

Red Cloud Indian School

Matthew Rama

May 5, 2021

FINAL REPORT

LAKHÓTA IMMERSION CLASSROOM

CREATED BY

Carnegie Mellon University

Caitlin Huang, Kevin Wang, and David Yuan

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COMMUNITY PARTNER BACKGROUND

The Red Cloud Indian School is a private Catholic K-12 school located in Pine Ridge, South Dakota. It was founded through a partnership between the Jesuits and the Lakȟóta people and currently has 131 faculty members and around 600 students. It primarily serves children from the Oglala Lakȟóta Native American tribe on the Pine Ridge reservation.

The mission of Red Cloud Indian school is to develop and grow as a vibrant Church, through an education of the mind and spirit that promotes Lakȟóta and Catholic values.

Around 95% of Red Cloud Indian School's budget comes from financial contributions from individuals and foundations across the country. It costs the school \$7,000 each year to educate each student and \$12.5 million annually to operate its school, the Heritage Center and Gift shop, and six Catholic churches within the reservation. For the solution we are delivering this semester, the client did not specify a budget and described the price limit as flexible.

The department that we were worked with this semester, the Lakȟóta Immersion Classroom, seeks to provide an effective and lasting education to students in the community. The Lakȟóta Immersion Classroom not only serves as an effective schooling system that can teach students to be successful, but also as a way to preserve culture by passing on important cultural values to students. Notably, the Lakȟóta Language Program was created in order to teach students the Lakȟóta language as well. Prior to this semester, this program employed Canvas as a way to distribute learning materials and assessments in both the language learning and math subjects, but is looking for a more effective and efficient tool. They have tried a number of different platforms and services to supplement Canvas, but none had appeared to completely meet their needs.

There are 131 staff members at Red Cloud Indian School. They work in various departments within the school, including the Heritage Center, the churches, and the Lakȟóta Immersion Classroom Program. In particular, the Lakȟóta Immersion Classroom has six teachers total who create the teaching contents and provide students with assistance. Among the six teachers is Mr. Matthew Rama, who heads the initiative and has been our primary contact. There are also several AmeriCorps volunteers on his team to assist him with lower-level tasks such as entering content and grading. Their IT department consists

of two support specialists. The department operates independently from the other departments and is primarily responsible for providing support for high stake cases such as network outages. They also manage on-premise Windows servers as well as working with off-premise vendors to maintain Linux servers to deliver software and services to the community. They also manage the school's iPads, Macs, and Chromebooks, which are issued to the students and faculty through the One-to-One program.

Recently, during the pandemic, the school has completely transitioned to online learning in order to meet the health and safety protocols. To facilitate this change, each student has been provided with an internet-connected device (iPads for K-4 grades, Chromebooks for 5-12 grades), as well as a reliable hotspot connection. This ensures that each student can participate equally in the online learning environment, regardless of what is available at home.

At Red Cloud Indian School, coursework includes a core curriculum with math, science, history along with courses in ethics, religion, Lakhóta language, and Lakhóta culture. Mr. Rama noted that students learn more in many of these subjects if the material is taught in an interactive way. To this end, for the learning software, the teachers had tried out a variety of different tools and programs prior to this semester. Mr. Rama showed us some of the programs that they had tried, including Canvas, Nearpod, Boom Cards, and Owoksape. The reason why they moved between so many different programs is that none of these fully met their needs. They were seeking a program that auto-grades assignments, allows students to move at their own pace, is intuitive to use, and is aesthetically pleasing for the students.

PROJECT DESCRIPTION

Project Opportunity

At the start of our engagement, our contacts at the Red Cloud Indian School presented three of their most pressing technological needs:

1. To digitize the Heritage Center's art collection in a way that is more intuitive and searchable
2. To improve the archiving system used by Marquette University for the Truth and Healing initiative
3. To create a tool that is more effective than Canvas for the Lakhóta Immersion Classroom

While we recognized the importance of each of these issues, we also noted that given our time constraints, it would have been infeasible to take on all three issues at once. Thus, we decided to focus on creating a solution for the Lakhóta Immersion Classroom. Students interact with learning management systems more than they would interact with the Heritage Center's art collection or Truth and Healing initiative's archives. By focusing on the Lakhóta Immersion Classroom, we believed that we would be making a more direct impact on the learning experience of the students.

As discussed above, the Lakhóta Immersion Classroom, prior to this semester, employed Canvas as the primary mode for distributing materials, taking assessments, and making announcements for classes. The main disadvantages to this solution were that students could not interact with the materials at their own pace, that it was difficult for instructors to view the progress of each individual student, and that Canvas offered a poor aesthetic for the K-4 learning experience.

