CREATIVE IDEATION

CAPSTONE PROJECT
HONOURS BACHELOR OF COMPUTER SCIENCE
(MOBILE COMPUTING)

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ABSTRACT

This project aims to solve the problem of creative roadblocks in group ideation. Our goal is to create a mobile app that helps groups of users generate creative ideas with the help of AI assistance and guided game-like activities (E.g., arranging sticky notes, idea voting). This project was inspired by Creative Problem Solving (CPS) principles, which has been explored via personal study and learned through Sheridan College's Certificate in Creativity and Creative Problem-Solving courses. This project aims to emulate the experience of table-top ideation by providing an online, mobile workspace that replaces the need for considerable desk space and automates much of what would normally be manual physical effort. Currently, there are some notable digital tools that attempt this (such as Miro, MS Whiteboard, Google Jamboard, Mural, and Lucidspark), however, mobile equivalents tend to be rare and/or underwhelming in terms of performance and features. Additionally, our app strives to avoid the common pitfalls of traditional group ideation, such as portability, crosstalk, fear of participation, and pressure to conform to the opinions of others. Our application was developed primarily for Apple iPad. Physical ideation activities typically require considerable working space, which reinforces the selection of a tablet as our target mobile device.

ABOUT CAPSTONE PROJECTS

TIMELINES • PROGRAM • SCHOOL

- **January 2021 – April 2021**: Capstone Project Inception, 4-credit course (18 hours / week)
- **September 2021 – December 2021**: Capstone Project, 4-credit course (18 hours / week)

PROGRAM • SCHOOL

- Hons. Bachelor of Appl. Computer Science (Mobile Computing)
- Applied Computing, Faculty of Applied Science and Technology

Sheridan | Get Creative

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INTRODUCTION

This is the Capstone Project Report for the Creative Ideation project. This document provides a detailed breakdown of the project; it covers all relevant information pertaining to the target problem & solution, design, development, and deployment of the application. This report begins with a Project Overview that addresses the motivation for the project, first describing the problem, proposed solution, and its feasibility. The Project Requirements section describes the requirements elicitation process, which includes a look at main functional areas, use cases, and UI design. We then discuss the project's architecture, highlighting the project's structure that was eventually realized. Following this section is our Project Plan, which details our team's responsibilities within the project, our iteration plan, risk mitigation strategies, and test plan. Lastly, the report concludes with a project summary containing domain expert evaluations, and future work.

PROJECT OVERVIEW

Project Name: Creative Ideation

Project Scope Summary: This project aims to streamline virtual, group-based ideation with the help of guided activities and artificial intelligence on a simplified whiteboard interface. It will aid users in ideation processes by facilitating principles of creativity: minimizing distractions, guiding users through activities/exercises, and helping them come up with creative ideas. Activities refer to exercises that help structure ideation processes for the purpose of improving group performance and participation. There are many well-regarded activities that people use today, each designed to produce specific outcomes. Our app has virtualized the popular *Brainstorming with Sticky Notes* activity, which is a staged procedure that begins by encouraging the production of as many ideas as possible, followed by converging to realize the most creative or useful ideas amongst the lot. This process results in creative output because it promotes participation amongst all group members without judgement, and sparks insight by displaying all ideas in one location. The convergence phase employs anonymous voting to come to a consensus. To support users in generating creative ideas, our app uses AI to suggest new ideas to users based on the ideas already on screen.

The structure of the application follows a team-oriented approach, such that users can organize their work in groups and have easier access to other collaborators in their domain. Therefore, this application will be well suited for organized groups that frequently work/ideate together (e.g., classrooms, departments, study groups, etc.). In our application, we call these Teams and Groups – where a Team consists of a large collection of users in a particular domain, and a Group is a subset of those users. Once users are established into Groups within the app, they can create and participate in ideation activities. We call these Sessions, with each having one Activity type – where the Activity is a distinct guided exercise (as described above). Ideation within groups is critical for achieving creative output, so currently, our application only provides group-based exercises.

Team Composition:

1. **Kellen Evoy**
   Project Owner, Requirements / Business Analyst, Requirements Model Lead, Domain Model Lead, QA Lead, Risk Analyst, Artificial Assistance Lead
   Kellen is a 4th year Mobile Computing student at Sheridan college. He has a passion for creative studies, which sparked the interest for this project.
2. **Vanessa Li**
   User Experience Design Lead, Deployment Model Lead, Test Model Lead, User & Group Management Lead
   Vanessa is a 4th year Mobile Computing student at Sheridan College with and interest in in developing mobile applications.
3. **Matt Marini**
   Scrum Master, Software Architect, Design Model Lead, Interaction Model Lead, Integration DevOps Lead, Session Management Lead
   Matt is a 4th year Mobile computing student at Sheridan College with an interest in game development.

Domain Experts:

1. **Jennifer Phenix**
   Professor of Humanities & Creativity, Faculty of Humanities and Social Sciences
   Sheridan College
2. **Dr. Nathaniel Barr**
   Professor of Creativity and Creative Thinking, Faculty of Humanities & Social Sciences
   Sheridan College

DOMAIN AND INDUSTRY OVERVIEW

As mentioned in the Project Overview, this application is team-oriented, and will be more beneficial to organized groups. With that said, the problem that this project aims to solve is not unique to a single domain. Ideation techniques are used in any domain that requires some sort of innovation/ideation. With our application, we aren't interested in narrowing down our target audience such that we exclude a large portion of potential users. Early versions of the application will have features that cater to specific types of administrative users (E.g., profanity filter / behaviour monitoring for teachers). As a result, this application has the potential to branch into many domains, though the most prevalent domains will be listed below followed by their North American Industry Classification System (NAICS) code [1].

Management of Companies and Enterprises (5511) \ Elementary and Secondary Schools (6111) \ Community Colleges and C.E.G.E.P.s (6112) \ Universities (6113) \ Arts, Entertainment and Recreation (71) \ Musical Groups and Artists (71113)

This list takes into consideration our choice of developing for Apple iPad. Although there has never been an intention to exclusively develop for Apple devices, it is beyond this project's scope / time allotment to develop on other mobile platforms. With this, we've taken a special interest in domains where iPads are used increasingly – specifically the education, arts, and business sectors, where Apple has taken a foothold with their iPad products.

Apple has reported impressive increases in students' literacy, math, and science scores within schools that have incorporated iPad into their curriculums [2]. Gallup, an American analytics and advisory company, reported in 2019 that 87% of teachers and 77% of parents agree that teaching with an emphasis on creativity produces positive outcomes for students [3]. With the growing presence of iPad and creativity in education, it makes sense for us to take special consideration for users in this domain for the early releases of our project.

In the arts sector, iPads are becoming increasingly common tools for the creation of digital drawings, paintings, and animations. However, "artist's block" is known to strike even the most talented of creators, and an application for creative ideation on the iPad would allow artists to quickly switch over to the app while they're painting and get some new ideas flowing. Artists are always dreaming up new creations, and the ability to ideate on the go with the aid of our app would also be beneficial for them in inspiring new ideas and jotting down the ones they come up with while they're out of the studio.

An example use case in a business environment could involve management's desire to ideate on-the-fly. Instead of gathering a department of employees/executives into a conference room to share ideas on a whiteboard, they could use an iPad application to replicate the process non-invasively. Employees could ideate from their personal spaces via the application. If they'd prefer to gather in-person, they won't need to worry about whiteboards, desk space, writing tools, and so on. Additionally, negative side effects of group dynamics in a corporate setting (such as groupthink, fear of speaking up, etc.) can be avoided with anonymity features in an app.

PROBLEM DESCRIPTION

Coming up with creative and useful ideas is challenging and it is a skill to be honed. Traditional ideation is commonly performed in groups; when you ideate alone, you are limited to your own perspective. However, problems with group dynamics can be detrimental to a group's performance. For example, social pressure from others can greatly influence an individual's thought process and behaviour: individuals naturally feel pressure to conform to the popular opinion (groupthink), some group members may be overbearing, certain individuals can feel afraid to speak, and so on. Negative group dynamics are common in traditional in-person ideation sessions (and all other facets of group collaboration), and it's almost always necessary to have someone take on a facilitator role to ensure the group doesn't fall victim to these drawbacks. It is also worth mentioning that ad-hoc ideation is ineffective when it comes to creative output – otherwise, individuals can hit mental roadblocks and the group can get carried away. Groups will benefit from structured activities or processes that are designed to reach particular outcomes (like creativity). Ideation activities often require plenty of space and materials, such as a whiteboard, sticky-notes, writing tools, and so on.

Virtual collaborative ideation/brainstorming apps *do* exist, though the most robust ones are exclusive to desktop computers. A possible explanation for this is that screen real-estate is limited on mobile devices and translating existing desktop solutions to smaller screens may not be worth the effort. Using these desktop applications may also limit in-person interaction; to communicate with your group, it is likely that you will have to do so via text chat or voice call, which is less efficient than being able to communicate in-person. Another downside of these well-known desktop apps is that they can be overly complex, distractive, and/or rely on users to tediously manipulate objects on screen to suit their needs. Research indicates that multitasking, distraction, and use of complex electronic devices

can lead to cognitive overload and a decrease in creative thinking [4]. Ideation activities benefit from simplistic environments, and the current leading applications often violate this.

In areas where some existing ideation applications thrive, others lack – and vice versa. To explain this, we can look at Lucidspark; an ideation-based platform developed by the creators of Lucidchart. Lucidspark offers a plethora of pre-made templates (pre-positioned editable objects), and an approachable aesthetic. Where Lucidspark lacks is its reliance on the user's manual effort, and their templates are static. For instance, their template for the CPS activity of "brainwriting" is stationary, requiring users to manually move everything around themselves.

Another example of an existing product having some good features is Google Jamboard. This is an extremely simplified whiteboard application – almost to the point where it's not entirely useful. Google Jamboard allows for rapid creation of sticky-notes without any need for manual user intervention other than typing their ideas, which is very beneficial to ideation as it limits distraction. Unfortunately, Google Jamboard lacks in areas such as presentation, aesthetics, and overall useful features – however it is a source of inspiration for the aspect mentioned.

To summarize, the problem at hand is that there is a lack of mobile tools that foster creative ideation in groups. While each tool mentioned does provide varying useful features, none of them are able to put it all together into a clean and simplified interface. It is not to say that virtual ideation tools do not exist or are not useful – it is that they can be improved upon. Our project aims to create a tool that addresses these issues.

SOLUTION DESCRIPTION

The solution to the problems identified is an iPad application that enhances and streamlines group ideation. Features such as a gamified activity and an AI-powered idea generator are used to avert the pitfalls of negative group dynamics and keep participants productive. Being a group-focused application (we intend our users to use the app with others), we propose an app structure that allows for increased quality of life when it comes to gathering users together to perform ideation sessions. This application was developed natively for the Apple iPad, allowing for the use of iPad-specific features such as the Apple Pencil Scribble framework, which will add a familiar physical aspect to a virtual environment. Delivering this app on a mobile platform allows users to gather wherever they're most comfortable and speak face to face when undergoing the ideation process, while also supporting easy and intuitive touch controls for a handheld experience. Such a platform will counter the drawbacks of traditional group ideation in that considerable space and materials are not required.

A core feature of our app is Activities. Activities are structured, semi-automated processes that help guide groups toward creative ideas by keeping them on track and utilizing divergent and convergent thinking strategies. This can prevent users from getting stuck and encourage creative responses. The application was developed to support numerous Activity types, however, only one was fully implemented so far – the Sticky Notes Activity. This Activity is explained in the Use Case section.

Mobile Computing

The application has been developed for Apple iPad. Utilizing iPad OS 14+, we've incorporated Apple Pencil functionality to the application providing users with the option to ideate in ways familiar to them – like classic pen &

paper. Swipe gestures also benefit our goal of emulating real-life ideation experiences (E.g., swiping notes across a table to move them, sorting/organizing notes, etc.). Being a mobile application intended for use in groups, we suspect that many users will be using this application in-person with each other – therefore, we've implemented QR code scanning to streamline the tedious process of making groups in online interfaces (no need for email links or access codes). Additionally, we have taken on the personal challenge of developing exclusively using the SwiftUI toolkit, which, at the time of writing, is still in its infancy. Using SwiftUI allows us to achieve a more pleasing aesthetic for our app. The development of an Android variant of the application remains a long-term goal outside the scope of our 1-year development timeline. Due to time limitations, we are not planning the development of the application for any other platforms for this term.

Cloud Computing

Google Cloud Platform (GCP) is our selected cloud platform due to its simplicity, plethora of free services, real-time database capabilities and Google's strong global presence. Considering our wide target audience, we believe it makes sense to use a cloud platform that appeals to a wide target audience as well. Google Accounts are very simple to use, and approximately 1.5 billion users are already signed up [5]. Google Identity offers the ability to integrate with applications, allowing users the option to sign in using their personal Google accounts. Because of the team/group-based nature of our proposed application, we would prefer to have access to a relational database. However, Cloud Firestore offers the real-time features we need, as well as having a structure that offers similar functionality to that of a relational database (Collections and Sub-collections). Another benefit of GCP is the ability to use Cloud Functions – serverless code execution. We intend to provide AI solutions for automated idea generating assistance, and Cloud Functions can be used to offload computational resources from our app and reduce our application's file size by storing large AI models on the cloud. In summary, our application is heavily reliant on the cloud.

Advanced Areas of Computer Science

Cognitive Computing (CC) / Artificial Intelligence (AI)

Chatbot – IBM Watson Assistant (CC)

Because our app is so closely tied with the field of Creative Studies it will contain plenty of jargon that may not be familiar to some. Additionally, our app has custom ideation activities that users may require instructions for. It's also possible that users might not know where to find certain settings or know how to do a certain task (E.g., adding members to Groups). We'd like to have a one-stop spot where users can have their questions answered without hassle. IBM Watson Assistant is used to provide a good, lightweight solution for providing help to the user.

Idea Generator – Word2Vec Embeddings (AI)

One of the most important features of our application is the idea generator. It serves as a catalyst within ideation sessions that users can call upon when they can't think of anything. This feature is made possible by utilizing NLP word embeddings. These word embeddings are learned representations of words produced by analyzing billions of words, phrases, and paragraphs, and calculating each word's similarity with others. Word2Vec refers to a category of neural network models that produce these word embeddings – a representation of all input words in a several-hundred-dimensional vector space, where each word has a corresponding vector [6]. We use these word embeddings to find the similarity between two words by measuring their distance in the vector space. Additionally, we use these

models to find the similarities between numerous words at a time, which can lead to some very interesting results. For instance, if users entered the words “wheel” and “food” and hit the idea generator button, it might produce a suggestion, like “cheese” (wheel of cheese). It is unique suggestions like this that creativity benefits from – novel ideas prime the thoughts of users to come up with more novel ideas.

