bar also differs from traditional e-reader navigational tools because it highlights other users in the book. We will dive deeper into this feature in in the proceeding section.

3.2 Collaborative Learning

Collaborative learning is when individuals work together to accomplish a goal or solve a problem, and the concept has numerous benefits for students. In his paper, *The Motivational Benefits of Cooperative Learning*, Theodore Panitz discusses the social, psychological, and academic benefits of learning with peers. From the social perspective, Panitz points out that collaborative learning helps students create a support system that "encourages their involvement in the learning process". Another social benefit is that learning communities are built within a classroom. Psychologically, students who learn collaboratively can reduce anxiety and raise their self-esteem. In terms of academic benefits, students learn to think critically and become active participants in discussions [38].

This project harnesses the power of collaborative learning in the form of an e-reader. As seen in Figure 11, the bottom of the e-reader book screen contains a progress bar. This bar displays the current user's completion percentage and the completion percentage of different friends for a given book. This way, users can quickly reference how much their friends have read. Each friend also contains sub-data, which includes emoji reactions and comments for specific pages. As seen in Figure 12, a user can click on one of their friends, and the progress bar updates to show a single user's engagement with the text. Displaying other users' book progress, reactions, and comments on the screen helps facilitate more peer discussions about the text.
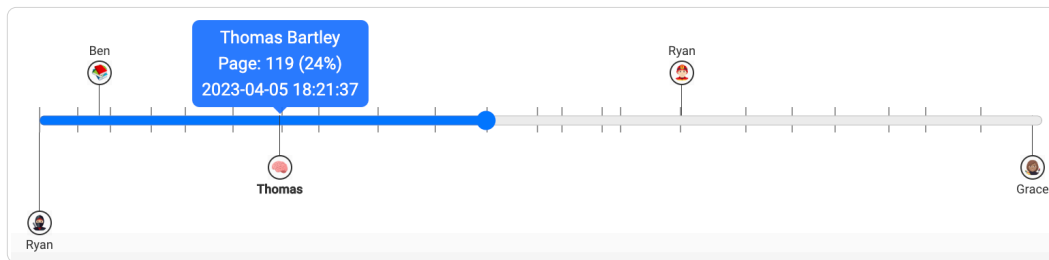
Figure 11: E-Reader Progress Bar
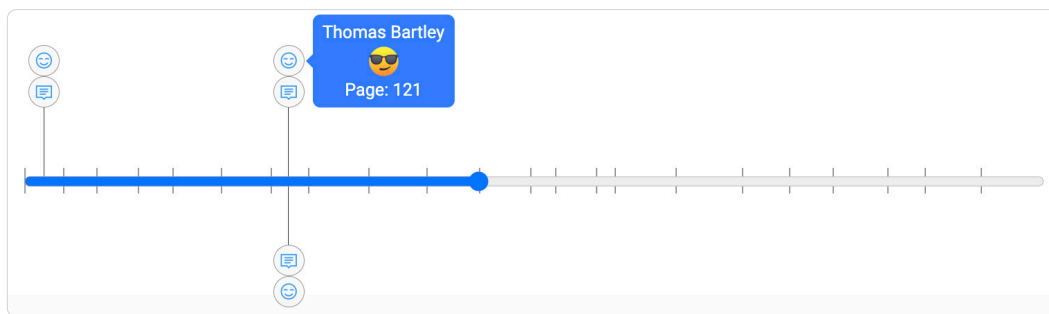
Figure 12: Individual User Progress Bar

To make a comment or emoji reaction to a part of the text is easy using my e-reader. The user clicks on the ＋ 🗨 button to comment and the ＋☺ button

to make an emoji reaction, as shown in Figure 10, E-Reader Interface Overview. After selecting one of these options, a dialog modal opens on the screen, and the users can type in a comment or choose an emoji. Figures 13 and 14 show sample comments and emoji reactions from students. It is crucial to point out that this feature's user interface and design are simple and manageable. Users can easily view all the discussions about a book. This seamless integration maximizes the product's usability while keeping the students' attention on the book's content and sharing their thoughts.
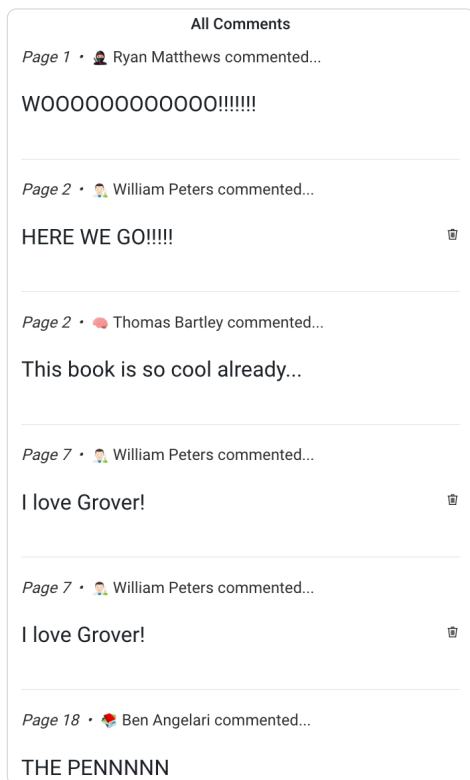
Figure 13: View All Book Comments
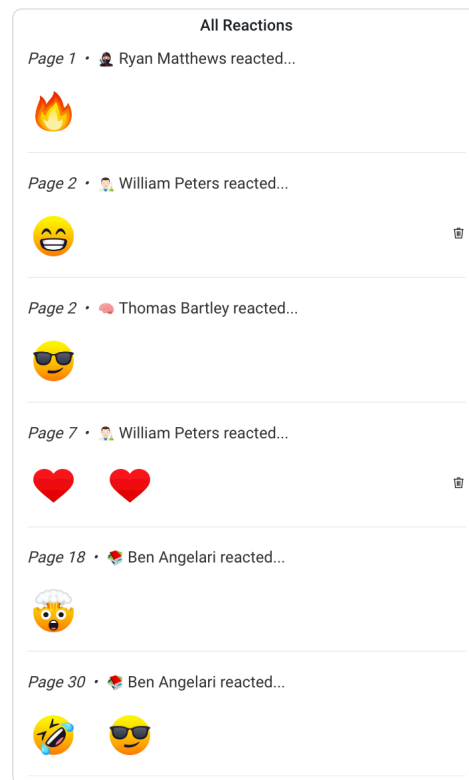
Figure 14: View All Emoji Reactions

3.3   Emoji Integration

Emojis are a vital component of our e-reader's approach. The icons represent

a universal language of expression that people can visually understand. In an article about the history and use of emojis, Wired Magazine wrote, "In the future, as the world becomes increasingly digital and increasingly globalized, emoji will become important tools for translation and communication—a lingua franca for the digital age" [38]. The reach of emojis extends far past the United States and acts as a language bridge between different groups of individuals—especially young people. In their paper, *Emojis in the Digital Writings of Young Danes*, researchers Hougaard and Rathje write, "Emojis are the latest communicational playground for both young people and adults because emojis are also used just for fun and embellishment" [25]. A Danish article from Kristeligt Dagblad journal wrote that emojis are "a language of adolescents" [32]. Emojis are communication tools of the future, and this project leverages their popularity among young people to help engage with reading.