Mr. Rama, our contact at the Lakhóta Immersion Classroom, introduced a number of tools that they had considered, but none of them met their needs completely. For example, he mentioned that they briefly considered using a tool such as Khan Academy, but that it required too many resources and operated at a scale that they were not prepared for. Canvas offered a useful feature in the form of plugins for other tools, but is still lacking in the ways mentioned above. Nearpod was an improvement on Canvas in its interactivity and aesthetics, but still failed to allow instructors to gain a full picture of each student's progress. Owoksape, a Lakhóta language learning website, was effective for the language learning portion of their education, but was not compatible with other subjects, such as math or science. Another tool that they had been using, Boom Cards, allows them to create interactive questions and worksheets, but does not offer grade migration into Canvas, and so makes grade consolidation difficult.

This problem was important to solve because it limited the effectiveness of their educational system. They believe that an ideal education should be tailored to each student, so without a better tool, they would not be able to provide that. The ability to educate the next generation on cultural values is crucial to their mission, so an improvement on this front would be critical.

Project Vision

The stakeholders to the proposed project included Red Cloud administrators and IT department staff members, the self-directed learning software vendor, teachers, students in the Language Immersion program, and parents. The end-users of the outcome of the project included the students, teachers, and maintainers of the solution.

Our vision was to integrate an interactive learning tool that the client currently uses with a learning management system (LMS), such as Canvas, for the client. After several discussions with the client on needs and pain points, we settled on seeking a solution that integrated Boom Cards, an external learning tool, and Canvas, which they were already using.

We started by exploring third-party solutions for this problem. There were several benefits that we identified for that approach. One major consideration was the availability of many open-sourced services on the market. We reasoned that by implementing a widely-used system, we might be able to meet the client's needs. Additionally, we believed that using a third-party system would assist in the maintainability and privacy of the solution. Reputable third-party vendors would come with professional tech teams, robust data privacy policies, and an abundance of documentation — all making it easier for our client to maintain and use the system. Lastly, we considered the fact that widely-used third-party solutions are proven to be easy to use and navigate, as well as intuitive to pick up. This would make it easier for the students and parents.

Eventually, in the course of our research, we decided to build a custom solution. We could not find a third-party solution that met all of our client's needs and were not able to establish a consistent line of communication with the technology teams of the services that came close to satisfying the client. Looking elsewhere, we settled on building a plug-in for Canvas that could accept inputs from Boom Cards. This approach could have many of the same benefits as third-party vendors — maintainability, privacy, intuitiveness — as long as we were meticulous in our documentation, punctilious in our observance of privacy laws, and rigorous in our user testing.

PROJECT OUTCOMES

We carried out this project in four phases: Research, Development - Part 1, Development - Part 2, Testing, and Transition. Each phase has a set of related outcomes.

Research

During the research phase, we started by mapping out the problem space with our client. We performed a Contextual Inquiry study with the client, which involves Mr. Rama walking us through his process of assigning and grading assignments for the Lakhota Immersion Classroom program and answering our questions. Together, we determined the three main goals for the project:

1. Keep the lessons interactive
2. Make it possible for students to learn at their own pace
3. Make it easier for the teachers to track student progress

OUTCOME 1

The client was able to determine the three goals he wanted to achieve with the proposed learning management system.

Once the problem space is defined, we guided the client to map out the software vendors that provide the services we need by drawing a Venn diagram on Miro (see Figure 1, also Appendix A).

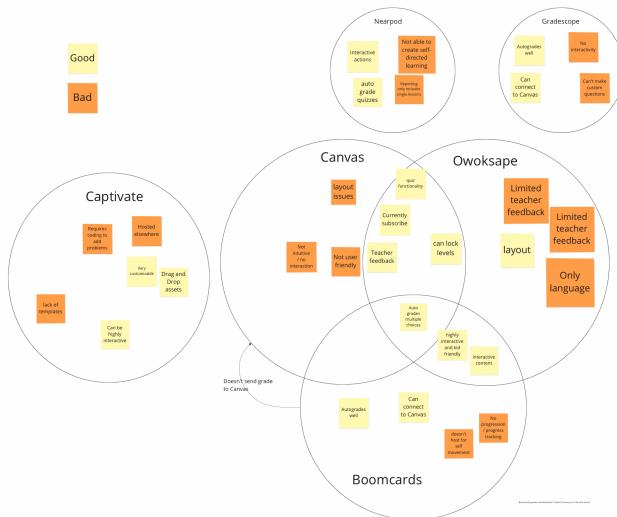


Figure 1: Venn Diagram Analyzing Needs. Created together with the client.

The client determined, visually through the diagram, that there is a gap to be filled between Canvas and Boom Cards. While Canvas enables progress-tracking and allows students to learn at their own pace, it can be greatly complemented by the interactive lessons offered by Boom Cards. Again, together with the client, we identified the gap between Boom Cards and decided that the best solution that would address all of the client's needs would be to create a solution that enables the two-way communication between Canvas and Boom Cards.

OUTCOME 2

The client explored six third-party solutions and chose to bridge the gap between Canvas and Boom Cards.