SOLUTION IMPACT

The proposed solution would be most impactful to educational domains as we shift towards a generation of technology-infused learning, as well as artistic domains where the use of iPads is already prevalent. Creative Ideation is an overall useful tool that can be utilized in any industry/domain by ultimately increasing creative output by making creative activities more accessible, streamlined, and portable. The educational sector would likely see the most benefit as school boards could standardize this tool for classrooms to use. The push for group work has become increasingly more common in all areas of study and as a result, it is important to provide user friendly tools that encourage collaborative work. Working or learning from home can prove to be challenging at times, and isolation can lead to mental roadblocks. Creative Ideation aims to solve that by streamlining ideation to help users initiate the mental process of searching through an unknown idea or solution and building off others as well.

SOLUTION FEASIBILITY

This section will discuss the design, construction, deployment, and adoption of Creative Ideation in terms of feasibility. The development of an application must consider a multitude of aspects to ensure that it is able to meet both technical and marketable needs for end users and industry partners. The design and construction section highlights different tools and technologies that are used within the application to fulfill its intended purpose. Secondly, the deployment section further elaborates on how the application is deployed and what platforms it uses. Lastly, the adoption section discusses how end users can easily adapt and use this application.

It is important to note that the application developed over the 1-year Capstone timeline is a partial solution to the problem identified (as proposed). By fully implementing a single Activity, we’ve demonstrated that the app can serve as a platform with the potential to support more of them in the future.

Design and Construction

The application developed is the product of numerous hours of hard work and dedication from all team members. A consistent effort was required throughout both academic terms, as well as throughout the optional summer term bridging them. Design and construction plans changed with each iteration of the project, as risks were discovered and addressed. The following risks posed the most challenging obstacles: SwifitUI infancy and limitations, unfamiliarity with languages used, managing clutter in a tablet UI design, selecting an appropriate data storage method capable of real-time changes, and time management according to ambitious plans. We took extra care ensuring that the UI would adapt to all existing iPad screen sizes, as well as both orientations. Dark mode is also fully supported.

Deployment

The deployment of Creative Ideation to schools, school boards, and/or businesses should be quite feasible, so long as they have adopted the use of iPads in their facilities. The application would be available through the Apple App Store or provided by the school/organization via a distribution license. In addition, Creative Ideation is suitable for all ages and can be deployed almost anywhere. However, the only notable restriction when it comes to deployment is that the application is not cross-compatible with Android for the time being.

Adoption

The adoption of Creative Ideation would be simple. Being a group-oriented app, we envision it being adopted through school resources or simply accessible on the Apple AppStore. For end users, they will be greeted by the familiar "Log In" screen, in which they can bypass via their Google credentials, or create their own account. From here, a user can expect a Home View, showing a list of the Teams they belong to, various Group listings within those Teams, and buttons inviting them to start ideating. Creators of a Team will have administrative control over it, allowing them to create Groups, add and remove members via access codes / QR codes, and set global permissions. Creators of brainstorming sessions can have administrative control over the Session, allowing for tools that may be beneficial for certain use cases – such as teachers needing to control profanity, or group leaders wanting to set time limits, toggling anonymity during idea voting, etc. Session results can be saved in the cloud and viewed later. Users can also be a part of numerous Teams, which would be ideal if the app was used in numerous domains.

PROJECT REQUIREMENTS

This section discusses the requirements elicitation process, including a breakdown of critical use cases, and UI design.

SYSTEM CONTEXT

The Creative Ideation application is useful for end-users in a variety of domains. With this, it is difficult to select particular end-users with specific needs. Instead, we've isolated "Team Lead" as one actor, and "General End User" as an actor group. Team Leads refer to anyone with authority within a group of individuals. General End Users are used to refer to all other users (including Team Leads). This distinction is necessary as many use cases of the application are required by all users, and only some are exclusive to admin-level users. Creative Ideation has numerous supporting actors; namely our data storage, cloud computing, and open-source package providers.

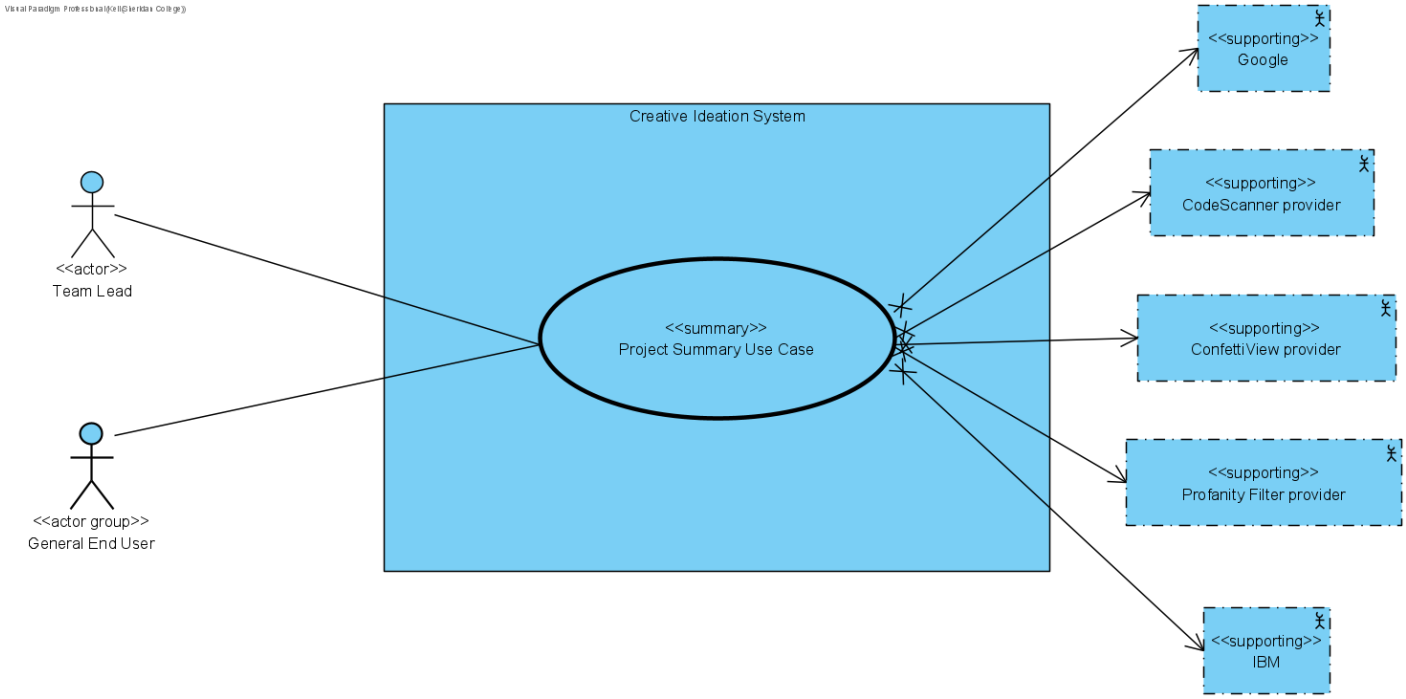


Figure 1: System Context Diagram

USE CASES

This section discusses the most important use cases identified in our project plan. Before elaborating on these use cases, we will first define the three main functional areas (FAs) that they belong to: User and Group Management, Session Management, and Artificial Assistance.

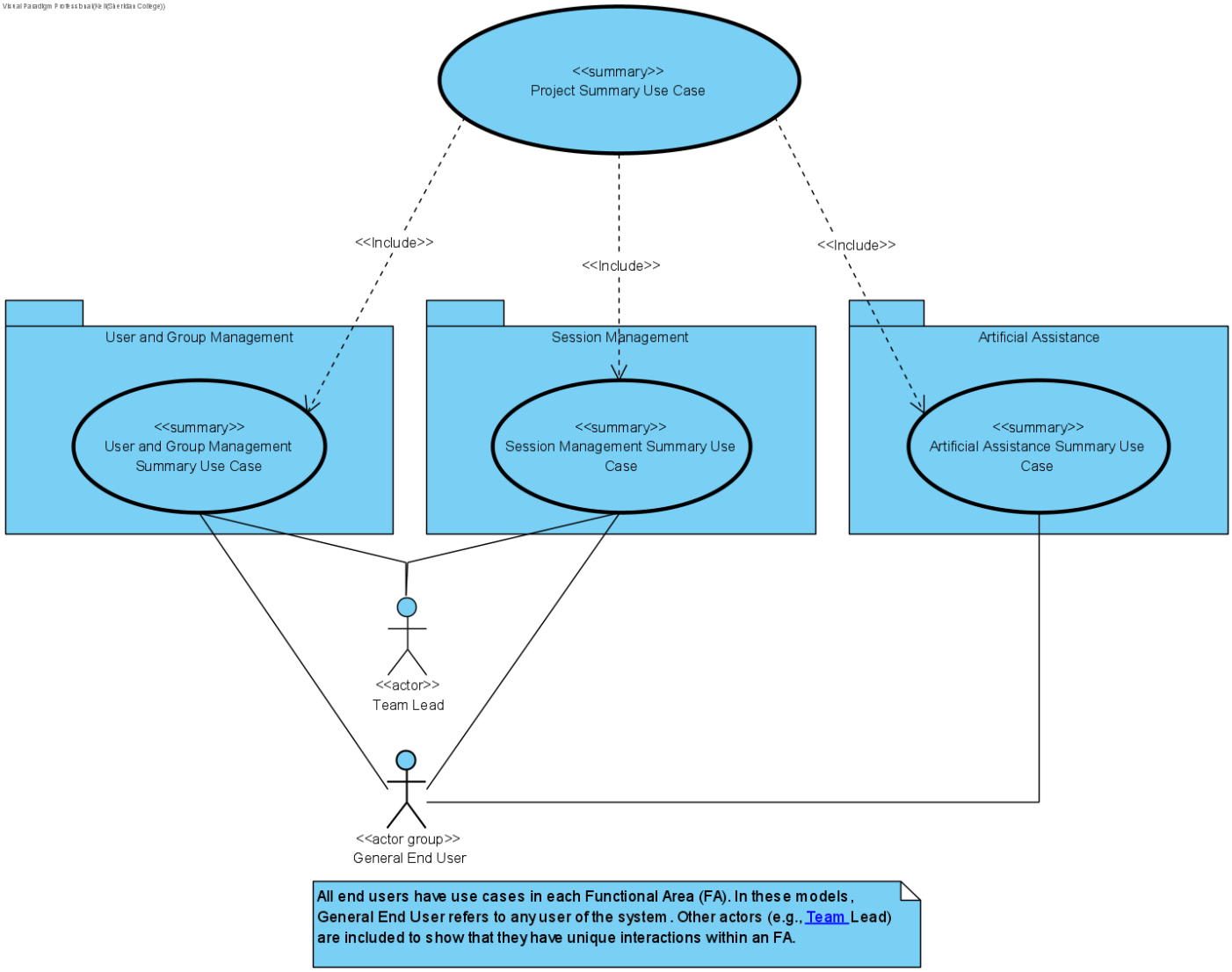


Figure 2: System Overview Diagram

FA: User and Group Management

The User and Group Management functional area encompasses all use cases relating to user interaction with administrative/organizational features of the app. This includes logging in, creating accounts, adjusting settings/preferences, and managing Teams and Groups.

Manage Teams & Manage Groups

The most notable use cases within this functional area are *Manage Teams* and *Manage Groups*. These use cases describe how users want to organize their experience – I.e., managing Team/Group members, creating & deleting Teams/Groups, and setting preferences for each. Teams and Groups are one of the most important aspects of Creative Ideation, and they are inspired by well-organized applications such as Microsoft Teams, Discord, and Miro. Teams offer the ability to organize a large number of individuals in a single domain, which enables access to other

users in the domain on a username-basis rather than email-basis. This leads into the Groups feature, which allows for grouping subsets of Team members. To explain with an example, a Team could consist of all students and teachers belonging to some classroom domain, and students within the class can split into Groups of three – because all the students are registered in the Team, new Groups can easily be made in the future simply by selecting their names from a list upon creating a Group (i.e., no need for access codes).

Manage Profile

When users of an application create their personal profile, they're going to want to have control over it. This use case decomposes into various use cases covering how users create their accounts, log in, manage settings, change their username, etc. This is a fairly basic need for applications that support user profiles.

FA: Session Management

The Session Management functional area deals with all use cases that involve Sessions – I.e., real-time collaboration features. Each Session has one dedicated exercise that users will participate in, called Activities. They are a vital part of Creative Ideation, as they solve one of the identified problems that hinders creativity. Activities attempt to add structure to the ideation session by controlling what users see and do in a Session. An Activity is our app's way of carrying a user through an ideation exercise that may have multiple stages or tasks for the user.

Select Sticky Note Activity

"Sticky Notes" is the only Activity that Creative Ideation currently supports. In the physical world, brainstorming with sticky notes is a very popular and effective way to ideate for obvious reasons. Sticky notes (the objects) are used in nearly all of the popular ideation applications mentioned previously. These applications simply allow the user to create sticky notes, insert text into them, and place/move them on screen. However, sticky notes can be much more effective when used in a certain way. In the field of Creative Studies, a brainstorming strategy exists called "Stick-em Up Brainstorming", where a group of individuals write their ideas on sticky notes, place them on a whiteboard and verbally speak the words they wrote [7]. This serves as a catalyst for others in the session and leads to more creative results, as individuals can be inspired by the ideas they hear/see [8]. The goal is to produce as many ideas as possible – quantity over quality. Once numerous ideas have been generated, groups typically attempt to converge to the ideas they deem best.

Creative Ideation draws inspiration from the CPS process and emulates it in the Sticky Notes Activity. Users won't need to select an icon from a list, click and drag the object on screen, double-click to enter text, and manually move it around. Instead, a virtual pad of sticky-notes will exist at-the-ready, and users can simply type (or write) their ideas, and the note will be placed on screen for them. Once users have entered all of their ideas onto sticky notes, the Activity moves on to a 2nd stage, where users cast a vote for each idea. After the votes have been tallied automatically, each user may cast one final vote on the remaining top ideas. The idea with the most votes at the end is declared the best idea and presented to all users. Currently, none of the popular competing brainstorming applications offer this type of interactive template. Although it will be more difficult to implement, it will be more useful to users than a static template.

To be clear, this is the only Activity that has been implemented so far, as it is quite intricate. Future Activities would be unique and serve their own purpose in the realm of ideation.