The use of emojis in modern society does come with some criticism. Opponents say that emojis trivialize the written English language. Articles like *Emoji 'ruining people's grasp of English' because young rely on them to communicate*, from The Telegraph push this narrative [48]. Linguists like Gretchen McCulloch argue that the internet has naturally changed how we use language, which is okay. McCulloch writes, "Language is humanity's most spectacular open-source project, and the internet is making our language change faster and in more interesting ways than ever before" [35]. Another article from The Conversation titled, *Emoticons and symbols aren't ruining language − they're revolutionizing it*, argues that a single emoji can convey a more complex message than words [5].

Emojis are potent tools of communication that children in the digital age

find fun and engaging. This project encourages communication with emojis to make discussions about books more lively and modern. Students can add emoji reactions to a page they read and view emoji reactions from their friends, as seen in Figure 14. Figure 15 shows the different emojis students can select. Emoji integration and emphasis add a contemporary edge that differentiates this e-reader from other competing technologies.
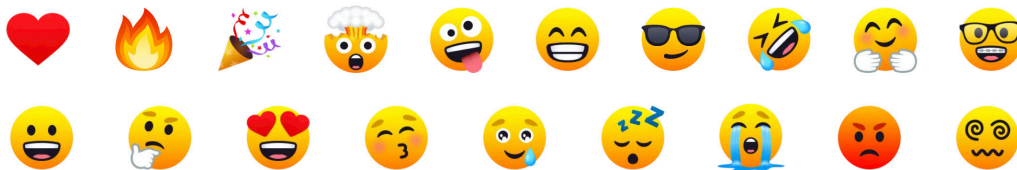
Figure 15: Emoji Reactions

3.4   Pronunciation

The e-reader designed and developed in this project also engages students with reading by helping them becoming active learners. Providing audio pronunciations for students to pronounce words they need help understanding can make reading less daunting. Although a student can search the internet for a term, making these tools available directly through the user interface is crucial for learning development. If a student has to leave a book to view external information, they will become disconnected and find it harder to re-focus on the material they were reading.

The pronunciation feature of this project is used by simply double-clicking on a word. Once clicked, a small pop-up opens, prompting the user to hear the pronunciation, as seen in Figure 16.

Asher, who talked too fast and mixed things up,
scrambling community silent, waiting, had made his
stomach churn. He words and phrases until they were
barely recognizable and had trembled

often very funny.

But it had been nothing. Within n
Jonas grinned, remembering the n
crackled again, and the voice, rea
dashed into the classroom, late as
had explained that a Pilot-in-Training had misread

Definition

Pronunciation 🔊

Search Google

Search Wikipedia

Figure 16: Word Pronunciation

3.5 Interactive Maps

For the second semester of my junior independent work, I enhanced an open source e-reader adding geo-location functionality. This project refines and tests this feature. Although I will not go in-depth on the implementation detailed in my paper *Framework for Augmented Children's Book Reader*, I will reiterate how and why it benefits students.

Adding interactive maps to books with physical locations helps students improve their geographical awareness and engage better with the story. Oden suggests in his paper, *Geography is Everywhere in Children's Literature*, that mapping out stories with physical locations can improve reading comprehension with children [37]. It is likely that students will not know some of the places mentioned in a book they are reading. If students have a map on-hand to visually reinforce their understanding of a location, teaching geography through children's books can be benefitial [37]. In his paper, *Using Children's Literature to Promote Critical Geographic Awareness in Elementary Classrooms*, Lintner states, "By using select language arts books to specifically teach the theme of human-environment interaction, elementary teachers can

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create both relevant and powerful classroom experiences" [31].

They went back to their conversation as if I'd never existed.

The only person I dreaded saying good-bye to was Grover, but as it turned out, I didn't have to.

He'd booked a ticket to **Manhattan** on the same Greyhound as I had, so there we were, together again, heading into the city. **1.**

During the whole bus ride, Grover kept glancing nervously down the aisle, watching the other passengers. It occurred to me that he'd always acted nervous and fidgety when we left Yancy, as if he expected something bad to happen. Before, I'd always assumed he was worried about getting teased.

But there was nobody to tease him on the Greyhound.

Finally I couldn't stand it anymore.

I said, "Looking for Kindly Ones?"

Grover nearly jumped out of his seat. "Wha-what do you mean?"

I confessed about eavesdropping on him and Mr. Brunner the night before the exam.

Grover's eye twitched. "How much did you hear?"

"Oh … not much. What's the summer solstice dead-line?"

He winced. "Look, Percy … I was just worried for you, see? I mean, hallucinating about demon math teachers …"

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"Grover-"

"And I was telling Mr. Brunner that maybe you were overstressed or something, because there was no such person as Mrs. Dodds, and …"

"Grover, you're a really, really bad liar."

His ears turned pink.

From his shirt pocket, he fished out a grubby business card. "Just take this, okay? In case you need me this summer.

The card was in fancy script, which was murder on my dyslexic eyes, but I finally made out something like:

Grover Underwood

Keeper

Half-Blood Hill

Long Island, **New York** **2.**

(800) 009-0009

"What's Half-"

"Don't say it aloud!" he yelped. "That's my, um … summer address."

My heart sank. Grover had a summer home. I'd never considered that his family might be as rich as the others at Yancy.
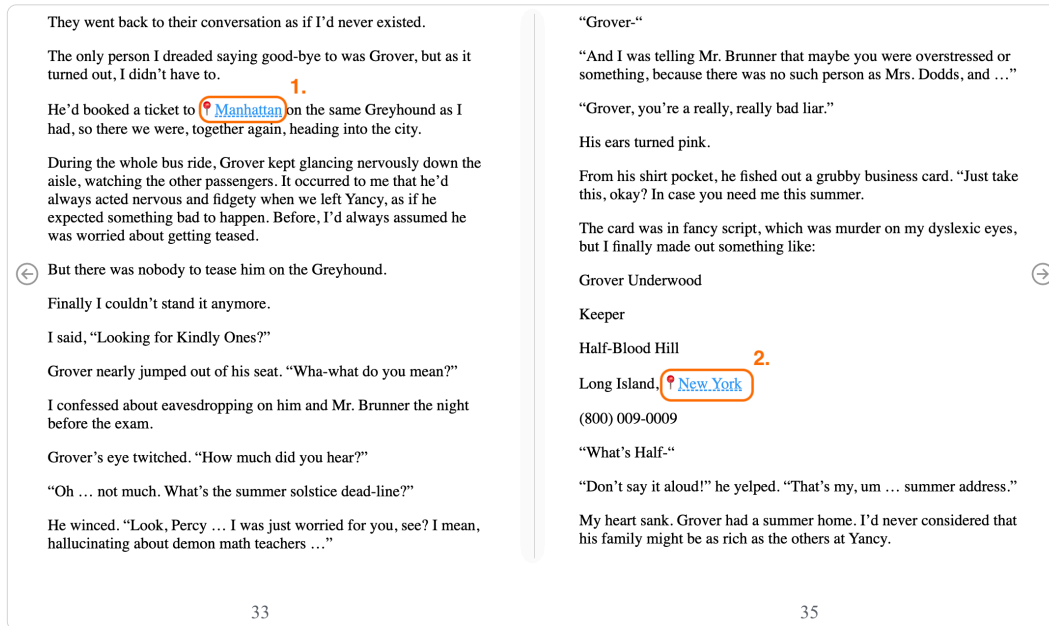
35