With the goal of enabling two-way communications between Canvas and Boom Cards in mind, we began our search for a solution by performing a "Crazy 8" activity with our client. Prior to the activity, we created several storyboards detailing the "crazy idea" we had for the solution. These solutions, ranging from a student survey to a canvas plug-in were all illustrated with 2-4 storyboard frames (as you can see in Figure 2). During the session, the client was first given a detailed narration of each set of storyboards. He was then asked to rank the 7 storyboards based on his preference. We then invited him to provide us with specific comments and feedback on each set of storyboards. We learned that the client wanted to save time by having the tool auto-grade but also wanted to ensure an intuitive experience for the students in the immersion program.

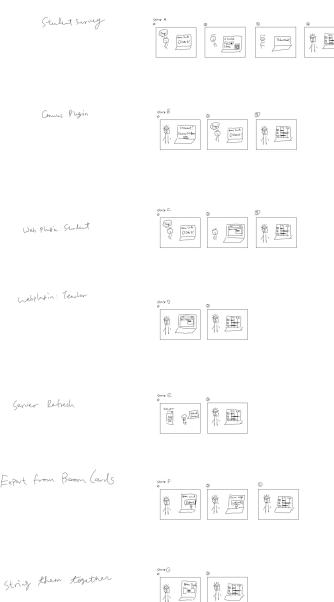


Figure 2: The Crazy 8 storyboards shared with the client

Development - Part 1

We communicated with Boom Cards to check if they have the capacity to create a Canvas plug-in. It came to our attention that while the vendor is actively creating a Canvas plug-in, it likely would not become available this year. Hence, we have pivoted to creating custom solutions for the client.

OUTCOME 3

We developed iPad and Web apps to allow semi-automatic grading of student-submitted Boom Cards results.

The first prototype we created was a semi-automated grading solution. It involves students using a client-side application to submit screenshots of their Boom Cards results and then receiving a redemption code that they could input into Canvas to unlock the next lectures. We created two apps, one for iPadOS and one for the web. Both versions use on-device intelligence to determine the grade information from the screenshots. On iPadOS, the native Swift app uses the Vision framework for accelerated machine learning and is capable of recognizing grade information in less than 0.8 seconds. On the web, custom Javascript is used in conjunction with Tesseract.js to offer cross-platform OCR of grade information. Both apps process screenshots on-device and purges the screenshots from the memory upon completion. These apps were tested on iPadOS 13.6.1, the operating system used by the students in the Lakhota Immersion Classroom program.

Along with the first proof-of-concept prototype, we created refreshing designs using Figma (See Appendix B). The design is adaptive, meaning that the UI elements and interactions can be shared by native and web apps.

OUTCOME 4

We designed a Figma prototype with the aim to make it adaptive and intuitive.

Development - Part 2

The iPadOS and web apps were not the only solutions we were exploring. We made a breakthrough with our Canvas plug-in solution, which involved creating a Canvas plug-in capable of processing grade information from Boom Cards screenshots on-device, and then passing the grades back to Canvas via an encrypted channel—the Learning Tools Interoperability protocol (or LTI).

Building on top of the `ims-lti` repository from Instructure, the parent company of Canvas, we were able to develop a custom Ruby on Rails app capable of establishing a two-way encrypted communication channel with Canvas. We were able to retrieve assignment information with LTI. We used the same custom Javascript code and Tesseract.js package from the web app as mentioned in the previous part to process Boom Cards result screenshots. Using LTI, we can then pass the grades back to Canvas to directly grade the assignment and unlock the next lesson. (See Appendix D). This outcome allowed us to effectively eliminate the risk of not being able to integrate Boom Cards with Canvas, as mentioned in our proposal.

OUTCOME 5

We developed a Canvas plug-in that extracts Boom Cards grade info from screenshots and auto-grades assignments.

We also met with the client once per week to collect feedback from him. We made several design changes to the Figma prototype before implementing it using HTML/CSS and Javascript (see Appendix D):

- Removed the UI elements related to the redemption code (as it is no longer necessary)
- Added a new text component that shows a random “gift emoji” to incentivize students
- Added a button that lets students toggle between Lakhota and English. Our client translated our text components using a shared document, which you can find in Appendix C.

With its beautiful, animated, and intuitive design, the Canvas tool was also given a new name—BoomBridge—to symbolize its function as a metaphorical bridge between Canvas and Boom Cards.

OUTCOME 6

A new design that is beautiful, animated and intuitive was implemented to incentivize students.