FA: Artificial Assistance

The Artificial Assistance functional area outlines all user interaction with AI or cognitive computing features within the app.

Generate Ideas

The most important use case within this functional area is Generate Ideas. This use case describes how a user will interact with a button that, when tapped, will present the user with new words that relate to the current topic of discussion within a Session. The reason for including this feature is simple – exposure to new ideas primes thoughts and facilitates creative thinking [8]. It can help users when they get stuck and cannot think of more ideas. They can simply resort to the Idea Generation button to give them some help. This use case is fulfilled by Word2Vec Embeddings, as described in the Advanced Areas of Computer Science section.

Provide Help

Being a fairly complex app with domain-specific jargon, users may find themselves needing explanations. Users can interact with a chatbot that has answers prepared for questions that a user may have regarding most aspects of the app, including jargon descriptions, and how-to guides. This use case is fulfilled by an IBM Watson Assistant, as described in the Advanced Areas of Computer Science section.

USER INTERFACE

This section will go into detail of the UI design process: describing wireframes and providing for a user-guide of the application with screenshots from the actual implementation.

Wireframes

As mentioned previously, Creative Ideation relies on a highly organized, yet simplistic interface. Most of the user's time will be spent in either the Home View (to manage Teams and Groups), or the Session View (to participate in ideation Activities). Below are our initial UI mock-ups created with Figma.

Home View

The Home View is akin to the dashboard of the app. It provides the user with a summary of usage, and the ability to navigate between Teams, and Groups – as well as create Sessions. The following images describe various states that the Home View can be in.

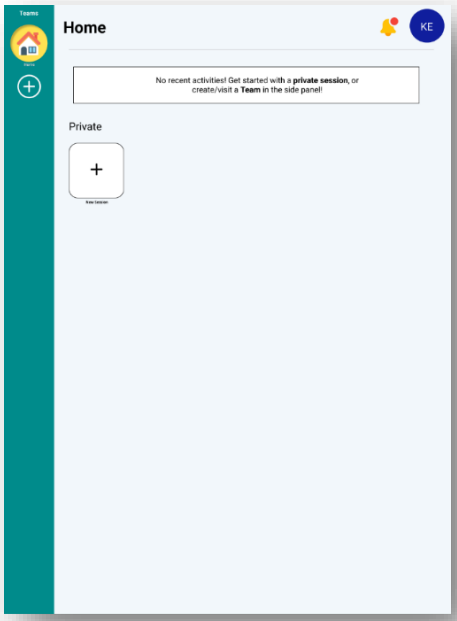


Figure 3: Empty Home View

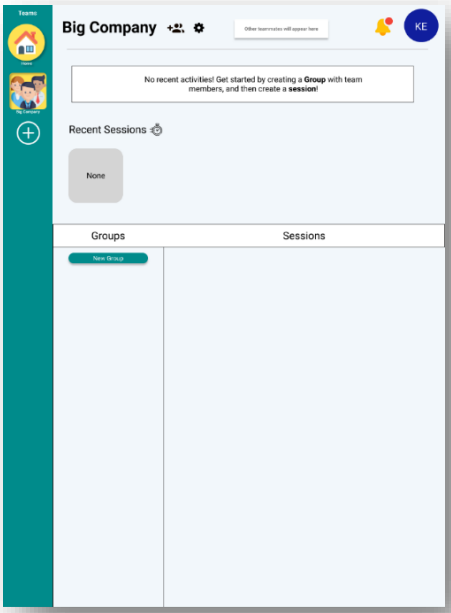


Figure 4: Home View after creating a Team called "Big Company"

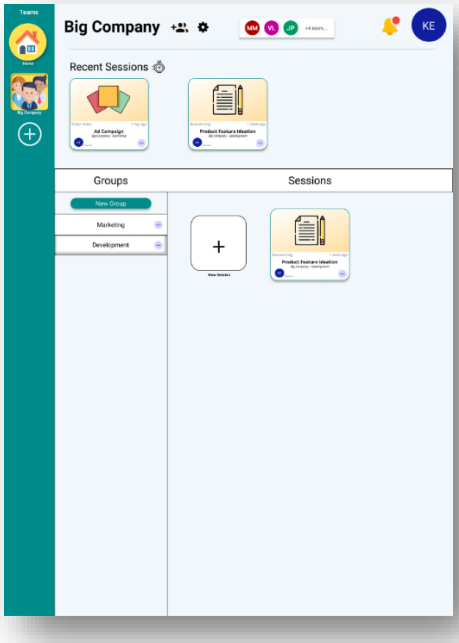


Figure 5: Home View after creating two Groups within the Team, and one Session within each Group

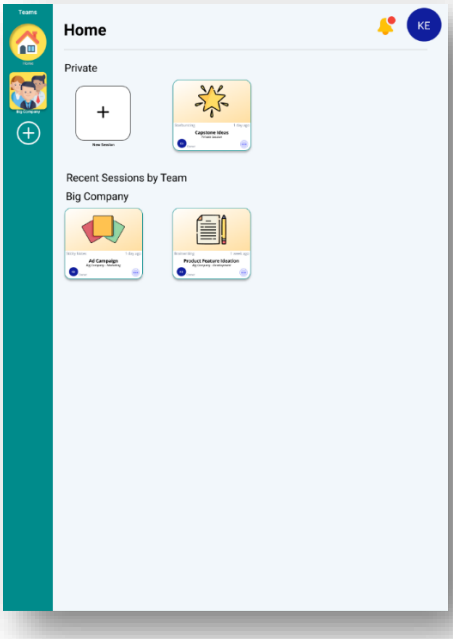


Figure 6: The resulting Home Summary page after adding content from Figures 4 and 5

Session View

Note that each Session tile has an image according to the brainstorming Activity it fosters. This gives the user an idea of what is taking place within that Session. Below are some wireframes that showcase Session creation and the Session View itself. In its current state, the Session View mock-up is a bit rough around the edges. For the scope of the capstone project, we plan to implement at least one Activity type, which is the Sticky Notes brainstorming Activity – therefore, we created a mock-up for it alone. The lightbulb button in the bottom right corner of the Session View is our Artificial Assistance tool that will provide users with ideas as they brainstorm.

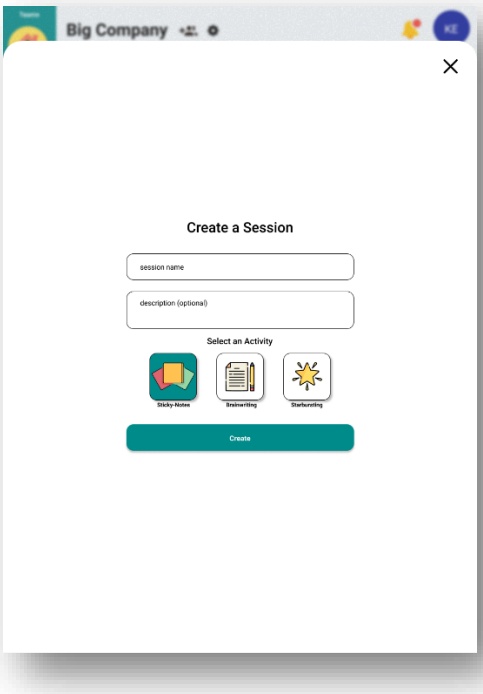


Figure 7: Creating a Session

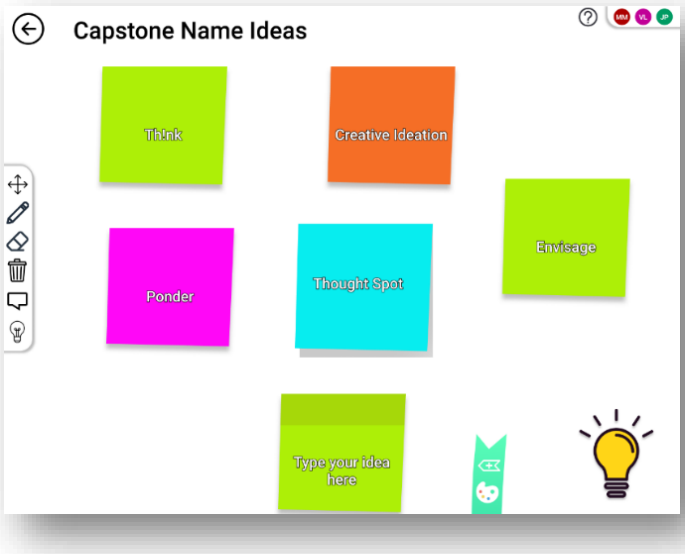


Figure 8: A Sticky-Notes brainstorming Activity in a Session

UI Implementation & User Guide

The following section shows the main screens currently developed in the Creative Ideation application with a simple walkthrough for getting started with your first Session.

Log In / Create Account

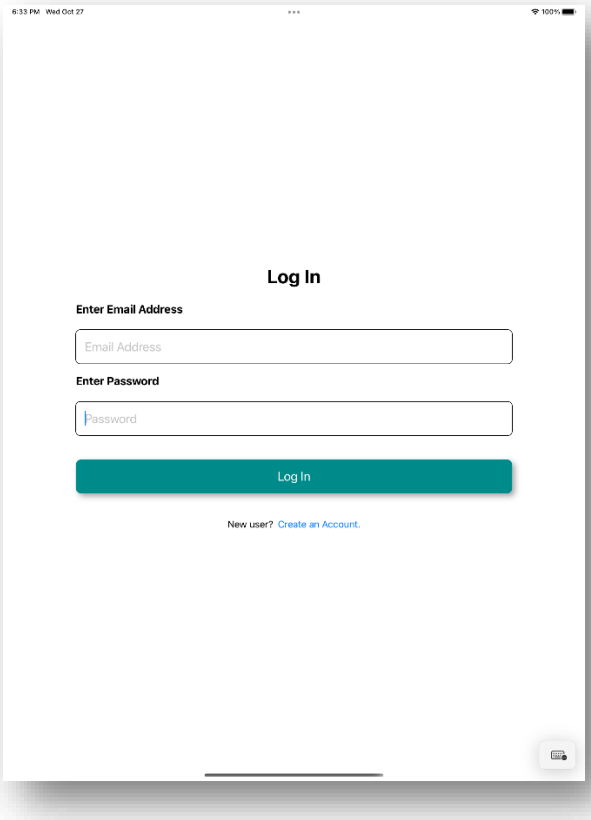


Figure 9: LoginView

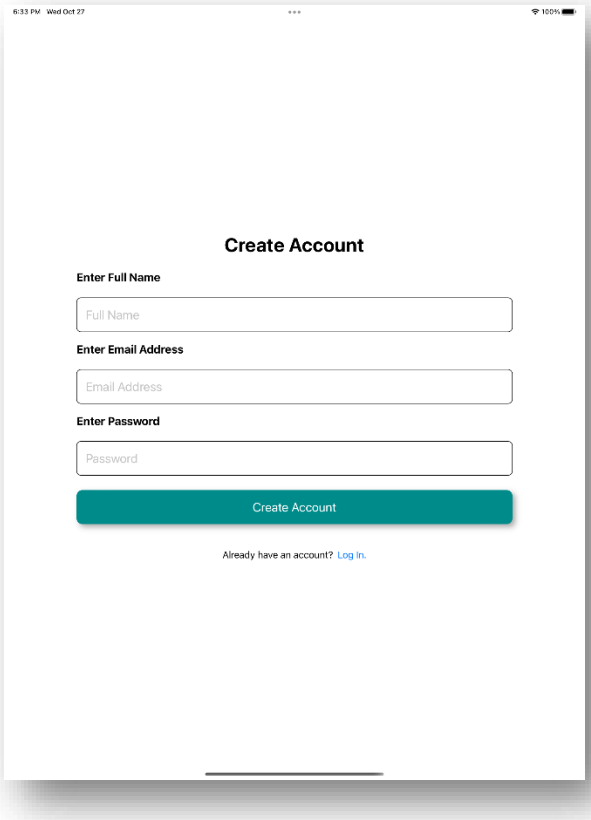


Figure 10: CreateAccountView

Begin by creating an account with any email address or logging in with an existing account. Future work could involve allowing users to sign in with pre-existing Google accounts.

Home View (new account) / Home View (w/ Team selected)

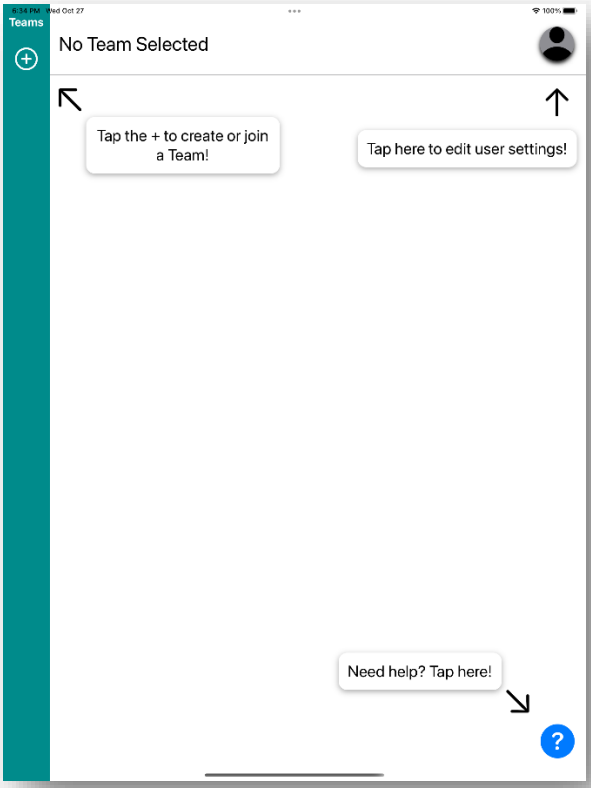


Figure 11: HomeView upon new account creation

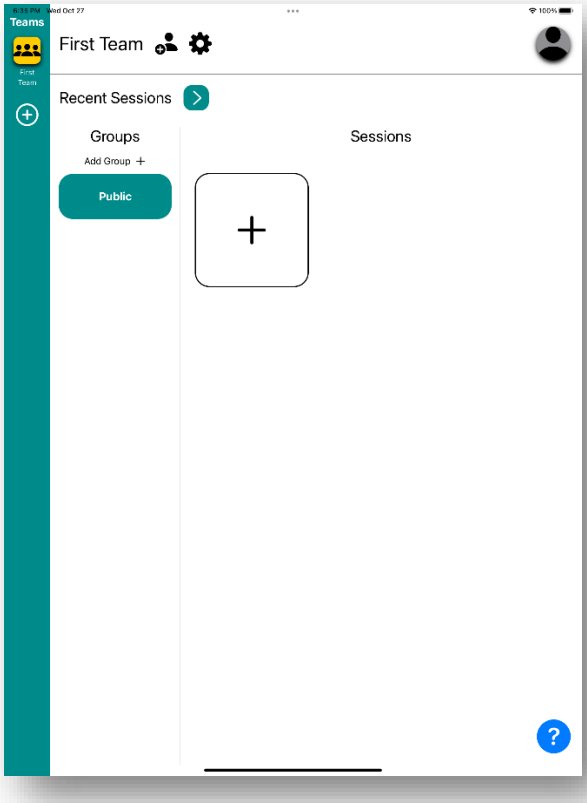


Figure 12: HomeView with a Team selected in the side bar

Upon logging in for the first time, the user will be given prompts of what they can do to start. We've designed it so that the user doesn't have many options, ultimately resulting in them creating or joining a Team. The second figure shows what the HomeView would look like if a Team had been created and selected. Note that a Public Group is created by default with your Team – this Group always contains all members of the Team; it is a place where the Team can participate in Sessions as one large unit.