Figure 17: Locations in Text

My independent work project resulted in a functioning e-reader highlighting locations in a given text and displaying the places on an interactive map when users click them. As seen in Figure 17 with Manhattan (1.) and New York (2.), cities, states, countries, places, etc., are highlighted in the text. Once a user clicks a location, a modal opens, containing a map of the place, as seen in Figure 18. My junior project used a natural langauge processing (NLP) library to parse locations from the text, and I tested its effectiveness by calculating the percentage of times it correctly identified the place. Fantasy books averaged the correct location 43.33% of the time, realistic fiction books 55.66%, and non-fiction books 65.66% of the time. Due to these low percentages, this project created an admin interface to choose which locations would be included and excluded from the e-book. When parsing the book *Charlotte's Web*, the word 'Charlotte' appears numerous times as the name of the main

character. The NLP library picked this up as the location as Charlotte, NC. In order to ensure that all locations are correctly identified it is crucial that I confirmed each location before including it in the e-book. This way the places displayed to students in this project are guaranteed to be correct.
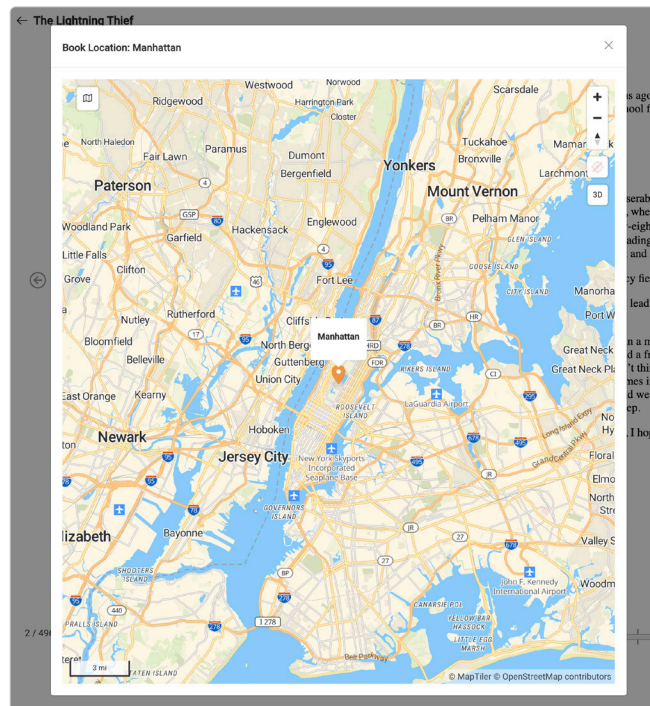

Figure 18: Book Location Modal

To summarize, this project's approach is to engage students on a deeper, more intuitive level with the books they read. Features like collaboration with friends, emoji integration, and learning tools like audio based pronunciation and interactive maps accomplish this goal. This project starkly contrasts the incentive-based approaches designed to inspire students to read that I was accustomed to in grade school and the gamification of the reading process, as seen in many new technologies and studies.

4. HOW IT WORKS

"There is great promise and opportunity in the digital-books revolution. The question is: Will we recognize the book itself when that revolution has run its course?"

— The Wall Street Journal

This project uses the Bookji application as a launching point for developing my contemporary e-reader. The user interface tier consists of HTML, JavaScript, and CSS. The processing tier, written in Python and Flask, handles the website's back-end logic and routing. The data management tier utilizes a clustered PostgreSQL database to store relational book and user data and a Redis object store for caching and session management. The application runs on two Amazon EC2 web servers which sit behind an Application Load Balancer accessible through the domain name *gobookji.com* [42].

In my second independent work paper, *Framework for Augmented Children's Book Reader*, uploading an EPUB file (the standard file for an e-book), then parsing it to find its possible geo-locations within the text and augmenting the EPUB linking the place names to open a modal that shows the location on a map [41]. To find the possible geo-locations within the text, I used the

open-source NLP library spaCy [24]. Then, to map the found place names to an actual physical address I used the geo-coding web service offered through *nominatim.org* [2]. Finally, I display these locations to users on an interactive map in the text using the open-source library MapLibre [3].

I completed the basic implementation of the Bookji application and location parsing features in previous work. Since its creation, it has been modified and improved. This section will describe any significant modifications related to this project and dive deeper into the database schema, server-side implementation, and front-end user interface.

4.1 Modifications to Independent Work

The previous version of the EPUB found place names in a book, looked up their physical locations, and augmented the EPUB's HTML files to link the place name in one sequential pass through the EPUB. The parser started at the top of each of the EPUB HTML files and passed each sentence one at a time to the spaCy engine for name recognition. If any geo-entities were found, the logic called Nominatim's API to retrieve the physical location's address and update the place name within the HTML. As a result, all possible places found were linked in the manipulated EPUB even though they may not be appropriate (i.e., Charlotte in Charlotte's Web) or even the wrong location based on the place name (i.e., the country Georgia versus the state name Georgia). The previous version provided UI on each location link or via the admin console to mark that location as not a location or incorrect.

Under this project version, the process was split into the following distinct

steps. First, find and record the geo-entities within the text. The, look up physical addresses. Next, manually identify and verify the correct place names to be linked in the EPUB. Lastly, regenerate the EPUB linking only the verified place names.

I updated the admin interface to reflect these new steps. An administrator can now view a report showing all the possible place names found for the specified EPUB and mark next to the desired ones that are valid. Once all the places are checked, the administrator can click a button to regenerate the EPUB linking only those selected place names.

4.2   Database Schema

This project relies on a PostgreSQL database to manage book progress, emoji reactions, comments, and other user reading information. For this project, students and teachers create their own Bookji accounts at *gobookji.com* to access the e-reader. Figure 19 diagrams the relevant database schema, where each arrow represents a foreign key relationship between tables.

The *users* table stores information (first name, last name, username, email, password, etc.) about each student and teacher. This table has a foreign key relationship with the *reading_groups*, *reading_group_participants*, and *book_ progress* tables. This relationship entails that a record can only be added or deleted in the *reading_groups*, *reading_group_participants*, or *book_progress* if it contains or deletes a record in the *users* table first, respectively.

Each *books* table record contains data like title, cover image, synopsis, etc.

This table stores the information for every book on the Bookji application. A foreign key relationship exists between the *books* table and the *reading_ groups* and *book_progress* tables.