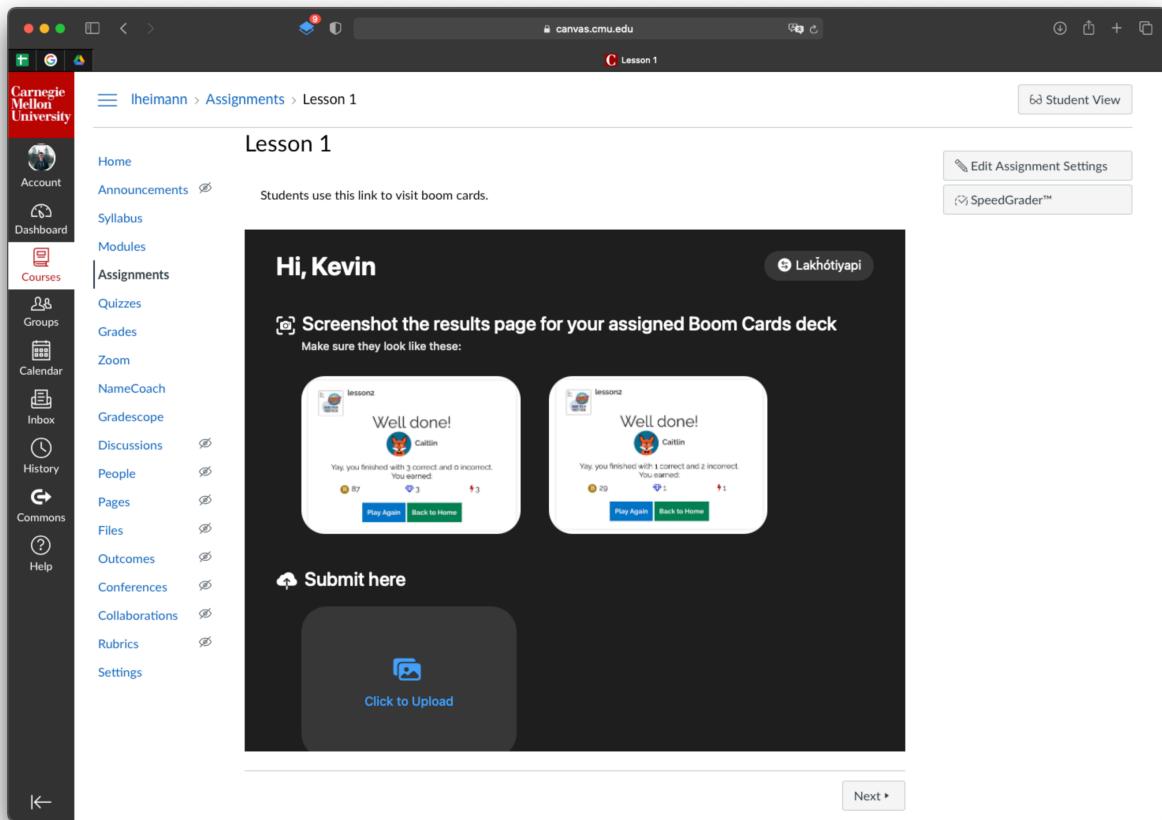


Figure 3: The final product with improved design and Canvas integration

Testing

We conducted extensive user testing with both teachers and students upon the completion of our final prototype. We created a research plan, detailing the five methods we used to carry out the testing (see Appendix B for more details).

Student Portion

For the student test, we asked our client to recruit three parents whose children are students in the Lakhota Immersion Classroom program ($n=3$). Given that these children are in grades K-4, we did not perform the study ourselves. Instead, we provided detailed instructions to the parents and asked them to conduct the study on our behalf. We asked the parents to do the following:

BoomBridge Student Survey

* Required

What did you like about submitting your homework like what you just did? *

Your answer

What did you NOT like about it? *

Your answer

Do you want to submit your BoomCards homework like this? *

1	2	3	4	5	6	7
<input type="radio"/>						

No never Yes absolutely!

Would you recommend your friend to submit homework like this? *

1	2	3	4	5	6	7	8	9	10
<input type="radio"/>									

No definitely not! Yes absolutely!

Figure 4: The student survey

- **Think-Aloud Study:** students are asked to think aloud while using BoomBridge. This study helps us identify UI bugs and collect feedback.
- **Student Survey:** once the student has experienced BoomBridge, we asked them to fill out a four-question survey. The first two ask them to write about what they like and dislike about the product. The third question asks them to rate their experience on a Likert scale. Lastly, we asked them how likely they would recommend BoomBridge to their fellow classmates (to calculate a NetPromoter score). (See Figure 4)

From the think-aloud and the first two questions of the survey, we learned that:

- Students enjoyed the gamification process.
- Some students experienced UI glitches and had to retake the screenshot.

The average rating we received for the question of "would you like to use BoomBridge again" was 6.67, meaning that we will likely see good student retention. Deducting to percentage of detractors (0%) from the percentage of promoters (100%) yields a net promoter score of 100, meaning that students would likely promote BoomBridge among their peers.

OUTCOME 7

User testing with students yielded a retention score of 6.67 out of 7 and a NetPromoter score of 100. Students would likely enjoy continued usage of BoomBridge and will promote it to their peers.