NOTE: The screenshot feature within Apple's Simulator program appears to randomly decide whether divider lines are included in the image. Within the real application, there are thin lines dividing each section within the HomeView, separating the top bar from the Groups and Sessions panels.

User Settings View

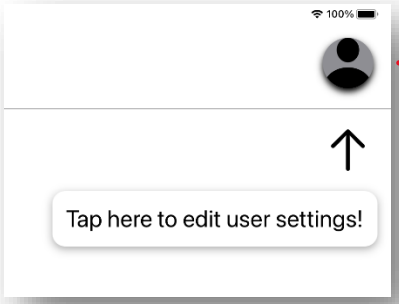
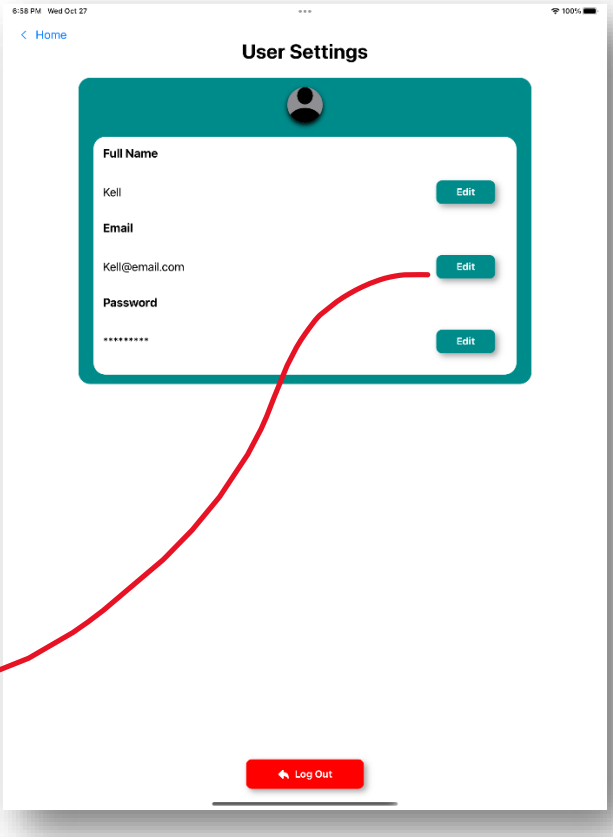


Figure 13: Profile picture in HomeView



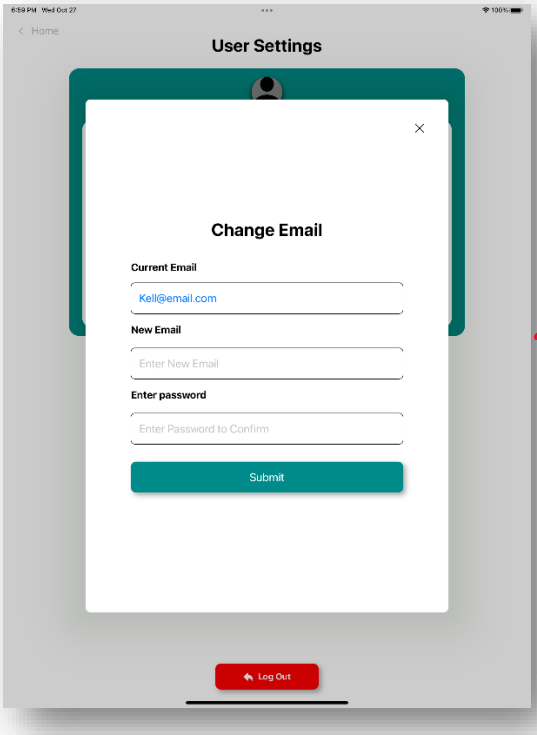


Figure 14: "User Settings" interface

Figure 15: Example - changing email

Users can access their account settings by tapping their profile picture icon in the top-right corner of the Home View.

Create/Join Team

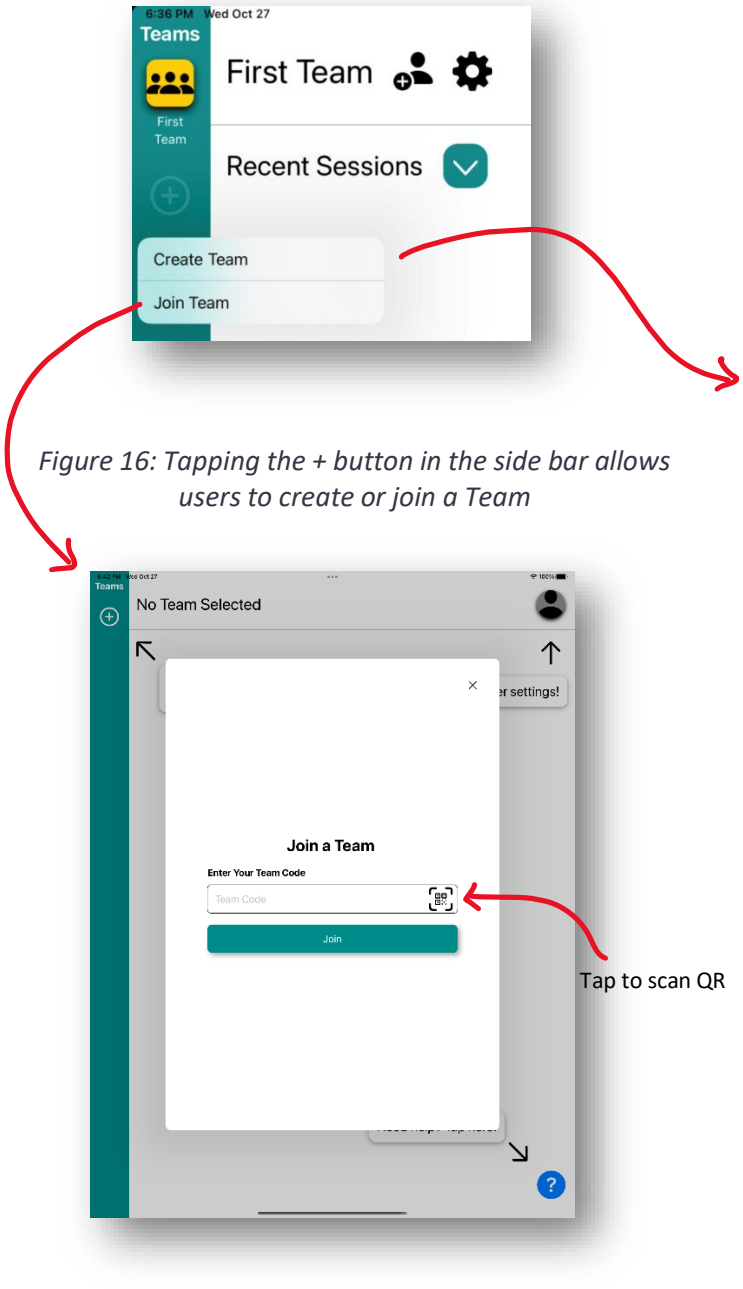


Figure 16: Tapping the + button in the side bar allows users to create or join a Team

Figure 17: "Create Your Team" interface

Figure 18: "Join a Team" interface

Clicking the white plus button in the side bar will reveal a drop-down menu, where a user can open a Create Team form, or join a Team using a unique code (which could be shared with the user outside of the app or scanned via a QR code). The second image shows the Create Team form.

Team Settings / Team Access Code

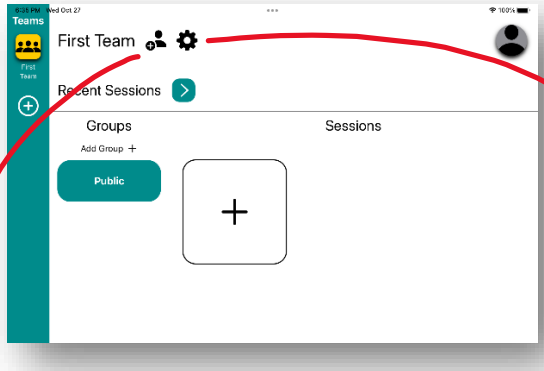


Figure 19: HomeView

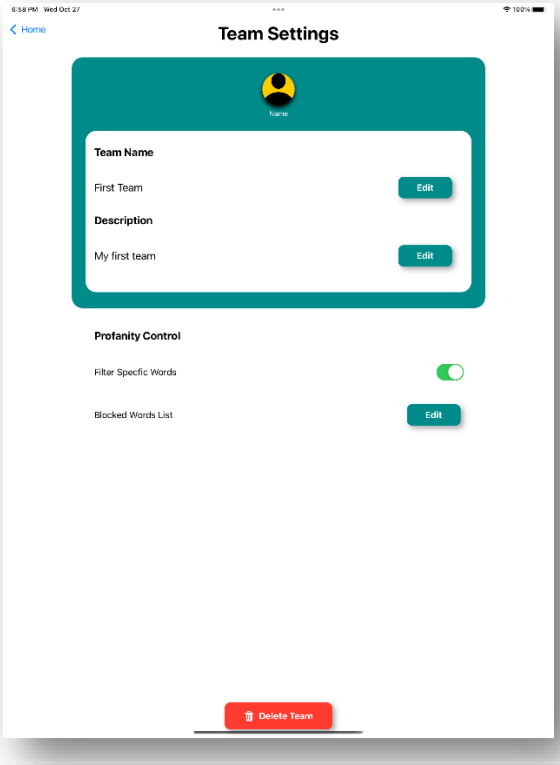


Figure 20: Team Settings

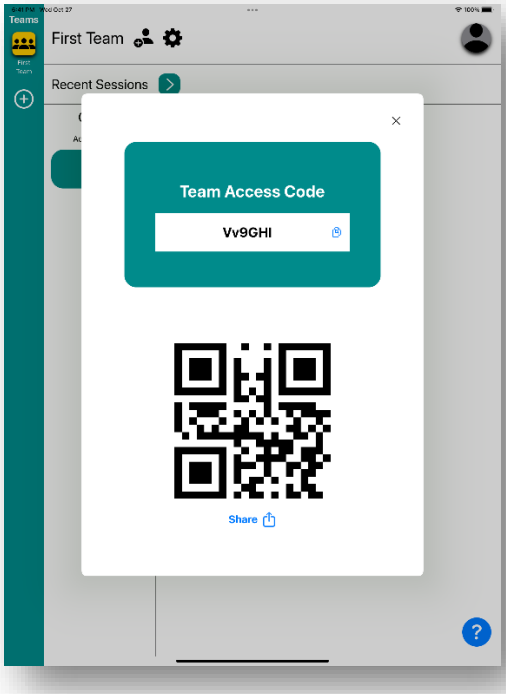


Figure 21: Access Code + QR

From the Home View, a Team's admin can generate an access code for others to scan/enter to join the Team. The gear button opens Team Settings. Settings may not be accurate with final release.

Create Group

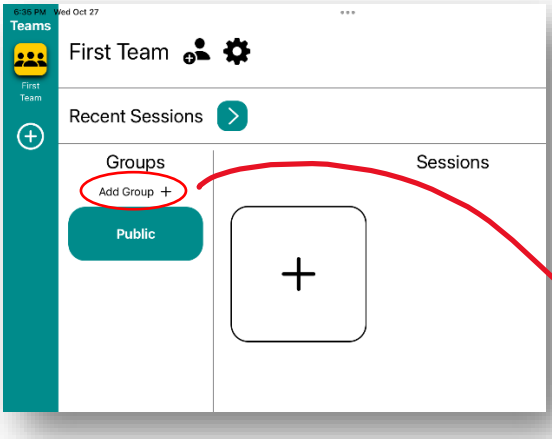


Figure 22: "Add Group" button

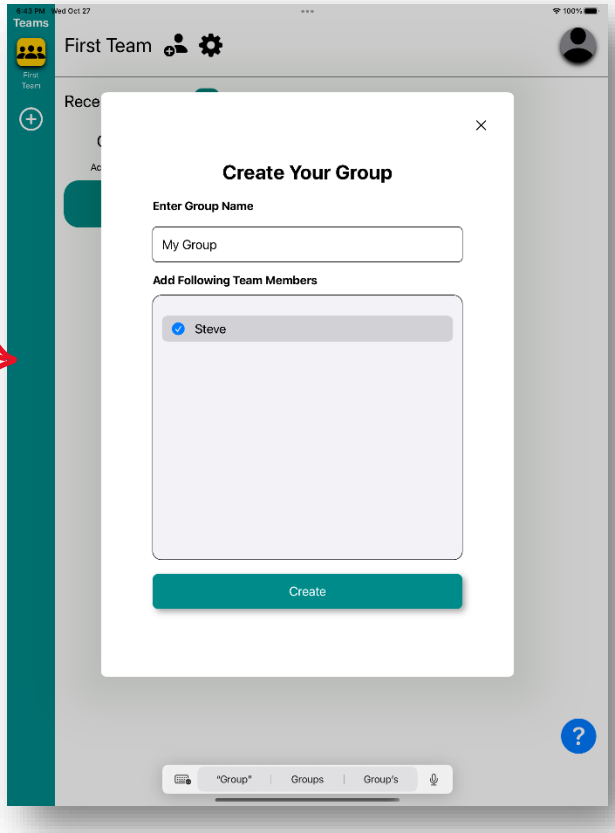


Figure 23: "Create Your Group" interface

Creating a group can be done by clicking the Add Group button indicated by the arrow. We plan for this to be locked behind a Team permission, but for the beta release, any Team member can create a Group. The second image shows the Create Group form. In this form, the creator of the Group has instant access to all members of the Team. As you can see, a member named Steve has joined my Team, so we can easily add him to this new Group. This feature is useful because once everyone in your domain is added to your Team, you no longer need to share access codes to group-up and brainstorm – you can just access them by name.