In the application, the collaborative reading feature goes by the name: reading group. The *reading_groups* table stores information about each group, including the *owner_id*, *book_id*, *start_date*, *end_date*, and other group settings. A record is created in the *group_participation* table when group members are added. To track the book progress, emoji reactions, and comments of users when reading with this e-reader, we store this information in the *book_prog-ress* and *book_progress_emojis* tables. A foreign key relationship exists between these two tables since *book_progress_emojis* contains a *book_prog-ress_id* column.
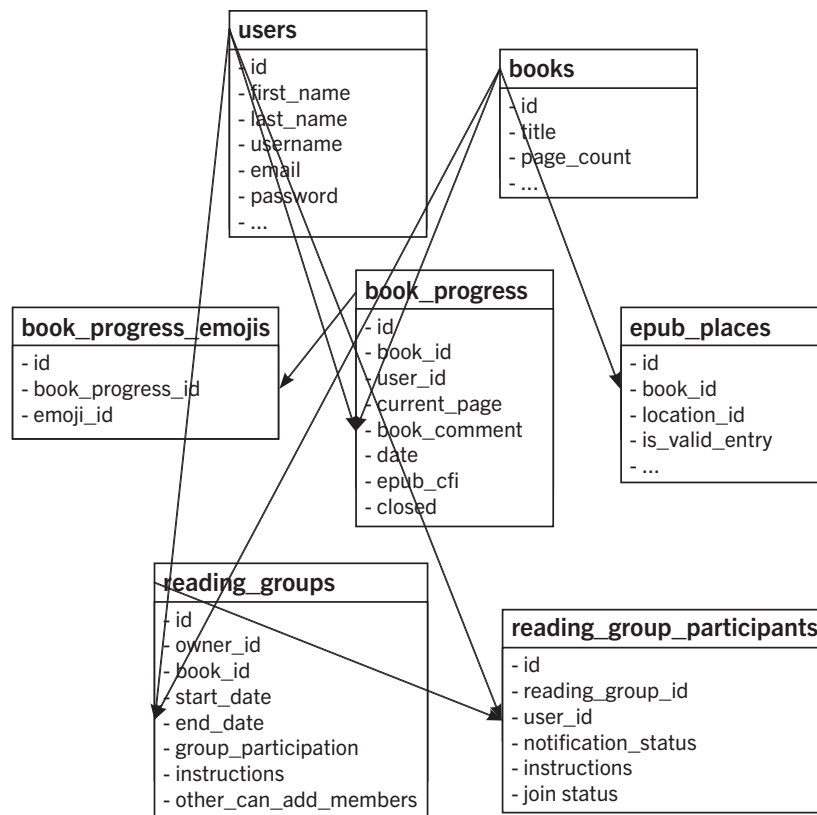

Figure 19: Relevant Database Schema

4.3   Server-Side Implementation

The server side of my e-reader was built using Python and Flask. Three Python files make up the server-side implementation of this e-reader: *routes.py*, *epub_mod.py*, and *group_read_mod.py*. For the sake of simplicity, I will not walk through the complete functionality of each API method in this section of the paper. Instead, I will discuss the purpose of each file in implementing my e-reader.

The file *group_read_mod.py* includes the methods that provide group read data to the user interface and manage any modifications to the settings of the reading group. The functions *createReadingGroup()* and *deleteReadingGroup()* handle creating and deleting a reading group by accessing the *reading_groups* table in the database. While the functions *addReadingGroupParticipant(), getReadingGroupParticipants(),* and *getReadingGroupParticipants()* update and query the *reading_group_participants* table. The *getPartipantProgressData()* and *getIndividualUserData()* functions join the *users* and *reading_group_participants* tables to extract the book progress users in a given reading group for the progress bar feature. The data returned from the *getPartipantProgressData()* function is a dictionary of the form:

```
mode: 'user_progress'
user_progress: [
     {user_id: '1',
      first_name: 'Ryan',
      last_name: 'S',
      avatar_filename: 'brain.png',
      pct_complete: 50,
      last_updated: '2023-01-25 12:00:00'
     }
]
```

The data returned from the *getPartipantProgressData()* function is a dictionary of the form:

```
page: 250,
comments:[
    {
        user_id: 3,
        first_name: 'Karl',
        last_name: 'P',
        values:['This is my Comment...']
    }
],
reactions:[
    {
        user_id: 3,
        first_name: 'Karl',
        last_name: 'P'
        values:['1f92a3.png']
    }
]
```

The function *checkInAGroupRead()* determines whether or not a student is in a group read so that we can load its data or not upon rendering the e-reader. Function *removeUserFromReadingGroup()* removes a user from a group read and is only callable from a group read participant. This function will raise an exception if the user is not in the reading group. The functions *acceptReadingGroupInvite()* and *rejectReadingGroupInvite()* update the *notification_status* column in the database based on a participant's reply to the reading group invitation. If the invitation is accepted, the *notification_status* column updates from "pending" to "accepted." When the invitation is rejected, the *notification_status* column updates from "pending" to "rejected." Finally, the self-explanatory *quitReadingGroup()* method removes a user from a group read and is only callable from the participant that wishes to leave the group.

The file *epub_mod.py* contains all functions for delivering book progress, comment, emoji reaction, and location data to the user interface. The function *viewEPubEmojiReactions()* is called via AJAX from the front end to get all the emoji reactions for a reading group's book. It queries the *book_progress* table joined with the *book_progress_emojis* and *users* tables. The results of this query are specific *epub_cfi*"s (epub page markers) and emoji reactions for a particular user. It then stores this data in a list and returns the list to the front end of the application.

The function *viewEPubComments()* is called via AJAX from the front end to get all the comments for a reading group's book. This method is similar to *viewEPubEmojiReactions()*; however, it only needs to join the *book_progress* table with the users table because each comment is stored directly in *book_progress,* as seen in Figure 19.

Both *viewEPubEmojiReactions()* and *viewEPubComments()* return data for all reactions and comments for a book, respectively. When a user flips through the pages of a book on this e-reader, emoji reactions and comments are displayed per page as well. This requires two additional functions: *getPageAllReactions()* and *getPageAllComments()*. These functions query the database in the same way that *viewEPubEmojiReactions()* and *viewEPubComments()* do, but contain a "WHERE" clause in the SQL statement that makes sure the *current_page* column in the *book_progress* table is the same as the current user's *current_page* on the e-reader.

The three methods *markEpubPlaceValid(), markEpubPlaceNotValid(),* and *regenerateEPUB()* modify the locations feature from my junior paper. In that

paper, we described how the function *geoparseEpubFile()* unzipped the EPUB file into a temporary directory and looped over each HTML file in the folder. While looping over each file, it replaced each location identified by spaCy with a *<span class="possible_place" ...>* tag, stored these places in the epub_places table in the database, and re-zipped the HTML files into a new EPUB file. The methods *markEpubPlaceValid()* and *markEpubPlaceNotValid()* update the *is_valid_entry* column of the places found by spaCy and stored in the *epub_places* table. This aims to identify which locations are correct and which are incorrect. Finally, *regenerateEPUB()* regenerates the epub with only places marked as valid using the same steps found in *geoparseEpubFile()*.

The Python file, *routes.py*, is the final step that connects the back-end of this e-reader to the front-end. A route or URL schema must exist for a front-end request to reach a function on the back end. Let us look at an example of Python code from the routes.py file:

```python
@app.route("/creategroupread", methods=['GET', 'POST'])
@login_required
def createGroupRead():
    import group_read_mod
    return group_read_mod.createGroupRead()
```

Each route takes the same form. A declaration of the URL exists — in this case, "/creategroupread" is used — and this route will allow both "GET" and "POST" requests. When a request is made to this URL, it will call the function *createGroupRead()*, which exists in the *group_read_mod.py* file.