Teacher Portion

We first asked teachers from the Lakhota Immersion Classroom to configure the Boom Cards and Canvas assignments prior to our study. They monitored the Canvas grade book while the students completed their tasks. Once the student completed the tasks, the teachers were asked to do the following:

- **Present vs Future:** the teachers were asked whether or not their current solution or BoomBridge fulfills the three goals of this project—progress tracking, self-directed learning, and interactive lessons. If they answered yes, we ask them to rate how well the current solution or BoomBridge achieves these goals. The part of the study not only helps us understand *whether or not* we fulfilled our goals but also *how well* we fulfilled them.

- **NetPromoter:** we asked the teachers to rate how likely they would recommend BoomBridge to their colleagues on a scale of 1-10. We then used this information to calculate a NetPromoter score.
- **Focus Group:** the previous two steps were performed with teachers in separate breakout rooms. For this study, we ask the teachers to come back into the main breakout room and gave them the floor to speak about what they liked or disliked about BoomBridge.

The three tasks were presented in the format of a Google Form survey (see Figure 5). For the first part, the teachers indicated that both their existing solutions and BoomBridge fulfill their three needs. Hence, we report the following:

- BoomBridge did not significantly improve the interactivity of the lessons. ($p=0.423$; $n=3$).
- BoomBridge marginally improved student progress tracking ($p=0.184 < 0.2$; $n=3$).
- BoomBridge magically improved self-directed learning, but no statistical significance was observed. ($p=0.225$; $n=3$).

BoomBridge Teacher Survey
* Required

Does the existing tools you use support interactive learning? *

Yes
 No

If you said yes, how well does it do it?

Very Bad	1	2	3	4	5	6	7	Very Well
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Does the existing tools you use support student progress tracking? *

Yes
 No

If you said yes, how well does it do it?

Very Bad	1	2	3	4	5	6	7	Very Well
----------	---	---	---	---	---	---	---	-----------

Does the existing tools you use allow students to progress through lecture content at their own pace? *

Yes
 No

If you said yes, how well does it do it?

Very Bad	1	2	3	4	5	6	7	Very Well
----------	---	---	---	---	---	---	---	-----------

How well does BoomBridge support interactive learning? *

Very Bad	1	2	3	4	5	6	7	Very Well
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OUTCOME 8

We fulfilled all three of the client's needs: interactive lessons, progress tracking, and offer self-directed learning to students.

From the focus group study, we were able to generate 10 pieces of feedback and 5 action items. For example, we learned that the students were not sure what to screenshot. Hence, in a later prototype, we added text descriptions on what is an acceptable screenshot. You can read more about the focus group feedback in Appendix B.

Coincidentally, we confirmed our suspicion that the teachers are able to create assignments following the instructions and with no input from the project team. This would imply a sustained capacity to create assignments. We also learned that our tool is able to save each teacher up to 10 minutes per day because of the auto-grading feature.

OUTCOME 9

Teachers can create BoomBridge assignment with no input from the project team, implying sustained capacity.

OUTCOME 10

BoomBridge auto-grades assignments, which saves each teacher up to 10 minutes per day.

Transition

For transition, we connected the IT department at Red Cloud with the hope to deploy the service on-premise using Red Cloud's servers. We learned that to do this, Red Cloud's leadership needs to approve this deployment plan. Hence, we provided the IT department with a detailed deployment plan (see Appendix C) and chose to proceed with a hybrid plan: we will first deploy the service to a CMU-hosted trial server that will be available to our client as a production server for up to 3 months upon the completion of the project. The client will then be given the options to:

- Transfer the ownership of CMU's server
- Receive a disk image of the server that they can quickly restore using their on-premise server

For sustained maintenance capacity, we created a document called the Project Documentation Package, which includes the following sections:

- **Introduction:** introduces BoomBridge the project team
- **Setup:** helps the IT department to configure the server and provides teachers with instructions to configure the plug-in with their courses and creating assignments.
- **Maintenance:** illustrates the software stack used, the code structure, and the emergency response plans.
- **Privacy:** includes information on how BoomBridge is FERPA compliant and details some of the privacy and data protection features.

We are not particularly concerned about the sustained capacity of students being able to submit assignments as this has been sufficiently demonstrated by our user tests with the students.

OUTCOME 11

IT department are provided with extensive code-level and server documentation, as well as emergency response plans for eight different scenarios.

For teachers, they can always refer to the Setup section for instructions on how to link BoomBridge to their new and existing Canvas courses, as well as creating new assignments with BoomBridge embedded.

For the IT department, we have given them the deployment and maintenance documents that include the following:

- Server configuration documentation in the setup section
- A section on how we use each component in the software stack
- How each file in the code repository is used
- Emergency response plans for eight different scenarios

If given more time, we believe that this project can greatly benefit from the additional outcome of training of Red Cloud IT personnel in terms of migrating the service from our CMU-hosted server to Red Cloud's on-premise server. This would greatly reduce the switching cost of migrating between servers, eliminating the potential risk of our client no longer wanting to proceed with the service we are delivering. If given more time, we would schedule a time with the IT department at Red Cloud and answer questions about migration to their server. We would be able to see the specific problems they experienced while migrating and work with them to ensure a smooth transition.