Group Settings View

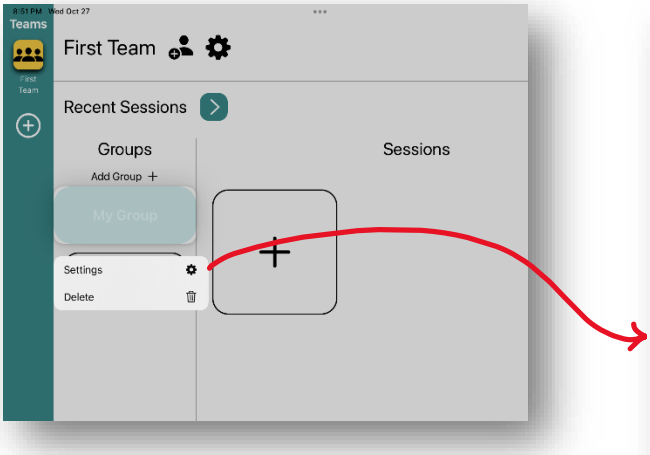


Figure 24: Group's context menu with settings option

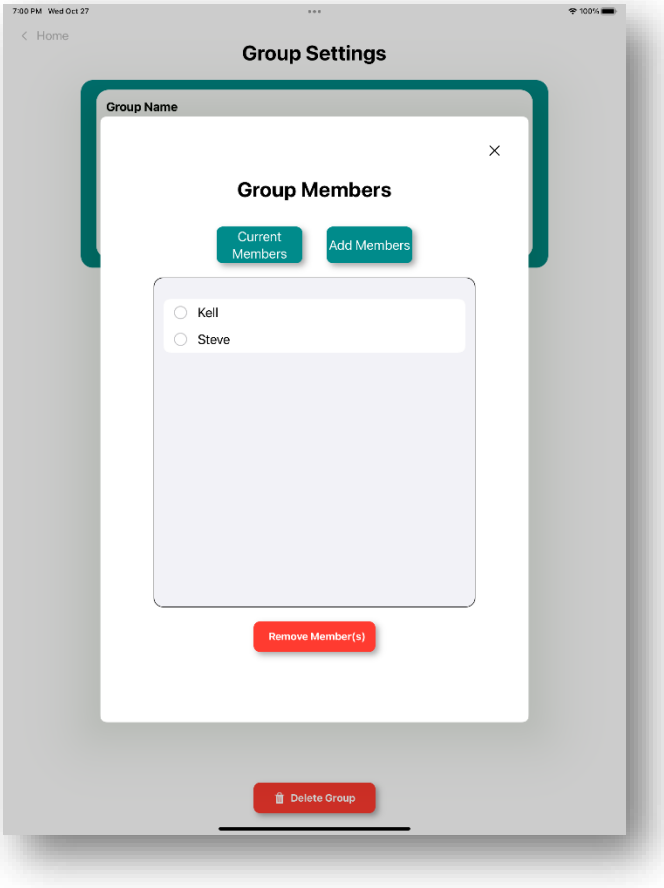


Figure 25: Group settings -> Edit Members

Accessing Group settings is easy – just tap the Group button and hold until you see the menu. Tap settings, and you'll be greeted with a settings page that is very similar to the User Settings View. The second image shows one of the options within the settings page, called "Edit Members". In this pane, you can add and remove Team members from the Group.

Create Session

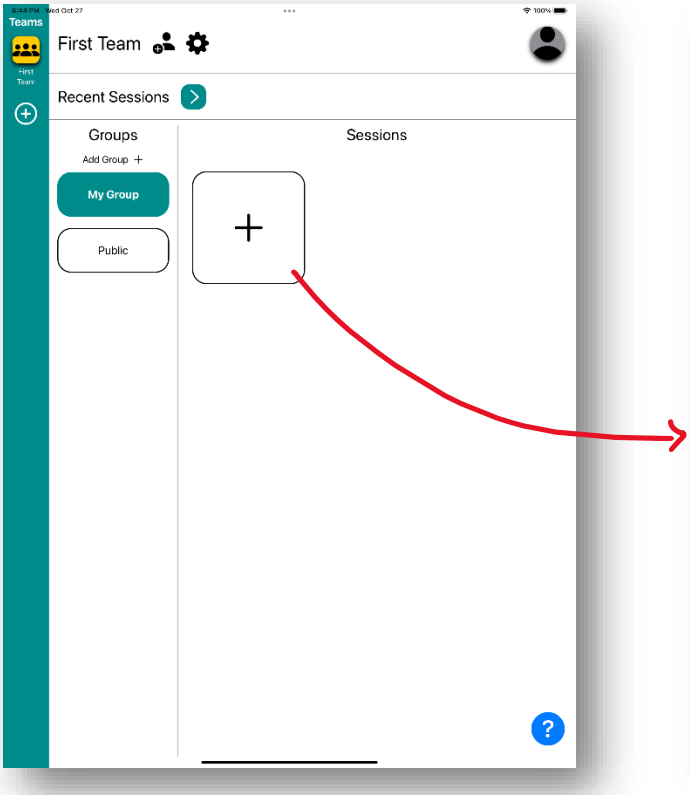


Figure 26: Create Session button

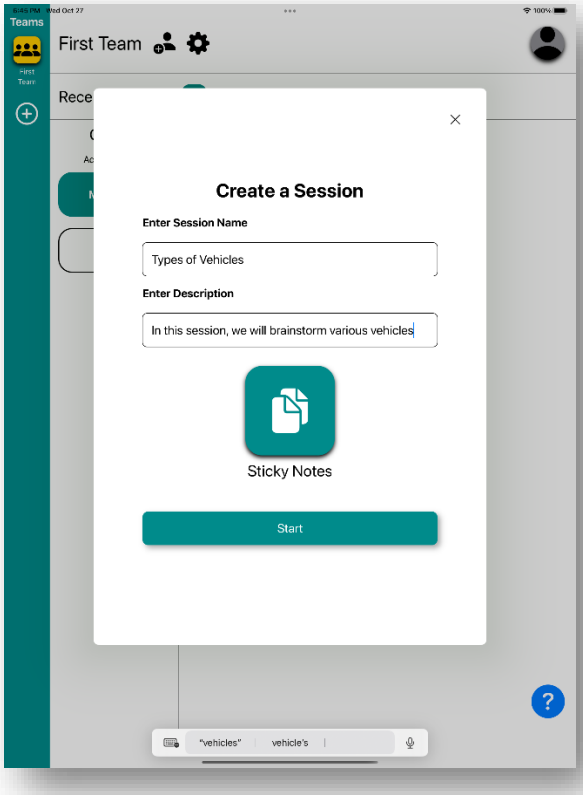


Figure 27: "Create a Session" interface

Similarly, to creating a Group, a user may then create a Session. We'd like the ability to do this to be locked behind a permission within the Group's settings, but that currently isn't implemented, so all group members can create Sessions by default. Upon clicking the big + button (which we intend to replace with a more elegant button), users will be greeted with another form for creating a Session. This form will offer various Activity types a user can choose from (currently, we only offer the Sticky Notes Activity). An Activity defines the features, tools, appearance, and flow of the ideation exercise it defines.

In this example Session, I'll be brainstorming different types of vehicles with sticky notes!

Session View – Sticky Notes – Stage 1: Ideate

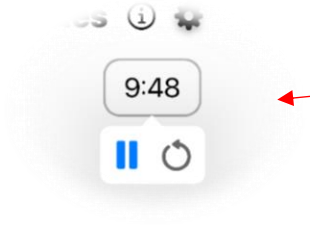


Figure 28: Tapping the timer as an admin in the Session View will show options for pause/play/restart

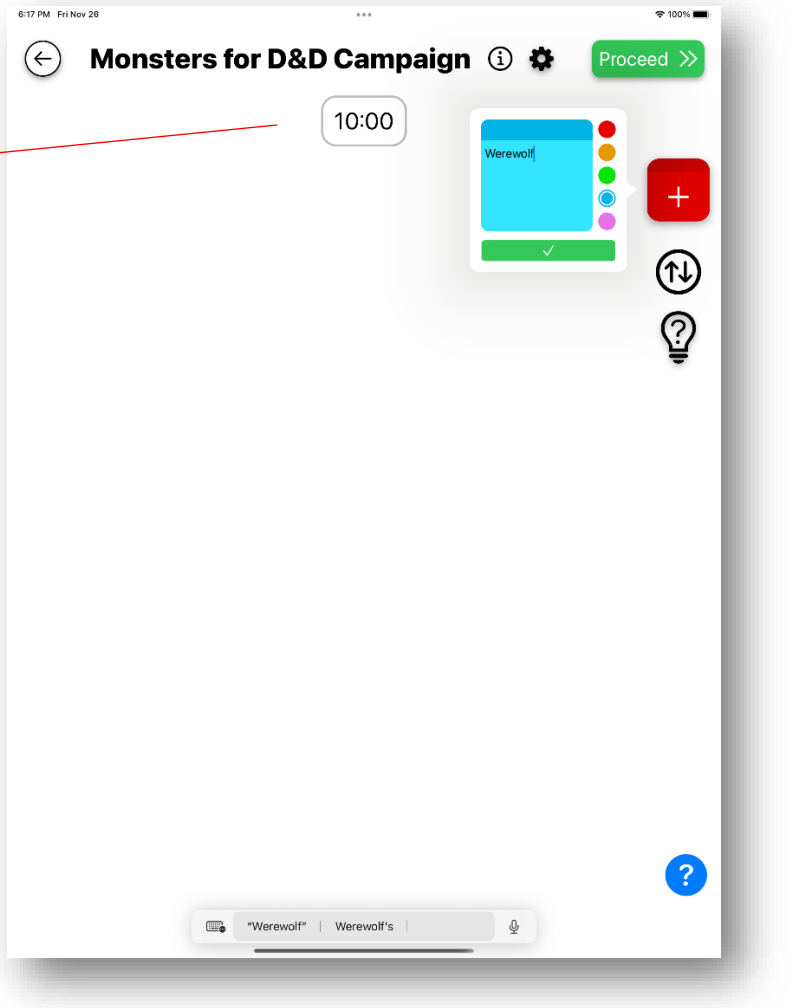


Figure 29: New Session View with sticky note creation interface open

Upon creating a Session, users are taken to the Activity screen where they have access to a simple interface providing the tools for what they need to do. This screen can be manipulated by the Apple Pencil. Tapping the sticky note icon (1) will allow a user to enter text, edit its colour, and tap the checkmark to submit it to the screen. After submitting a sticky, this interface will remain open in case the user would like to enter another sticky note quickly. The changes made to this screen are reflected for all viewers in real time.

Here, admins have special tools that nobody else can see. They can tap/manipulate the timer at the top of the screen, adjust settings for the Activity via the settings gear button, and forcefully move the Activity to its next stage by tapping the green "Proceed" button in the top-right corner of the screen. By default, once the timer runs out, the Activity moves on to the next stage.

Session Settings

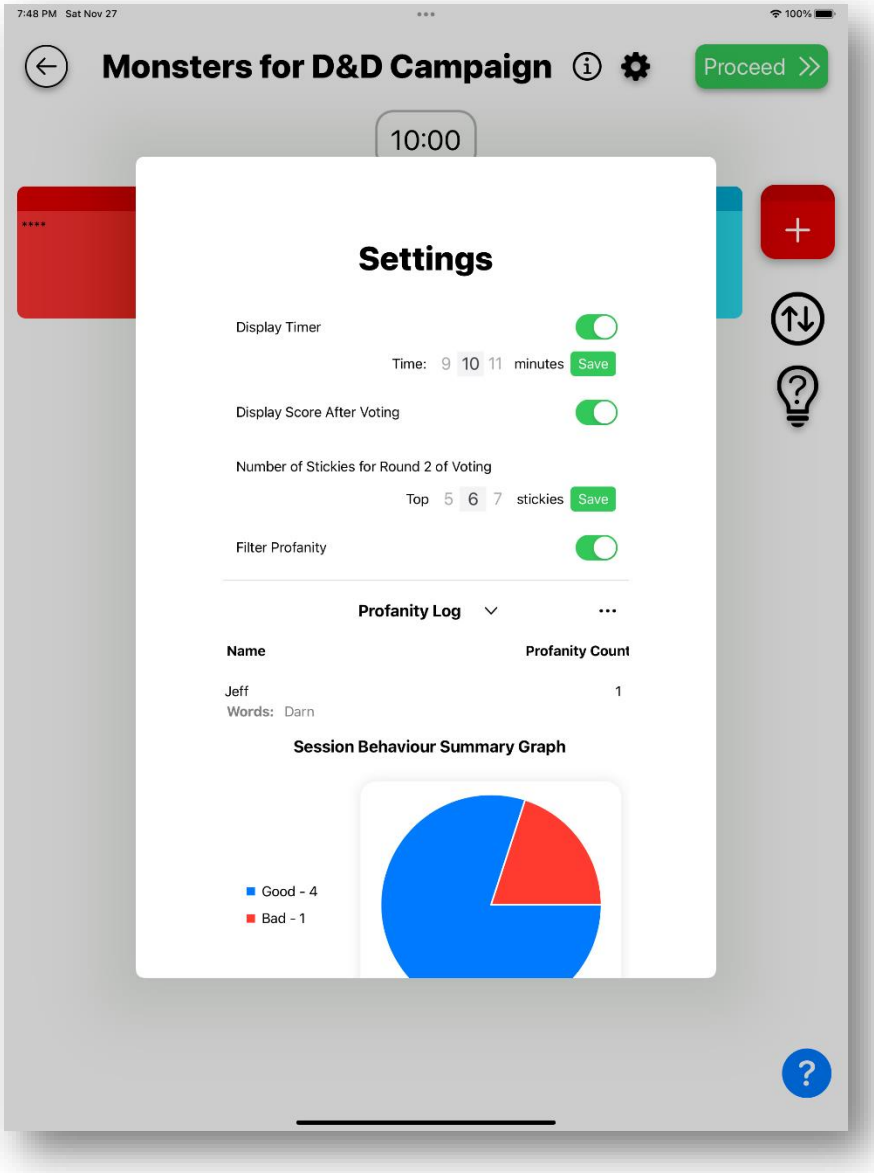


Figure 30: Session Settings View

Tapping the gear at the top of the screen as an admin will bring you to this settings page. Here, you can adjust the behaviour of the Activity. Additionally, if profanity is a concern for you or your users, you can enable the profanity filter. This feature also tracks who uses profanity within the app, so it is particularly beneficial to teachers who need to keep tabs on the behaviour of their students.