4.4   User Interface

The user interface of this e-reader consists of HTML, JavaScript, and CSS files that work in unison to present content to the user and deliver data to the server. *Read_book.html* serves as the skeleton for the e-reader, containing the HTML code. *Read_book.js* and *group_read.js* allow the front end to communicate via AJAX (asynchronous HTTP request) calls with the application's back end. The CSS files *read_book.css* and *group_read.css* control the stylistic elements of the user interface.

Figure 20: E-Reader Menu Bar

The top of the *read_book.html* file contains a menu bar, as seen in Figure 20. When a user clicks on the "view all emoji reactions" icon, seen as (1.) in Figure 20, a JavaScript function is called to get the data from the server. In this case, the function *viewEPubEmojiReactions()* from the file *read_book.js* is called. When the data is returned, it is inserted into the *<div id="reactions-dropdown">* element in *read_book.html*. Similarly, when a user clicks on the "view all comments" icon, seen as (2.) in Figure 20, the function *viewEPubComments()* is called from the *read_book.js*, and the result is interset into *<div id="comments-dropdown">*.

Users can also be added and removed from a group by clicking on the "manage Your Reading Group" button, seen as (3.) in Figure 20. This opens a modal, as seen in Figure 21, where the user can easily search for members to add to their group. The JavaScript function *getGroupReadUserSuggestions()*

is called when the user keys up in the search bar. To select a member you wish to add, the user clicks on the open circle adjacent to the desired name, and the JavaScript function *selectDeselectUser()* is called. This function adds a *selected* class to the corresponding *<div>* element. Once a user has added all of their desired members, the "Add Members" button is clicked calling the front-end function *addGroupReadMembers()*. This adds the selected users to the *reading_group_participants* table in our database.
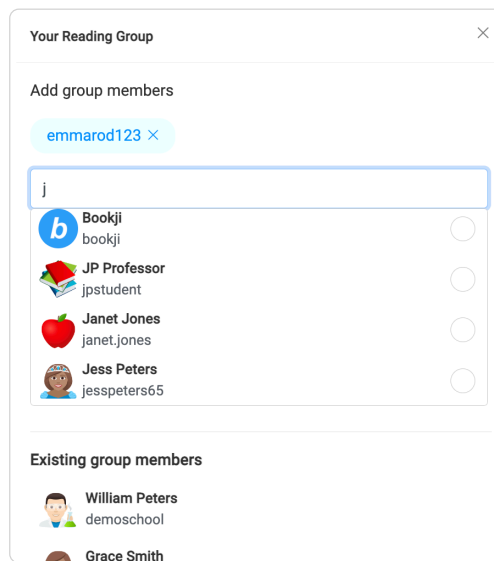

Figure 21: Add Users to Group Read

When a user decides to give an emoji reaction or a comment to a specific page, they will call the javascript functions *openEPUBAddEmojis()* and *openE-PUBAddComment()*, respectfully. These two functions open modals, which prompt them to input their reaction and comment. After the user enters this information and clicks "Save," the function *doSaveBookProgress()* is called, and the user's book progress is passed to the server and saved in the database.

In the bottom section of *read_book.html*, I include a progress bar. This progress bar has multiple functionalities. First, when a value change with the progress bar occurs, the JavaScript function *progressUpdate()* is called, which updates a user's book progress on the server side and in the database. Second, when a user is in a reading group, the book progress for the other members appears on the bar, as seen in Figure 11. Upon loading the page, the Javascript function *getData()* is called, and the participant progress data from the server is returned. After this is returned, the function *updateEpubProgress-Bar()* is called, which builds HTML from the user data to be inserted on top of the progress bar.

The pronunciation feature is displayed by double-clicking on a word in the e-reader. When this is done, it triggers the JavaScript function *getSelection-Definition()* to be called. This makes an AJAX call to the server, which uses an open-source dictionary API found at *dictionaryapi.dev* to return a definition and pronunciation for the given word [1]. The audio then plays for the user be calling the function *playSelectionAudio()* when the pronunciation button is clicked, as seen in Figure 16.

Finally, I will discuss the user-interface refinements made to the book locations feature of this e-reader. As shown in Figure 22, the admin console allows administrators to add or remove possible locations for a given book. Upon clicking the blue check mark, labeled as 1 in Figure 22, this calls the JavaScript function *markEpubPlaceValid()*, which sends an AJAX request to the server to store this correct location in the database. Similarly, the blue "x," labeled as 2 in Figure 22, calls the JavaScript function *markEpubPlaceNotValid()*, which indicates that this location is not correct. The "Regenerate EPub"

button, labeled as 3 in Figure 22, calls the JavaScript function *regenerateE-PUB()*, which sends an AJAX request to the server to re-build this EPUB file with the updated locations.

Figure 22: Corrected EPUB Places

5. EVALUATION

5.1   Design of Study

To test the effectiveness of my e-reading device, I recruited one fifth-grade, three sixth-grade, and six seventh-grade students from two different public schools in New Jersey through contact with their librarians. These students were asked to read two to five chapters from a selection of young readers' novels and complete a survey about their experiences with the e-reader. Our study was granted approval from the Princeton IRB office.

The e-books provided to the students included: *Wonder*, *Percy Jackson and the Olympians: The Lightning Thief*, *Peter Pan*, *Treasure Island*, *Tom Sawyer*, *Charlotte's Web*, and *A Little Princess*. After selecting a book, the students were asked to log in to Bookji from *gobookji.com*, create a reading group, and add students. Once all the students could access the book and reading group,

I asked the students to read 2-5 chapters, leave 5+ emoji reactions and comments, click on 2-3 locations, and hear the pronunciation of 2-3 words. I provided the librarians overseeing the study at the schools with detailed instructions to get everything set up and working.

The students then completed a survey on Google Forms, which can be found in the Appendix. The methodology behind the survey was to ask students about the levels of engagement and enjoyment for each main feature (collaborative reading, emoji integration, pronunciation, and locations). The first question asked students how much they liked using a particular feature on a scale of 1 to 10. The second question asked students if reading became more enjoyable with this feature. The third question asked students if they were more engaged or distracted when this feature was added to the e-reader. Finally, the fourth question asked students to leave any comments or thoughts they may have had.

These questions seek to understand better which features engaged the students with the book and which did not. I also wanted to hear directly from the students and allow them to express their thoughts on the e-reader.

5.2 Results

The results from the study were positive overall. The students most liked the emoji reaction feature, with 8.625 out of 10, while the lowest-scoring feature was the pronunciation tool, with 7.375 out of 10. The collaborative reading feature scored 8.25 out of 10, and the interactive maps feature scored 7.5 out of 10. We will proceed to evaluate our e-reader, looking at each component.