FINAL DELIVERABLES

The final deliverables include the BoomBridge Canvas plug-in, the GitHub code repositories of BoomBridge, the Project Documentation Package, and this Final Report. All deliverables have been delivered to the client digitally via our Slack group channel.

01 BoomBridge

BoomBridge is a Canvas plug-in that auto grades student-submitted screenshots of their Boom Cards results. Currently, the plug-in is delivered via a server sponsored by the CMU IS department. The client has been informed of the option to receive a server image that they can use to deploy BoomBridge on their on-premise servers. (See Appendix D)

02 Code Repositories

Two GitHub code repositories have been delivered to the client. The URL link to the BoomBridge Canvas plug-in repository has been provided to the client as a part of the documentation. While we have scrapped the development of the iOS and Web app, we nevertheless provided the apps' repository to our client. (See Appendix E)

03 Documentation Package

The documentation package has been delivered to our client digitally. It includes the server deployment specifications, Canvas tool configuration instructions, maintenance information, as well as a privacy policy section dedicated to helping our client navigate the FERPA compliance requirement imposed on BoomBridge. (See Appendix C)

04 This Report

The purpose of this report is to serve as a process book and a living document that not only illustrates the final outcomes but also the intermediate steps we have taken before arriving at our final solution. In the appendix sections, we included almost all of the artifacts we have produced throughout the project to offer our client insights into how BoomBridge came to be.

RECOMMENDATIONS

Recommendations

To sustain and to increase its capacity, Red Cloud Indian School needs to take the following recommended steps.

First, we recommend that Red Cloud conducts training sessions during which teachers and students learn to use BoomBridge. We believe that these training sessions can yield the following benefits:

- **Accelerate the adoption:** training help students and teachers adopt the solution faster and better. We expect that training can accelerate the adoption of BoomBridge by up to 4 weeks.
- **Prevent common mistakes:** this helps the users avoid making certain mistakes that could be lead to a bad user experience. Our focus group study shows that students tend to be able to maneuver through BoomBridge much faster and smoother during their second time of using the service when compared to their first time.

We have already provided our client with walkthrough videos and step-by-step guides for setting up and using BoomBridge, which students and teachers can review. The teachers who attended our focus group have successfully used our application, and have the capacity to *teach* other students and teachers how to use BoomBridge.

Secondly, the BoomBridge solution is currently hosted on a server in CMU's Information Systems department. While we have provided Red Cloud with several application migration options, we recommend that they migrate BoomBridge to their own on-premise server. The benefits are as follows:

- **No added server cost:** there will be no additional hosting budget requirement, given that they are already maintaining their on-premise servers.
- **Better protection against attacks:** since Red Cloud's on-premise servers are protected by preconfigured firewalls, deploying BoomBridge to these servers can offer better protection against attacks than deploying BoomBridge to public cloud services.
- **FERPA Compliance:** the client is already hosting FERPA-compliant services on-premise. Deploying to public cloud services requires them to check if these services are FERPA compliant.

Lastly, Red Cloud also could benefit from having access to an external professional who is familiar with full-stack development and deployment using our software stack. This professional can offer the following:

- **Support the need for modifications or extensions of the current solution:** for example, if the user interface for Boom Cards changes in a way that student scores cannot be parsed, the trusted

professional can make modifications so that the app is compatible with the new design on Boom Cards.

- **Help reduce service downtime:** this professional can assist the IT department with maintaining the service from the code level. They will be able to respond to emergencies as well as further optimize the codebase.

To gain access to such a professional with code-level expertise, Red Cloud Indian School can designate a full-time employee with the necessary expertise to maintain the solution. Another option is to seek a contracted resource in case the application needs changes to be made. We have provided the contact information of developers on Fiverr. Optionally, the client could also maintain the current relationship with CMU as their consulting and development resource.

For Future IS Teams

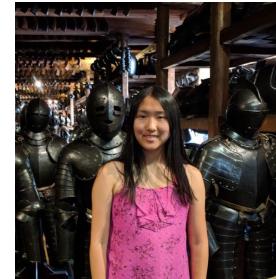
First, it is important to note that our client's vendor, Boom Cards, plans to release a Canvas plug-in in the near future. If the Canvas plug-in is available by the time the team works with them, the team should contact Boom Cards and work with the vendor to connect Boom Cards with Canvas. If the Canvas plug-in is not available, the team should continue to refine the custom plug-in we built for Red Cloud Indian School by focusing on the following categories:

- **Compatibility with Boom Cards:** if Boom Cards changes their user interface, the team should ensure that the solution is still compatible with the new user interface.
- **Anti-cheating:** add additional features to prevent cheating, such as matching lessons or student names with the corresponding lesson and student in Canvas.
- **Performance improvements:** future teams can work on improving the performance of the Tesseract optical character recognition engine. This will reduce the time that students spend waiting for their score report to load.
- **Additional user testing:** more user testing should be conducted to ensure that future iterations of the application better serve the changing needs of the client. User testing is also useful to further validate the design of the solution we have created.