Note: The graph in this page currently just shows the ratio of stickies with profanity vs without. In the future, it will be more useful.

Sticky Notes (w/ Idea Generator)

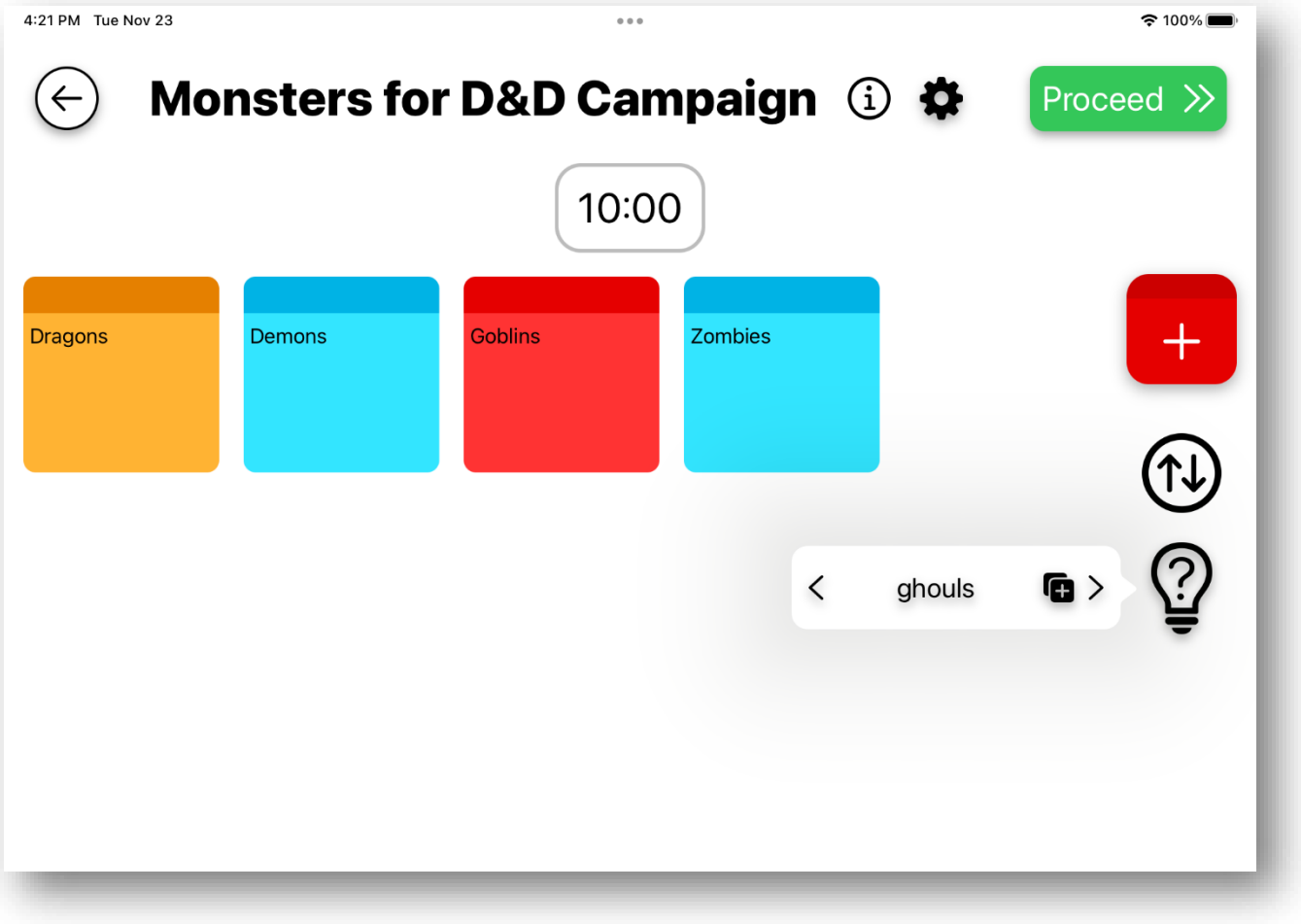


Figure 31: Session View with Idea Generator active

Once a few ideas have been placed onto the board, users can tap the Idea Generator button (light bulb) to produce a list of new ideas. Pressing this button extracts all of the text from sticky notes on screen, filters/pre-processes the text, and sends it as a query to a Google Cloud Function. This function executes Python code that further processes the inputs (getting pluralized versions of each word, as well as capitalized versions) and generates a list of the most similar words to that entire list by finding the converging point of all of the words' vector representations in a Word2Vec embedding. The most similar words are discovered by extracting words with vectors nearest to the converging point in the vector space.

Users can tap the word to insert a sticky note with the respective text or dismiss the popup.

Sticky Notes – Stage 2: Voting

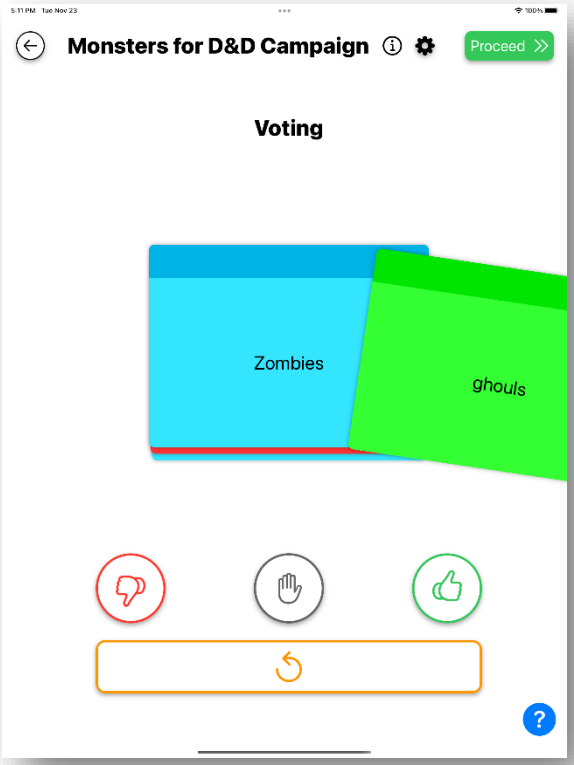


Figure 32: Voting Stage - sticky notes are stacked and user can swipe left/right to upvote or downvote ideas

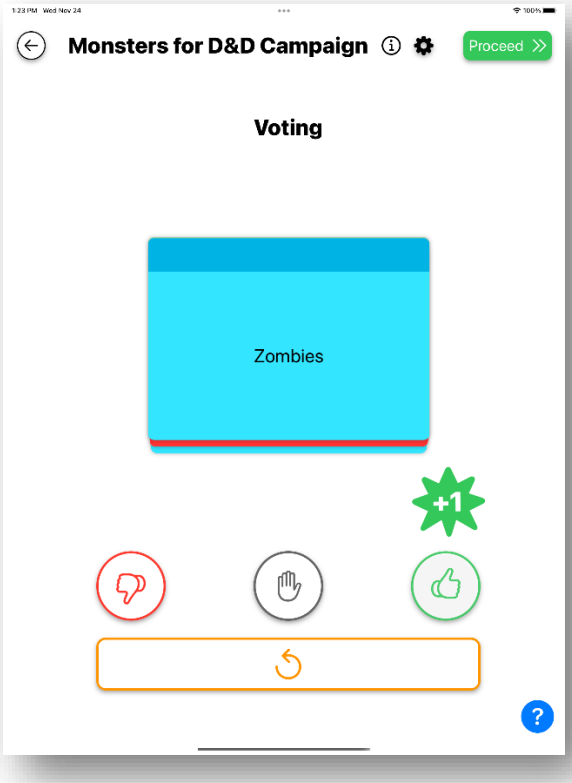


Figure 33: Animation appears after casting vote

Once the first (ideation) stage is done, we move on to the Voting stage. Here, users can expect a Tinder-style interface where they can swipe right to upvote, left to downvote, or tap the middle to skip. The buttons below serve the same purpose. Users can tap the bottom button to revert votes if they made a mistake. Once all stickies have been voted for, the user must wait for all others to finish voting as well. Alternatively, the admin can press the green "Proceed" button in the top-right corner to move on to the next stage any time.

Sticky Notes – Stage 3: Final Vote

Figure 34: Final vote, user casts a single vote

Figure 35: Result once everyone has voted

In the 3rd and final stage, users are presented with the top *n* number of stickies, where *n* is defined by the admin in settings. Users may case one final vote each, and the top vote(s) will be presented once everyone is finished, or the admin proceeds using the green button in the top-right.

Chatbot View

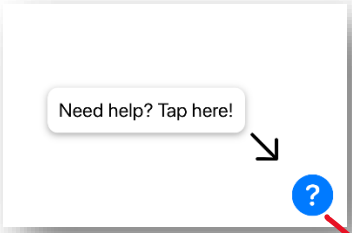


Figure 36: Chatbot button in the bottom-right corner of the Home View

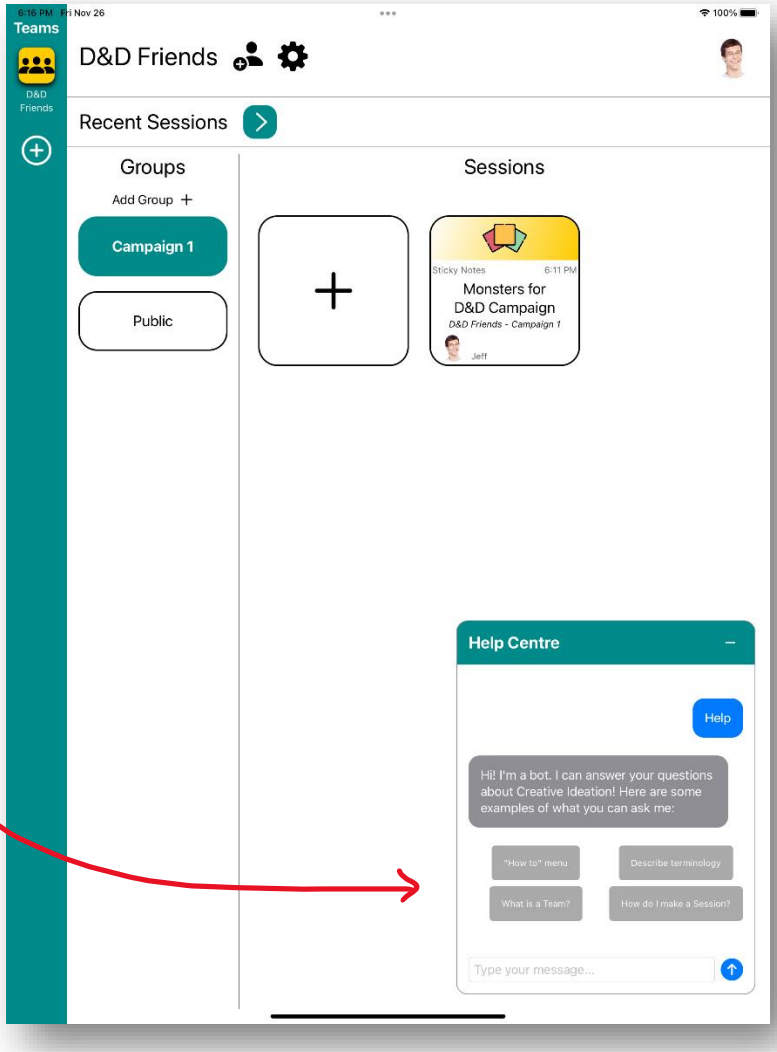


Figure 37: Home View with chatbot active

If the user ever needs help, doesn't understand something, or needs to know how to do something, they can ask the chatbot. From the Home View, tap the question mark button in the bottom-right corner of the screen, and the chatbot will appear. By default, it will ask the bot for "help" upon opening it. The user can tap options returned by the chatbot to save time or type a message themselves!

PROJECT ARCHITECTURE

This section will discuss the software architecture of Creative Ideation, from architecture design down to deployment.

ARCHITECTURE OVERVIEW

Creative Ideation is an Event Processing System – more specifically, an Editing System. The Editing System reference architecture describes a system that is meant for collaboration between users, provides rapid feedback to user actions, is responsive and easy to use. The fundamental structural organization schema is expressed by a layered architecture pattern, as our system appropriately fits this pattern. Creative Ideation benefits from a layered pattern because the app is designed to work on multiple screen types/devices, and the simplicity of the pattern is complimented by the Model-View-View Model (MVVM) structural design pattern.