The **collaborative reading** feature had positive feedback from students. When asked if reading with friends while in a reading group made reading more enjoyable, 62.5% of students agreed, while 37.5% took a neutral stance, as seen in Figure 23. Regarding the engagement levels for this feature, 75% of students said it helped them engage with the book better, while 25% said it was distracting, as seen in Figure 24.
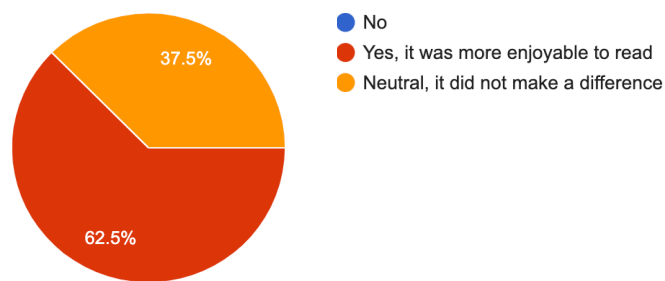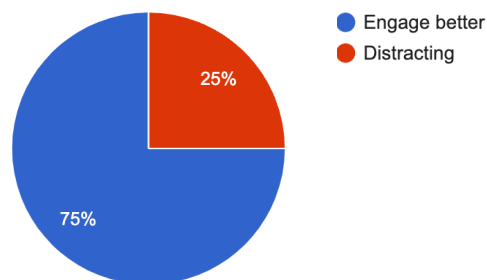

Figure 23: Collaborative Reading Enjoyment

Figure 24: Collaborative Reading Engagement

The students also left comments about their experiences. Three students left positive remarks about the feature and explained their reasoning. Another student, indifferent about the feature, also left a comment. There was also a comment about a user experiencing technical difficulties with the feature, but this user still thought it was "cool." Here are some of the responses:

> **Positive:** "I think that this was more enjoyable. This feature makes it not lonely to read, even if you are alone!"

Positive: "Overall, I loved this feature and found it was a nice way to read a book together. Even if you're unable to physically discuss your reading with your friends in person, you can connect with them through the comment and reaction feature. I don't see any flaws here, personally."

Positive: "I thought it was very cool to be able to see where your friends are in the book."

Neutral: "The 'Reading with Friends' is a very nice feature, but to me, it did not make a difference on how much I read."

The **emoji reactions** feature garnered the most positive feedback overall from students. The majority of young readers found that the emoji reaction feature made reading more enjoyable, as seen in Figure 25, and all users reported engaging better with the book, as seen in Figure 26.
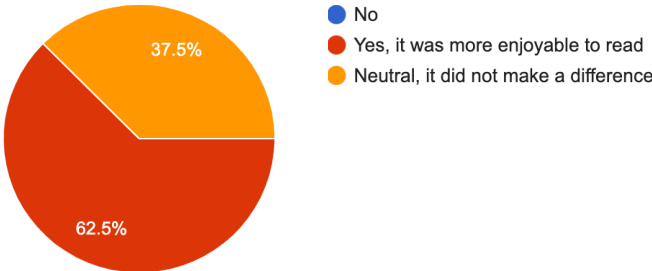

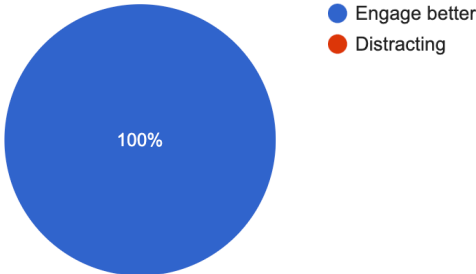Figure 25: Emoji Reaction Enjoyment

Figure 26: Emoji Reaction Engagement

This feature also had many insightful comments. Three students expressed positive sentiments toward the feature, while one expressed indifference. Another student recommended an improvement, which is particularly interesting because it shows a high level of engagement with emojis. The responses are shown below:

> **Positive:** "The 'Emoji Reactions' feature helped me react to what I was reading. This feature actually helped me check if I was paying attention to the book by letting me reflect on what's going on."

> **Positive:** "I liked the 'Emoji Reactions' feature, and it helped me describe how I was feeling to my peers."

> **Positive:** "It was fun! If one of my classmates made a positive or negative reaction, I would look through the pages to find what they are talking about."

> **Neutral:** "I think it was a cool idea, except I couldn't really find a notable purpose for it. I don't think I would go back while reading to use emojis, although I can't speak for others."

> **Reccomendation:** "I would reccommend adding a wider variety of reactions, including common phrases. I also wonder if it would be possible to add your reactions to paragraphs/lines/phrases instead of pages. This would make it clearer exactly what I'm referring to. For example, if I comment 🖤😯😭 on page 23 of a certain book, which says,

> It was a cloudy afternoon in late December of 1984 when George's mother took her final breath. At the funeral, it is like a knife was being twisted into his heart as he whispered his final goodbyes.
> A year later, it seems as if said knife had become a sword, and his heart had become stone. And every waking hour, it is driven

deeper and deeper into his body.

A year after that, George went to the wizard on the Heaven-Reaching Peak, gained magical powers, and became a supervillain to inflict his pain upon hundreds of others, to make them feel what he had felt.

And three years of conquring and killing and blood had driven him insane. He could no longer stand his own sorrow, so he traveled back in time using his powers to embrace his mother one last time.

I apologize for the lack of a comprehensible plot and bad writing, but you get the idea.

You probably wouldn't that I ♥'ed (warmed my heart) "He could no longer stand his own sorrow, so he traveled back in time using his powers to embrace his mother one last time", was (shocked) at "became a supervillain to inflict his pain upon hundreds of others, to make them feel what he had felt", and 😭 (cried) at "At the funeral, it is like a knife was being twisted into his heart as he whispered his final goodbyes". In fact, you may think that I loved the fact that his mother is dead, I cried at the fact that he went to see some wizard, and was shocked that he decided to hug his mother while travelling back in time. But if you could highlight the line you want to react to and then add your reaction + comment -- I feel like that would be a much more engaging way to read.

Just my thought, no need to act upon it! Or maybe I just couldn't find the feature? I don't know."

The first student to react positively uses the term "actually" to emphasize their surprise that emojis helped them better engage with a text. Another student offers a lengthy recommendation regarding this feature, which I find particularly interesting. This young reader demonstrates, without stating

explicitly, how emojis can engage individuals with a book. The student creates their own short excerpt to a story and explains why reacting to specifics in a text is essential to the user experience instead of responding to just the page. This response is quite remarkable because it *shows* rather than *tells* us that emojis can be engagement tools for students to use while reading. In this response, we see how a student can become more involved with a text through the use of emojis.

The **interactive maps** feature generally recorded positive feedback from the students in this survey. Half of the students said this feature provided helpful information while reading, as seen in Figure 27. The vast majority of students also reported that this feature helped them to engage better with the book, as seen in Figure 28.
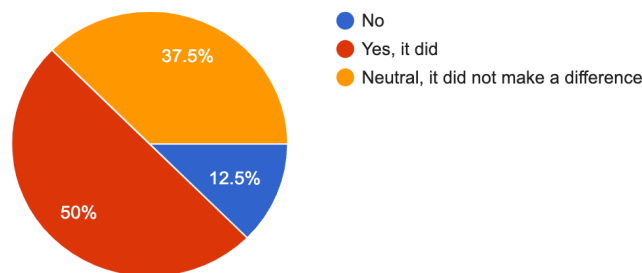

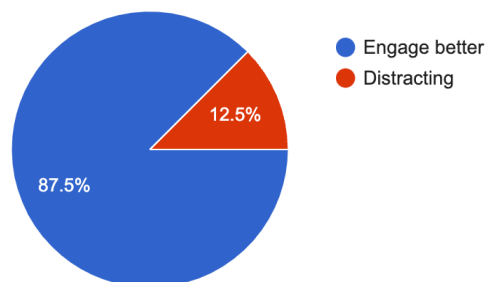
Figure 27: Interactive Maps Useful Info

Figure 28: Interactive Maps Engagement

The students had many positive comments about this feature, and one had a

thoughtful recommendation. However, one negative comment also said the feature was distracting from the text. The responses are listed below:

> **Positive:** "I could now see places that I have not seen on a map before. It helps visualize where the characters are from!"