ABOUT THE TEAM

Caitlin Huang

Caitlin was the Technical and Quality Assurance Lead. She is a third-year Information Systems student with an additional major in Statistics and Machine Learning. She will intern with UnitedHealth Group this summer and Finisar this fall. During this project, Caitlin developed the optical character recognition and front-end portions of the application. She also developed the initial web application proof of concept prototype and did research on the APIs of the two applications.



Kevin Wang

Kevin was the Project Manager and Design Lead. He is a third-year Information Systems student with an additional major in Human-Computer Interaction, graduating in May 2022. This summer, he will be interning with Apple as an Engineering Program Manager Intern. During this project, Kevin planned the project sprints, developed the initial iPadOS and BoomBridge LTI proof-of-concept prototypes, and led the UX design and research efforts.



David Yuan

David was the Client Relations Management Lead. He is a fourth-year Information Systems student with an additional major in Statistics and Machine Learning, graduating in May 2021. He is working full-time at Tapad starting this summer. For this project, David handled communications with the client as well as external vendors, assisted in the development of the app's UI, and helped design the user testing plan.



APPENDIX A: THE PLAN

Project Plan

We created an extensive document listing the action items we have completed during each of our sprints. The document can be accessed using this link:

<https://docs.google.com/spreadsheets/d/1YrH4zIm3Xj6n2NTA-Eh1ucBBHLY1o5fwIXtZ8NL7Bvo/edit?usp=sharing>

Meeting Notes

The following is a list of our client meeting notes + agenda:

- 3/10 (notes available on Miro): https://docs.google.com/document/d/1paej8xr8WHX4jhMVv9h_KzLx-aSXEeQHCbrYrNghtDo/edit?usp=sharing
- 3/23 (notes available on Miro): https://docs.google.com/document/d/1gYqo9Khsaed1T5YJ9uD_9eleJEL546z7yXNqkaG6ZAc/edit?usp=sharing
- 3/30: https://docs.google.com/document/d/1WW0t6eGX_PZs-uqzzKg7NUcp8qHsrzP4n0mrgWWo2AQ/edit?usp=sharing
- 4/13: <https://docs.google.com/document/d/1Bu1jt202rMtulPimE-1upXDlgsB5Yo2AhQJkgUlrkA/edit?usp=sharing>
- 4/27: https://docs.google.com/document/d/1J_vSOPqhBXqp7ypoL9Q6I_8R3DFwut0EMk8RIAD7dB8/edit?usp=sharing

APPENDIX B: UX DESIGN

User Testing

In the course of developing BoomBridge, we asked our client to invite a few students and teachers to participate in a user testing study. To facilitate this study, we drew up a plan for our team to follow, as well as consent forms for the various users. The UX testing plan, as well as the consent forms, can be found below:

<https://docs.google.com/document/d/10jv-TLwX30kbEQtDLcS9PZRYLP5dZYoqKu8BR9LN-0A/edit>

https://docs.google.com/document/d/1lyHHpfahylHKo28HBSNtVf799dQWI_041enz8yjMKIs/edit

Focus Group Feedback

We invited teachers to provide feedback on our prototype in a focus group. Our notes can be accessed via this link:

<https://docs.google.com/document/d/1D3yoz8ZHdLSWxaBO9Of3DwbLROuQQntj88JQEh0YaxE/edit>

Figma Prototype

We used Figma to prototype the BoomBridge user interface. Throughout the project, the design underwent multiple iterations. You can access the Figma document using the following link:

<https://www.figma.com/file/am34yXGsD6Gmx9QzwchYW3/BoomBridge>

You can also toggle between the pages to see the different iterations.

Miro Boards

Whilst trying to build a shared understanding of the problem space and pain points with the client, one tool that we utilized often was Miro. We have used three different Miro Boards, links for which can be found below:

1. Venn Diagram for likes/dislikes of current options: https://miro.com/app/board/o9J_IRKxRL4=/
2. Storyboard activity: https://miro.com/app/board/o9J_IQX8mi0=/
3. System architecture: https://miro.com/app/board/o9J_IO9dFbo=/

Presentation Slides

While presenting our MVP to the class and to the clients, we created an iCloud presentation to document our work. The link to the presentation can be found here:

https://www.icloud.com/keynote/0eAGYC9mOCCbGesbpZtawHt3Q#IS_Consulting_-_MVP_Presentation

APPENDIX C: DOCUMENTATION

Documentation

As part of the final handoff procedure, we have crafted a project documentation document. In this document, we introduce our app and discuss the deployment procedure, maintenance plan, and privacy policy. An online copy of the document can be found below:

https://www.icloud.com/pages/0jU8KZy27jbGky_uvfn9SmGiQ#Project_Documentation

Deployment Docs

We identified several options for deployment, all of which are outlined in the document below. We have provided this document to the IT department at our client's organization. The following is the link to that document:

https://docs.google.com/document/d/1Yq9a5I_vk9nXoelUQycf_kv4w9TtUCnwsLMKb0AuPik/edit