Software System Architecture Diagram

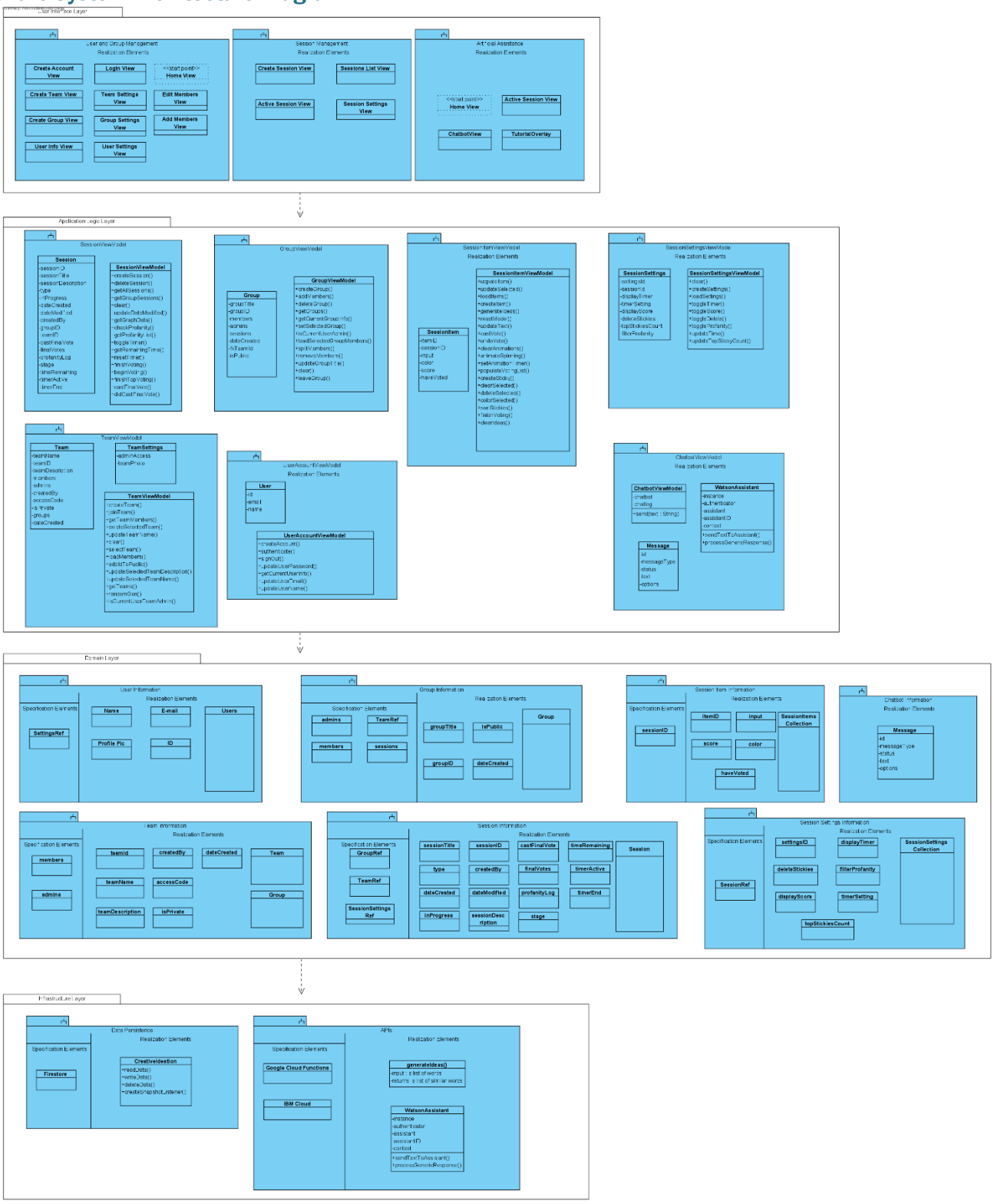


Figure 38: Software System Architecture Diagram

SYSTEM COMPONENTS AND DEPLOYMENT MODEL

The deployment of Creative Ideation takes place on a single mobile platform, the Apple iPad. This device can make use of the Apple Pencil. The app's real-time collaboration features are enabled via Google's Firestore database. The iPad also reaches out to Google Cloud Functions which houses our Python application that makes use of a pre-trained Word2Vec embedding. Lastly, the iPad also connects to IBM Cloud's Watson Assistant to provide enable the chatbot within our app.

In the near future (prior to beta release), our app will also make use of Google Cloud Storage for saving images belonging to User accounts and Teams (profile pictures).

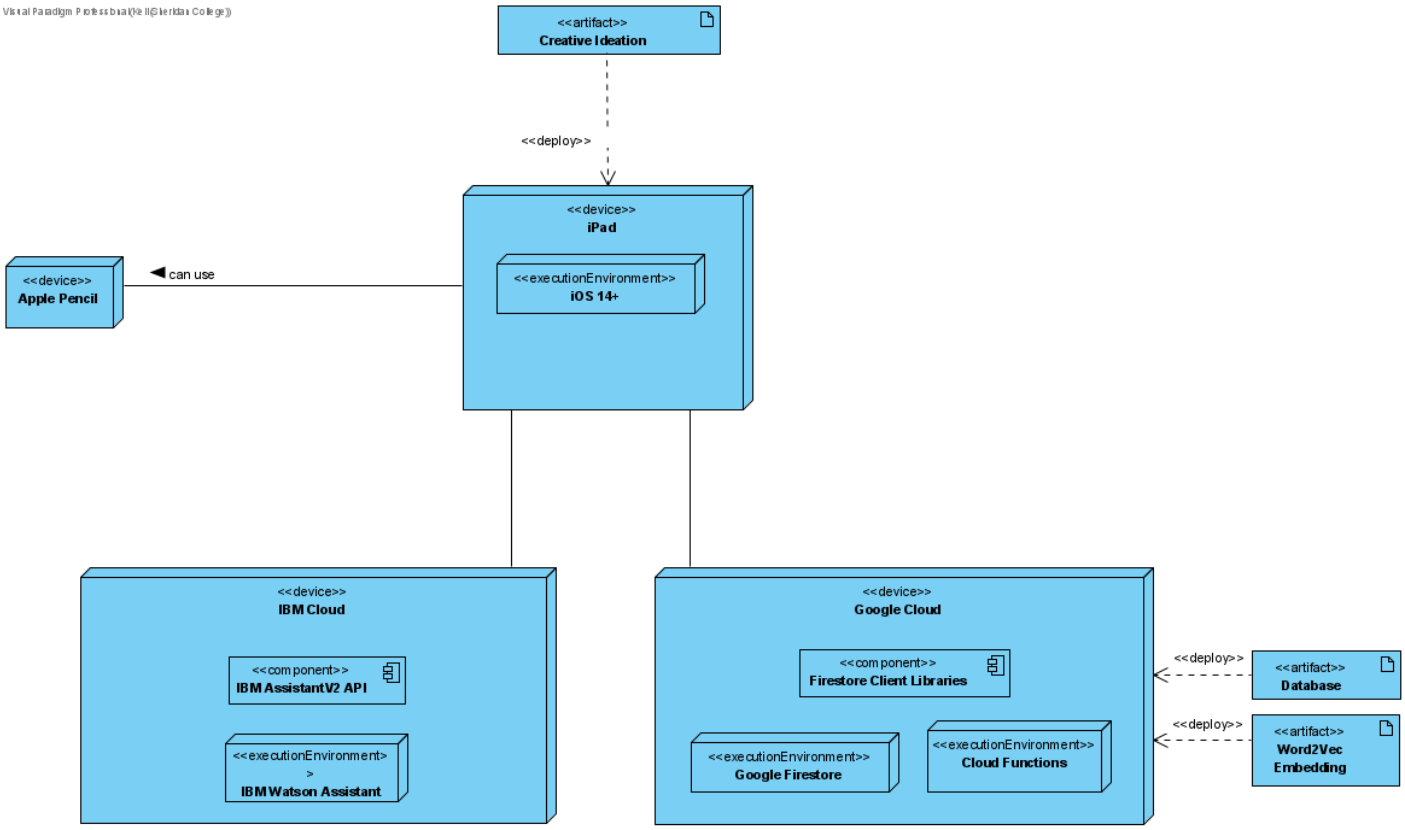


Figure 39: Deployment Model

PROJECT PLAN

This section describes the work breakdown structure of the project. Here, we will outline the distribution of work and roles, as well as how we managed and organized our tasks, risks, and testing.

RESPONSIBILITY MATRIX

Project Responsibility	Kellen	Vanessa	Matt
Project Management			
Project Owner	✓		
SCRUM Master			✓
Risk Analyst	✓		
Requirements Engineering			
Requirements/ Business Analyst	✓		
Functional Area Champion	Artificial Assistance	User & Group Management	Session Management
User Experience Design Lead		✓	
Software Architecture			
Software Architect			✓
Requirements Model Lead	✓		
Domain Model Lead	✓		
Design Model Lead			✓
Deployment Model Lead		✓	
Interaction Model Lead			✓
Construction			
Full-Stack Developer	✓	✓	✓
Integration/ DevOps Lead			✓
Testing			
QA Lead	✓		
Verification & Validation Champion (by functional area)	Artificial Assistance	User & Group Management	Session Management
Test Model Lead		✓	
Support			
Tools and Devices Support		✓	
Communication Support	✓		

ITERATION PLAN

The following table lists the sprint iterations defined in our Project Management Plan, and a brief description outlining the work completed.

Table 1: Iteration breakdown

SPRINT	DATE	GOAL
1	Jan 18th	Team orientation
2	Jan 25th	**Project Plan**, configuring JIRA with necessary projects, begin filling backlog
3	Feb 1st	Requirements modelling, use case modelling, UI wireframes, technology testing
4	Feb 8th	Create detailed wireframes, begin developing basic functionality
5	Feb 15th	**Inception Release**
6	Feb 22nd	Reading week, get head-start with Architecture Release
7	Mar 1st	Begin Architecture Release officially
8	Mar 8th	Begin implementing DB operations within app, macOS support
9	Mar 15th	**Architecture Release**
10	Mar 22nd	(2-week) – Begin Elaboration Release (implementing left-over features, bug fixing)
11	Apr 5th	(2-week) – **Elaboration Release**, Defence preparations
12	Apr 19th	**First Defence**, begin planning next term's iterations
13-16	July – Sept	Summer work: added Dark Mode, voting feature, DB optimizations, UI optimizations
17	Sept 13th	**Project Plan Revision**, begin software model revisions, begin development of core Activity features
18	Sept 20th	Continue implementing core Activity features
19	Sept 27th	Finalize core Activity features, begin implementing settings views
20	Oct 7th	Implement chat bot, profanity filtering/tracking, QR code scanning, bug fixes
21	Oct 13th	**Software Design Model Revision**, update risk documentation, bug fixes
22	Oct 18th	**Alpha Release**, modifications to Idea Generator, major UI changes to sticky notes
23	Oct 25th	Reading week, bug fixes, software design document updates
24	Nov 3rd	(3-week) **Software Test Plan**, long sprint to make up for reading week + exams
25	Nov 22nd	**Beta Release**,
26	Nov 29th	Defence preparation, cohort presentation
27	Dec 6th	Exam week
28	Dec 13th	**Final Defence, Final Release**

RISK MANAGEMENT PLAN

Listed below are the most pressing risks we've identified throughout development, and mitigation strategies for each:

1. **SwiftUI infancy and limitations**

   SwiftUI is relatively new. Additionally, none of our team members were familiar with the toolkit at the time of project inception. Being a declarative language, SwiftUI is difficult to get used to, as most languages we're familiar with are imperative. SwiftUI was chosen as the primary UI toolkit for numerous reasons: it is new and exciting, it is poised to have high potential and prevalence in future job markets, and it offers modern UI components and a pleasing aesthetic that suits an app like this. Choosing SwiftUI is a risk because it comes with its own app life cycle, and benefits greatly from the MVVM design pattern – so the selection is fairly irreversible as one decision leads to another.

   Mitigation: The best approach to mitigate concerns with SwiftUI is to invest extra time in familiarizing ourselves with it. Third-party educational resources can be purchased in order to provide ourselves with the necessary base knowledge to get started and ensure that this was the correct direction to take the project.

2. **Appropriate database selection and structure**

   Creative Ideation is the first application that our team will develop that relies on real-time collaboration features. In other words, we require a database that can handle transactions of data instantly and reflect that information on all connected devices without delay. This decision is important, as it is best to stick to a single cloud provider to serve our database and cloud computing needs (fewer SDKs to deal with and better compatibility). The database we choose needs to be suitable for an app that requires clean organization, and able to meet performance requirements.

   Mitigation: Our app requires an organized database structure. Being most familiar with relational databases, taking that approach is a safe option for enabling the User, Group, and Team-based features of our app. However, we also require real-time data transaction features. The best approach to mitigate the risk of making a poor decision is to research database services that offer real-time features yet have a familiar enough structure that we won't become overwhelmed with a new learning curve.

3. **Appropriate target audience selection**

   It's important to have a clear target audience as we define requirements for the application. The initial inception for the project is broad and insists that such an application could serve *anyone*. We should instead be clear about who this application is for and narrow the audience to better serve them.

   Mitigation: Our approach to mitigate risks involving target audience selection is to listen to feedback from domain experts and critics of our app. Restricting ourselves to our own perspective of who we think the app

should serve can be an irresponsible approach. While we do think the app should remain a generalized tool, we can offer additional features for potential users who we deem would be part of a beachhead market (E.g., profanity monitoring for classroom use).

4. **On-screen clutter**

   Ideation activities are often very busy and cluttered when attempted in real life. In order to replicate these processes digitally, we need to provide and interface that gives users plenty of space to work. UI design is critical.

   Mitigation: To mitigate on-screen clutter risks, we should embrace the fact that we will need to revise our UI numerous times before settling. We should do our best to take inspiration from successful applications with clean user interfaces, and carefully plan UI design from there. Our UI could be evaluated on a weekly basis by our supervisor.

5. **Multi-platform support**

   Capstone requirements expect projects to develop a product that supports numerous platforms. After judging the risks of the proposed solution, it may be extremely challenging to create a sibling application on another platform (E.g., Android).

   Mitigation: By selecting SwiftUI as our UI toolkit, we can write code that allows our app to run on nearly all Apple devices. As for platforms other than Apple, we are unable to allocate enough time to fulfil that requirement.

VALIDATION AND TESTING

This section provides an overview on the testing process we followed, and the validation results respectively. The Testing Strategy section outlines the high-level overview of the plan used to test the system, identifying tools, and frameworks used. The Validation Results section describes the state of the project upon completion of testing. This document does not cover the steps taken to realize each test case – that information can be found in the Software Test Plan Document.

Jira Test Plan link: https://mvk-capstone.atlassian.net/jira/software/projects/TP/boards/3

TESTING STRATEGY

The testing strategy employed by our team to validate the system included unit testing, integration testing, automated UI testing, and manual system testing. Admittedly, the majority of our testing was performed in the later stages of the project due to time management issues. As a result, we were unable to create unit tests for functions of our application that relied on database interaction (E.g., Firestore, Cloud Function). Instead, we wrote unit tests to validate the code that manipulates data without API calls. Unit tests for the iPad application relied on the XCTest

framework, and the framework used to test the Idea Generator's code was Python's unittest framework. Manual system testing was performed to ensure the application operated as expected.

For all functional areas other than Artificial Assistance, test suites were designed to test the view models associated with the functional area, rather than testing by use case. By following the MVVM design pattern, each view model coincides with a functional area that can be tested to validate all containing use cases.

User and Group Management Test Plan

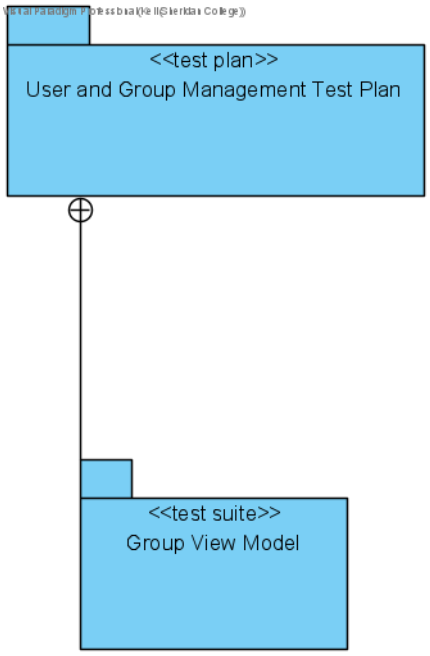


Figure 40: User and Group Management Test Plan - unit testing was performed for Group View Model offline functions. User Account View Model had no offline functionality.