> **Positive:** "This feature helped me visualize the places mentioned in the book, and they helped me get a sense on where they were located on the globe."

> **Positive:** "The 'Locations' feature helped me understand where in the world the place the book was talking about was. It was pretty helpful, and I think a lot of people would find it useful."

> **Positive:** "The 'Locations' feature was really cool! Although the locations my book featured (Manhattan, 5th Avenue, etc) were locations I were familiar with, so it didn't make a big difference in my reading, I could see this feature being useful when I was reading books when I was unsure of the exact location. I liked how I could see the exact pinpointed area in relation to other locations as well. It was interesting to know where in the real world the story was taking place."

> **Reccomendation:** "How would this work for fantasy books, etc.? What about anything that isn't realistic fiction? Would you be creating seperate maps for that? I found it to be pretty helpful otherwise."

> **Negative:** "I don't believe that this feature helped me stay engaged. Possibly in nonfiction books, but in my fiction book, the locations didn't really make a difference. They were just distractions for my group mates and I."

These responses demonstrate the learning powers of integrating interactive mapping software into an e-reader. Not only are students more engaged with

the book, but they are also actively learning more about the geographical places that are mentioned in the text. Although there was a negative review, the majority of students found this feature to be helpful.

The **pronunciation** feature was the lowest scoring of the four features being tested but still received positive reviews overall. Most students said the feature contributed to more reading enjoyment, as seen in Figure 29. It also performed well with students in making books more engaging, as seen in Figure 30.
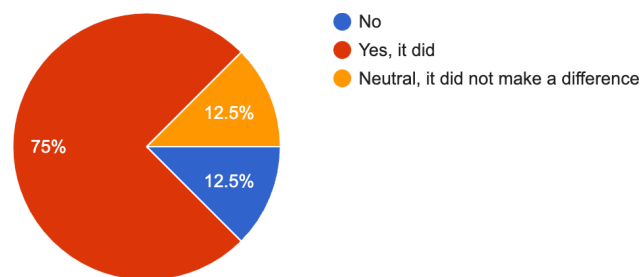

Figure 29: Pronunciation Enjoyment

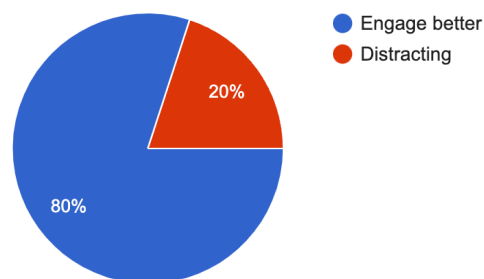Figure 30: Pronunciation Engagement

The comments about this feature are listed below:

> **Positive:** "While so far it hasn't been necessary for me to use this feature, I can see it helping many other readers."

> **Positive:** "If I don't know the pronunciation of a word, which I sometimes don't, I can easily find out instead of guessing. This will help me in my speech and comprehensibility."

> **Difficulty:** "Although I think the "Pronunciation" feature was a really useful and good idea that a lot of readers would utilize, and would help me in understanding what I'm reading (particularly advanced vocabulary that I don't know how to exactly pronounce), I found that on certain devices I was reading on, such as a Chromebook, didn't allow me to use the feature, which was a little bit disappointing."

Although there was some difficulty operating this feature on Chromebook, the pronunciation tool received positive feedback from the students that tested it. The students found the pronunciation tool to help deepen their understanding of a text.

In summary, the results indicate positive overall effects of reading engagement and enjoyment on the students in this study. This study tested the integration of contemporary features, including collaborative reading, emoji reactions, interactive maps, and word pronunciation. Looking back on the feedback, I found the responses to the emoji reactions feature to be especially compelling. Although each feature received positive feedback, the comments showed the highest engagement and enjoyment when reacting to book sections with emojis.

6. CONCLUSIONS & FUTURE WORK

"I have a passion for teaching kids to become readers, to become comfortable with a book, not daunted. Books shouldn't be daunting, they should be funny, exciting and wonderful; and learning to be a reader gives a terrific advantage."

— *Roald Dahl*

Roald Dahl said it best in the quote above. When children become readers, doors of opportunity, learning, and excitement fly open. Today we face severe setbacks in getting books into the hands of America's youth and creating enthusiasm around reading. Our increasingly digital age is phasing out traditional learning practices, calling for unique and contemporary solutions. This project provides a modern approach to captivating a generation born into the digital world of social media and the internet with books. The form of this approach is a social book platform, Bookji, and an e-reader that leverages the power of peer interactions, emojis, and maps.

I will continue testing Bookji and refining this e-reader with the help of more students of different ages and backgrounds. I will also listen to the feedback provided by the students in this survey to improve the overall product. Although the sample size was small for my survey for this project, great feedback and

data was obtained on the potential of an e-reader with these engagement features. This was the first iteration of a larger plan to contemporize how students become interested in reading.

This project's goal was never to have students rely solely on my e-reader to read a book but to make children of this new generation fond of books themselves again. I want kids to use my platform and e-reader, then pick up a real book.

When I was in grade school, there was a negative stigma attached to reading. Let us slowly break away from that notion by making books fashionable with America's youth. With all the adventures and advantages that come with reading, it would be tragic not to make the most of it.

APPENDIX

Contemporary E-Reader Survey

The following questions are about the "Reading with Friends" feature:

1. On a scale of 1-10, how did you like using the "Reading with Friends feature"

2. When using this feature, did you think reading became more enjoy able when you could see where your friends were in the book.
    A. No.
    B. Neutral, it did not make a difference.
    C. Yes, it was more enjoyable to read!

3. Did you find that this feature helped you to engage with the book better, or was it distracting?
    A. Engage better
    B. Distracting

4. Please write any comment you had about the "Reading with Friends" feature:

The following questions are about the "Emoji Reactions" feature:

1. On a scale of 1-10, how did you like using the "Emoji Reactions"

2. When you could add emoji reactions to specific pages, did you find it more enjoyable to read?
    A. No.
    B. Neutral, it did not make a difference.
    C. Yes, it was more enjoyable to read!

3. Did you find that this feature helped you to engage with the book better, or was it distracting?
    A. Engage better
    B. Distracting

4.   Please write any comment you had about the "Emoji Reactions" feature:

The following questions are about the "Locations" feature:

1.   On a scale of 1-10, how did you like using the "Locations" feature?

2.   Did this feature provide useful information to you while reading?
        A. No.
        B. Neutral, it did not make a difference.
        C. Yes, it did!