Translations from the Client

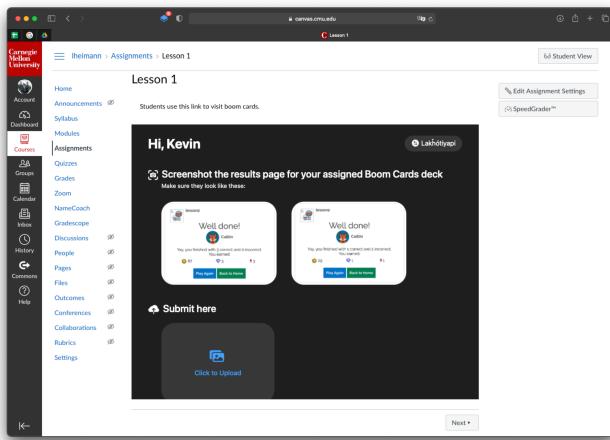
Since this Canvas plugin was made for Red Cloud's Lakȟóta Immersion program, we translated the application to Lakȟóta and allowed students to toggle between reading the instructions in Lakȟóta and English. The following is a link to the document with the application's text in both English and Lakȟóta:

https://docs.google.com/document/d/1gs_gMM-R94aoN71A8PZLNs3viDOqPvl_BXyPUPG2mek/edit

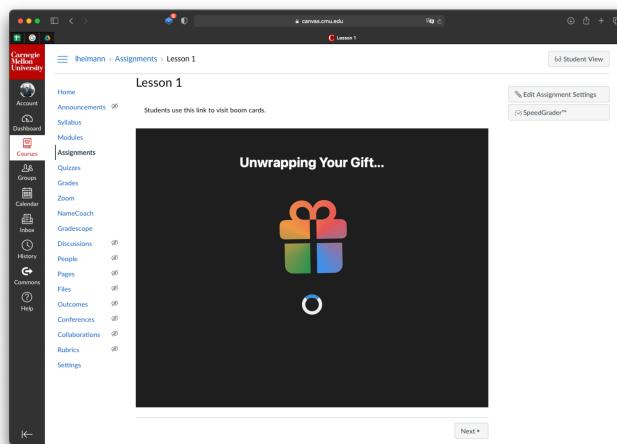
APPENDIX D: THE PRODUCT

Screenshots of the Final Product

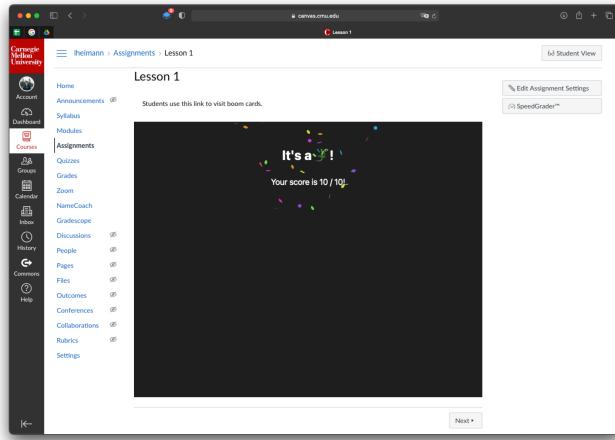
The final product is delivered in the format of a Canvas LMS plug-in called BoomBridge. The following are screenshots of the product from production version of the plug-in.



View showing instructions on how to submit Boom Cards screenshots



After uploading screenshot, this view is presented to indicating that the screenshot is being processed.



When the screenshot is done processing, this page shows the student their score and a random "gift" emoji to reward and congratulate them.

Link to the Final Product

The client is provided with a link to access BoomBridge via the dedicated CMU-hosted server. We do not include the link here as it has been provided to the client via a separate document. BoomBridge, however, is also available via a Heroku CI server that is configured to deploy code from our GitHub repository. The Heroku service can be accessed via: <https://boombridge.herokuapp.com>.

APPENDIX E: CODE

Github Repository Link

If changes are necessary, we provided the link to the GitHub repository below so that developers can continue to iterate upon the current solution. The following is the link to the GitHub repository:

<https://github.com/sirkevinwang/BoomBridge-LTI/tree/twig/v1.0>

iOS + Web app Repositories (which were deprecated)

Before the project team started developing the LTI, we explored alternative avenues which led to the creation of a suite of client-side apps. Like the final product, these apps process screenshots on-device and determines the students' grades. The key difference is that instead of reporting the grades directly, these apps provide students redemption code that allows them to unlock the next lessons on Canvas by submitting the code using Canvas quizzes. We have deprecated both the iOS and Web versions of the app. We never the less provide the link to the GitHub repository here.

iOS App Repository:

<https://github.com/sirkevinwang/RedCloudApp>

Web App Repository:

<https://github.com/caitlinhuang/react-ocr>