Group View Model Test Suite

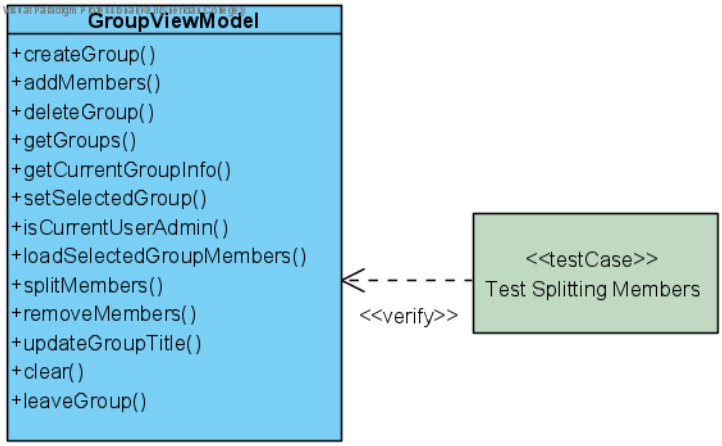


Figure 41: Group View Model Test Suite - single function tested.

Session Management Test Plan

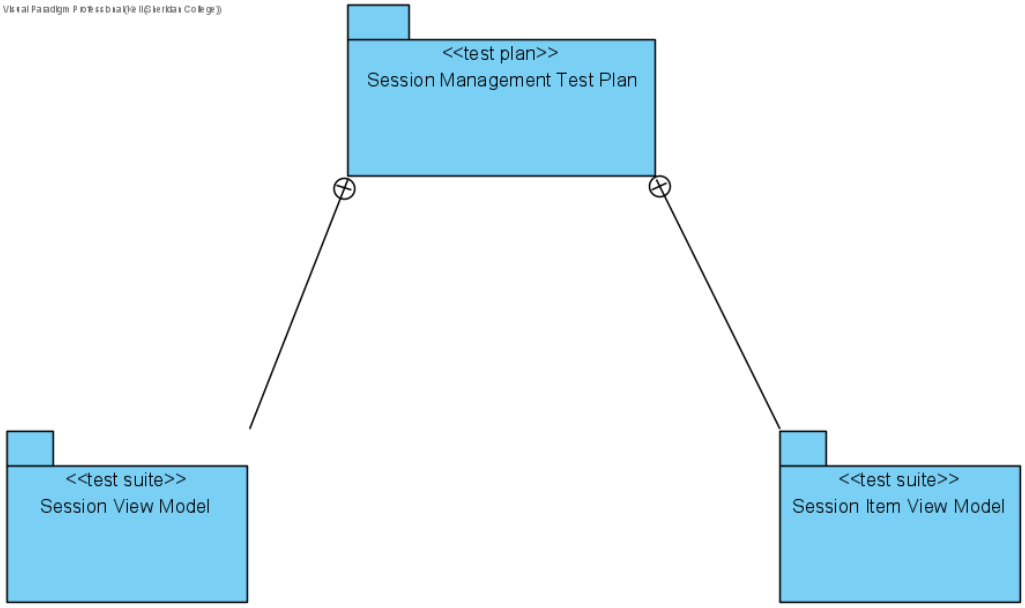


Figure 42: Session Management Test Plan

Session View Model Test Suite

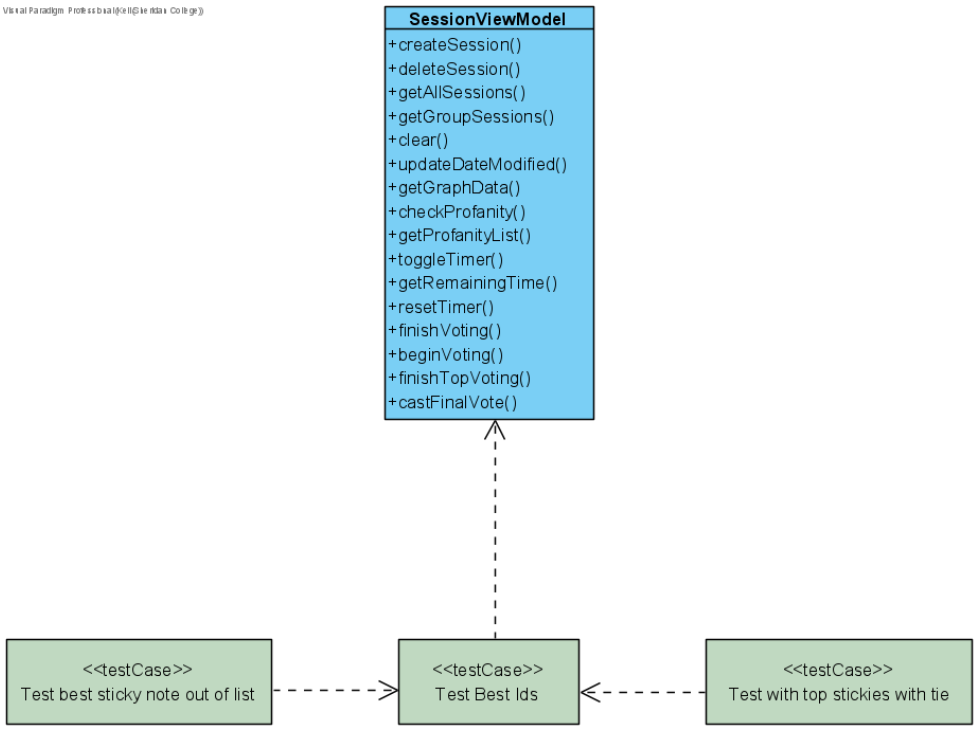


Figure 43: Session View Model Test Suite

Session Item View Model Test Suite

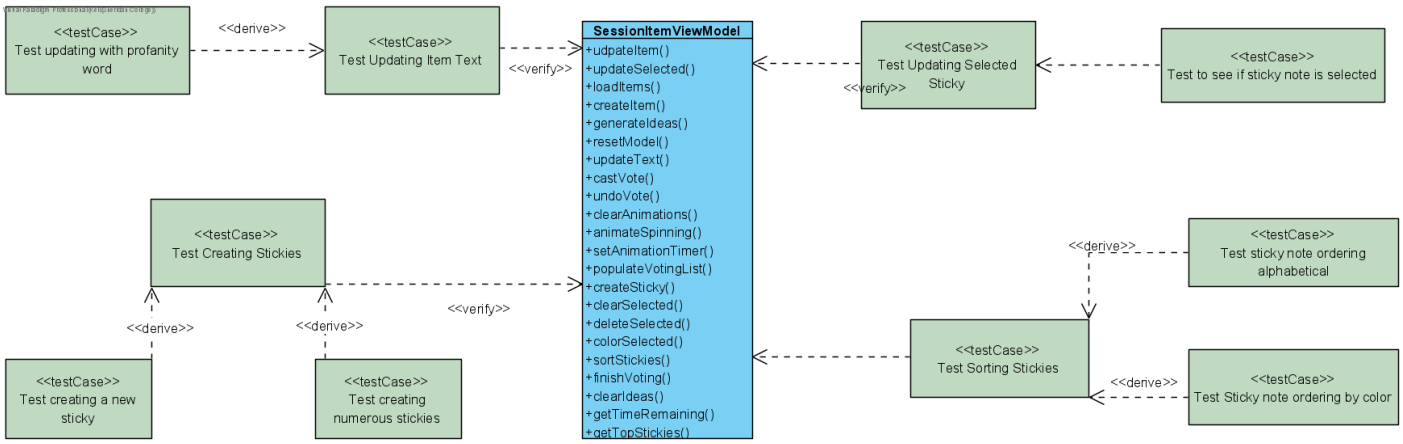


Figure 44: Session Item View Model Test Suite

Artificial Assistance Test Plan

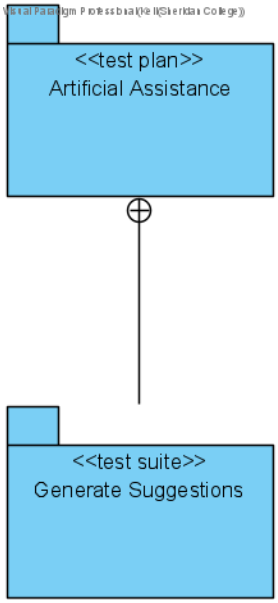


Figure 45: Artificial Assistance Test Plan

Artificial Assistance testing involved testing the Generate Ideas use case, rather than testing view models in their entirety like the previous FAs.

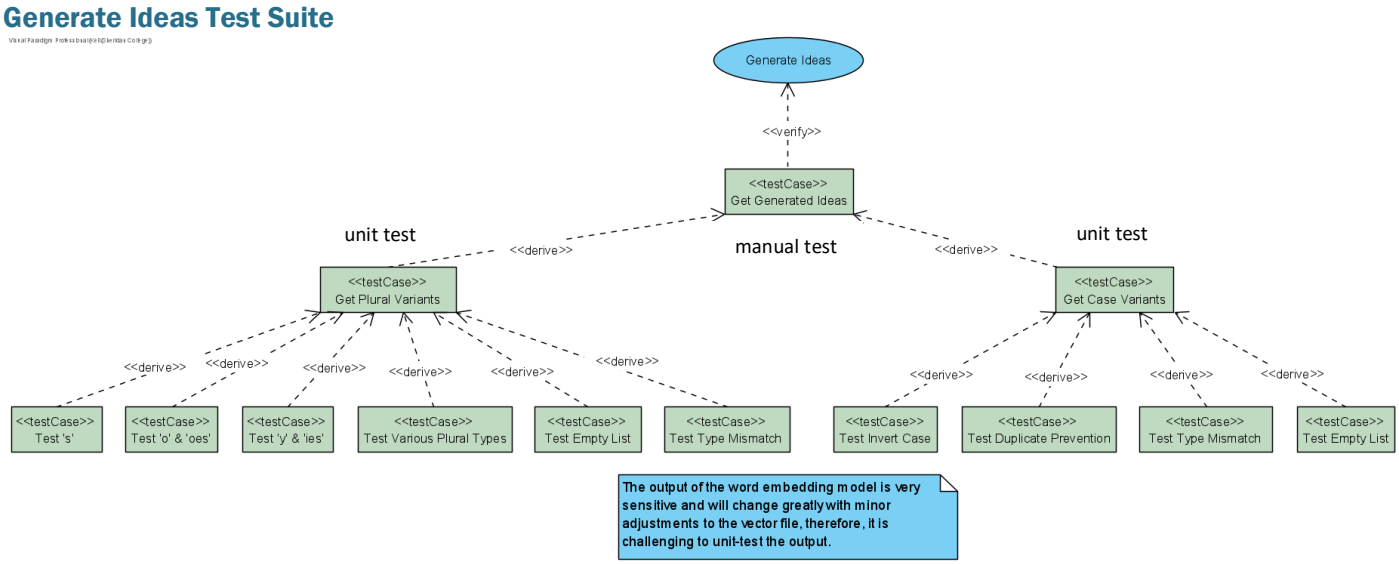


Figure 46: Generate Ideas Test Suite

VALIDATION RESULTS

Upon the end of the term, unit tests were executed and monitored. Automated UI testing was performed to ensure the application was navigable and functional, though there were some anomalous issues that arose that prevented us from automating all aspects of the UI. Manual testing was performed all throughout development to ensure the application functioned as expected. As issues and bugs appeared, they were recorded as *bug* tasks in our Jira Project Management Plan. Unit tests were recorded and monitored in our Jira Test Plan.

CONCLUSION

In conclusion, we developed a mobile tool that facilitates group-based ideation with features that enhance creativity. This tool positions itself in a market where mobile ideation tools are lacking in features and usability. Our application solves these problems with a streamlined user interface that makes it quick and easy to start and participate in an ideation session with a group. Our application was developed natively for the Apple iPad, taking advantage of device features such as the camera, Apple Pencil, and vertical and horizontal orientation support. This tool allows for a more portable, and less complicated alternative to traditional table-top ideation activities and averts the downsides of negative group dynamics.

Beta Release Demo: https://drive.google.com/file/d/1Xaa1iVyaH9H22fH5IWT2fFLiLqcd2A7T/view?usp=sharing

PROJECT SUITABILITY

We have successfully developed an application that meets the expectations proposed during inception. Our intention was to develop a mobile platform that could one day support numerous automated ideation activities, and this goal could certainly be achieved one day, as we've already demonstrated the use of a single activity. We've developed a

team-oriented interface, and a real-time collaborative environment with assistive AI tools that act as creativity catalysts. Having reached these milestones, we are confident in our project and its positioning for the future.

DOMAIN EXPERT EVALUATION

April 19th, 2021:

Our domain expert, Jennifer Phenix, has seen our application demo and has remarked that our progress and ideas are excellent, and that she is impressed with the amount of effort we have put forth.

October 14th, 2021

A demo was sent to Dr. Nathaniel Barr showcasing our ideas for the Sticky Note brainstorming Activity. His response was as follows:

> *"… from a technical standpoint this is well done and a useful app. In particular, I liked the voting mechanism- research on the value of electronic brainstorming shows that anonymous voting/idea generation can avoid the pitfalls of social pressure/loafing etc. and your platform ensures these benefits occur. I also very much liked the automated word association button you included-- that is a novel and creative addition to your tool, as far as I know. Not only might this sort of association yield new ideas itself, it could spur new thinking that inspires human contributions they might not have otherwise. I am quite keen on AI creativity lately, so thought this was probably most interesting piece. But in terms of the fundamental question as to whether it seems a viable tool for creativity and ideation- it does!"*
>
> Dr. Nathaniel Barr

December 13th, 2021

Jennifer received our elevator pitch video showcasing progress from our Beta Release and noted that it appropriately solved the problems we identified. She praised the fact that we were able to condense the ideation process into a mobile device and overall liked the product we developed.

FUTURE WORK

Short Term

- Additional UI optimizations (E.g., allow for adjusting Session settings prior to starting it).
- Improve NLP model for Idea Generator to better find similarity in seemingly unrelated words.
- Make profanity monitoring more useful with graphing features.
- Add automated timers to voting stage of Sticky Notes Activity to prevent the Team Lead from having to manually progress to next stage.
- Enable the ability for users to sign in with their existing Google account.

Long Term

- Add ability to toggle whiteboard style (E.g., re-implement loose sticky note maneuvering and allow users to choose between that and a more grid-based design). This feature was developed earlier, though later dropped in favour of a grid approach due to SwiftUI limitations.
- Add voice chat to allow for remote ideation.
- Reinstate macOS application to expand user base. This prevents people from being left out if they have a MacBook and not an iPad.

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