3.   Did you find that this feature helped you to engage with the book better, or was it distracting?
        A. Engage better
        B. Distracting

4.   Please write any comment you had about the "Locations" feature:

The following questions are about the "Pronunciation" feature:

1.   On a scale of 1-10, how did you like using the "Pronunciation" feature?

2.   Did this feature provide useful information to you while reading?
        A. No.
        B. Neutral, it did not make a difference.
        C. Yes, it did!

3.   Did you find that this feature helped you to engage with the book better, or was it distracting?
        A. Engage better
        B. Distracting

4.   Please write any comment you had about the "Pronunciation" feature:

WORKS CITED

[1] Free dictionary api, https://dictionaryapi.dev.

[2] Nominatim: open-source geocoding with OpenStreetMap data, https://nominatim.org.

[2] Maplibre: open-source mapping libraries for web and mobile app developers, https://maplibre.org, 2020.

[3] Monocle: a social e-reader, https://www.readonmonocle.com, 2022.

[4] L. Collister. Emoticons and symbols aren't ruining language — they're revolutionizing it. *The Conversation*, Apr 2023.

[5] L. Baines. *A teacher's guide to multisensory learning: Improving literacy by engaging the senses*. ASCD, 2008.

[6] L. Baines. Reading & happiness. *Phi Delta Kappan*, 90(9):686–688, 2009.

[7] BarbaraBushFdn. Barbara bush foundation, https://www.barbarabush.org/new-economic-study.

[8] J. Barshay. Proof points: Why reading comprehension is deteriorating. *The Hechinger Report*, May 2021.

[9] D. Belkin. How the covid pandemic will follow today's kids into adulthood. *The Wallstreet Journal*, Aug 2022.

[10] J. Bosman. E-readers catch younger eyes and go in backpacks. *The New York Times*, Feb 2011.

[11] R. Charles. Perspective — there's now an e-reader just for kids, and it misses what children love about books. *Washington Post*, Nov 2019.

[12] C.-M. Chen and F.-Y. Chen. Enhancing digital reading performance with a collaborative reading annotation system. *Computers & Education*, 77:67–

81, 2014.

[13] C.-M. Chen, M.-C. Li, and T.-C. Chen. A web-based collaborative reading annotation system with gamification mechanisms to improve reading perfomance. *Computers & Education*, 144:103697, 2020.

[14] M. T. de Jong and A. G. Bus. Quality of book-reading matters for emergent readers: An experiment with the same book in a regular or electronic format. *Journal of Educational Psychology*, 94(1):145−155, 2002.

[14] M. Drezek. Twitter https://twitter.com/m_drez/status/1582773147061084161, Oct 2022.

[16] R. Droke. for The Wall Street Journal. Reading and math scores plummeted during pandemic, new data show, Sep 2022.

[17] S. K. Frye. *The implications of interactive eBooks on comprehension*. PhD thesis, 2014. Copyright - Database copyright ProQuest LLC; ProQuest does not claim copyright in the individual underlying works; Last updated - 2023-03-04.

[18] D. Gioia. *To read or not to read: A question of national consequence*. DIANE Publishing, 2008.

[19] D. Goldstein. It's 'alarming': Children are severely behind in reading, Mar 2022.

[20] J. Hall. E-books could become the norm for children as sales soar, Sep 2012.

[21] S. A. Hess. Digital media and student learning: Impact of electronic books on motivation and achievement. *New England Reading Association Journal*, 49(2):35−39, 2014. Copyright - Copyright New England Reading Association 2014; Document feature - ; Last updated - 2023-02-23.

[22] N. Hoffelder. Aap reports us ebook sales up 46% in 2012, now well over a fifth of us book market, Feb 2013.

[23] M. Honnibal, I. Montani, S. Van Landeghem, and A. Boyd. spaCy: Industrial-strength Natural Language Processing in Python. 2020.

[24] T. T. Hougaard and M. Rathje. Emojis in the digital writings of young danes. *Jugendsprachen/Youth languages: Aktuelle perspektiven internatio-*

naler forschung/current perspectives of international research, pages 773–806, 2018.

[25] A. Itzkovitch. Interactive ebook apps: The reinvention of reading and interac-tivity. *UX Magazine*, Oct 2021.

[26] S. Johnson. How the e-book will change the way we read and write. *The Wallstreet Journal*, Apr 2009.

[27] I. Kirsch, J. de Jong, D. Lafontaine, J. McQueen, J. Mendelovits, and C. Monseur. Reading for change: Performance and engagement across countries. PISA, 2002.

[28] M. Laal and S. M. Ghodsi. Benefits of collaborative learning. *Procedia-social and behavioral sciences*, 31:486–490, 2012.

[29] Lee. Redshelf collaboration, https://solve.redshelf.com/hc/en-us/articles/360004146313-Collaboration, 2021.

[30] T. Lintner. Using children's literature to promote critical geographic awareness in elementary classrooms. *The Social Studies*, 101(1):17–21, 2010.

[31] J. F. Lyng. Offentlige myndigheder bruger teenagesprog, https://www.kristeligt-dagblad.dk/danmark/offentlige-myndigheder-bruger-teenagesprog, Sep 2013.

[32] M. Martin, I. Mullis, E. Gonzalez, and A. Kennedy. Pirls 2001 international report, iea's study of reading literacy achievement in primary schools in 35 countries, 2003.

[33] E. McCoy. Lost for words: Poor literacy, the hidden issue in child poverty. *A policy position paper. London: National Literacy Trust*, 2013.

[34] G. McCulloch. *Because internet: Understanding the new rules of language*. Riverhead Books, 2020.

[35] M. T. Nietzel. Low literacy levels among u.s. adults could be costing the economy $2.2 trillion a year. *Forbes Magazine*, Oct 2022.

[36] P. Oden. Geography is everywhere in children's literature. *Journal of Geography*, 91(4):151–158, 1992.

[37] T. Panitz. The motivational benefits of cooperative learning. *New directions for teaching and learning*, 78:59–67, 1999.

[37] A. Pardes. The complete history of emoji. *Wired Magazine*, Feb 2018.

[38] W. Peters. Book hero. *Princeton University Computer Science Junior Independent Work*, 2020.

[39] W. Peters. Framework for augmented children's book reader. *Princeton University Computer Science Junior Independent Work*, 2022.

[40] W. Peters. Bookji, https://www.gobookji.com/learn-more, 2023.

[41] B. Reed. Majority of parents worried about children's digital reading, survey finds. *The Guardian*, Feb 2016.

[42] K. Schreurs. Children's e-books are born: How e-books for children are leading e-book development and redefining the reading experience. *Partnership: the Canadian Journal of Library and Information Practice and Research*, 8(2), 2013.

[43] Seuss. *I can read with my eyes shut*. Harper Collins, 2018.

[44] SpoonRead. Academics' choice award™ winner: Spoonread, http://www.academicschoice.com/apps/spoonread.php.

[45] S. Tetreault. Twitter, https://twitter.com/DrTLovesBooks/status/1467955948618665984, Dec 2021.

[46] C. Turner. Emoji 'ruining people's grasp of english' because young rely on them to communicate, https://www.telegraph.co.uk/education/2018/04/17/emojis-ruining-english-language-young-people-rely-communicate, Apr 2018.

[47] J. M. Twenge. Teens today spend more time on digital media, less time reading. *American Psychological Association*, Aug 2018.