Grand Valley State University
Padnos College of Engineering and Computing

N-DROPP
UX Design and Evaluation

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1. Design Team

Mario Galeno – Data Analyst

Mario was in charge of creating the graphs and tables from the data gathered from the usability testing. He also wrote up the evaluation section and added the necessary graphs for further explanation.

Matt Lukasiewicz – Evaluation Analyst

For the final phase, Matt reviewed the results of the high fidelity prototyping and decide how future testing would go. Also talked about the lessons that the group learned and what is being taken away from the experience.

Kyle Peltier - UX Manager, Technical Writer

During the final phase of the UX design, Kyle reviewed the entire UX Design and Evaluation report, from start to finish. Kyle made many necessary modifications to the document to enhance its overall meaning, integrity, and clarity of the design process. Kyle also participated in the final design phase by contributing to the Evaluation Results (8.1) and Conclusion (8.3) sections.

Matthew Williams - Graphic Designer

Matthew's role in this phase was to review the evaluation notes from the latest evaluation and decide what further changes need to be made. Matthew did this and also created new mockups to show what the projected designs would look like. He also was involved in the write up of the design changes.

2. Product Concept

The Product Concept phase of the UX design process is meant to introduce the application and explain its basic and detailed functionality. UX design, or designing for the user experience, is a crucial part to the success of an application. Integrating application functionality with a simple GUI contributes to the user's overall experience, where the desired experience is a positive one. This document outlines the UX design process performed when developing the ideas of the application.

The Concise Product Description (2.1) introduces the basic purpose and functionality of the application whereas the Product Concept Statement (2.2) explains the high-level overview. Concluding this phase are the Technical Summary and Product Features which go in depth with proposed application functions.

2.1 Concise Product Description

Product Name:	N-DROPP (NCDA - Dodgeball Referee Officiating Application)
Audience:	NCDA dodgeball referees and players
Function/Purpose:	Assist dodgeball referees in officiation of a match and to help officials document game statistics easily
Desired UX:	Easy and quick way to keep track of in-game statistics as well as provide fluent assistance in officiating dodgeball games
Platform:	Android (mobile) Application

"*The N-DROPP Application will provide a quick, easy to use, and fluent mobile Android environment to help NCDA referees officiate dodgeball matches.*"

2.2 Product Concept Statement

The N-DROPP application will be a free Android application that will be available to all NCDA officials and the general public. This app will provide an easy-to-learn, intuitive user interface that will allow on-the-go functionality vital to officiating NCDA matches. A clean GUI will allow the officials to see the current game time and each team's shot-clock. Penalties can be easily assigned to offending players and provide minimal distraction to the official. The built-in whistles will also provide an alternative to traditional whistles and will stop the game time when necessary. Product settings will allow officials to customize the application to suit their needs. Officials will also be able to review statistics from the games they officiated. With this application, stalls in games will become less frequent because of the app's ability to easily report and manage common game information.

2.3 Technical Summary

The N-DROPP application will be a free dodgeball-referee application available on the Google Play Store. Other referee applications exist on the Google Play store (such football and soccer referee apps) but none of them are specific to the game of dodgeball; The N-DROPP application will be the first of its kind in the sport of dodgeball as well as the first mobile application to support the NCDA. The design team will use the Eclipse IDE and AVD Emulator to construct and critique the dodgeball application.

The application is packed with many useful tools and a lot of useful information about the game of dodgeball. For this reason, the android application will be separated into two modes. Gameplay mode contains any tools and information that are necessary during a dodgeball game. The other mode will include any miscellaneous tools and information that a user will reference at their own leisure (game statistics, history, etc.)

The main purpose of the application is to assist referees in officiating dodgeball games. For this reason, users will likely navigate to the gameplay screen. This screen contains various timers, whistles, and penalty cards that will be accessed by the officials. It is our main priority to design this screen to be as minimal and efficient as possible.

The whistle is one of the features that we expect to be used the most. Any sport is not a sport unless we have referees or coaches blowing whistles. Whistles are universally known to stop gameplay. N-DROPP's whistle button will sound the built-in whistle as long as the button is pressed down. The app comes with various versions of whistles and buzzers that the user can customize.

Referees can have 2 timers running at the same time. Each timer can count up or down. For example, one timer might count up to keep track of the game timer, while a second timer counts-down for a shot clock. Count-up timers may also have an upper limit or continue on as the user deems necessary. As we mentioned these timers can be linked to the whistle or any additional sound that may be needed to sound when the lower or upper limits are reached.

Of course, the app will support a score counter for each team. The referee will be able to increment scores easily with simple increment buttons that will not hinder the other features of the application. Likewise, each team will have a certain number of timeouts at the start of each half. The referee will be able to easily decrement the number of timeouts of each team as gameplay progresses.

A final feature is the penalty card displays. The user can select either yellow and red penalty card markers. When either option is selected, the screen changes the whole background color to the specified option. The referees can then wave it in the air so the players can see their ruling.

Dodgeball games are fast paced and change on the fly. That is why the team's goal is to make it easy for the user to learn and use. The clock is can be easily manipulated at any time during a game. N-DROPP's display is intuitive and always conveys information about the current state of a game (number of players, scores, game time, etc.). The default sounds are a whistle for a count-up timer and a buzzer for a count-down timer. These may be changed by going into the settings menu.

The non-gamemode screen has several features; current features include settings changes, history/statistics, and additional product information. Additional features may be included as development persists.

2.4 Product Features

- Timer
  - Official game timer
  - Shot clock timer
    - #Players > 5 : 15 seconds
    - #Players <= 5 : 10 Seconds
  - Allow for editing the clock (pause, rewind, fast forward, and set)
- Whistle
  - Time-out whistle
    - automatically stops game timer
  - Push-down whistle
    - whistle blows for as long as the button is held down
- Penalty
  - Yellow Card
  - Red Card
  - Shot clock-violation
  - Allow user to enter player # and team to document penalty
- Team Score count
  - Keep track of each team's score
- Time-out Count
  - Keep track of how many timeouts each team has left
  - For time-out events, denote which team called the timeout or if it was a ref, time-out
- History
  - The history of the current game can be queried and the screen will show a timeline of events that occurred during the match (which team scored a point and when; When an individual received a penalty; when a Shot clock violation for a team occurred; etc.)
- Statistics
  - Display match statistics/history at game completion
- Information Page
  - Display App Info (Version, Date Installed, etc)
  - Basic game rules
- Settings
  - Whistle Sound
  - Volume
  - Vibration
  - Buzzers/Flashers/Noise-Makers (time-outs/shot-clock-violation)
  - Set default number of time-outs
  - Set default half times (25 minutes)
  - Shot clock timers: count-up or count-down
  - Shot clock timers: audible count
  - Home team orientation (Left or right) / Away team orientation (Right or left)

3. Contextual Inquiry

Contextual Inquiry is the step in the design phase where the design team researches the target audience of the N-DROPP application. Research includes observing dodgeball games, asking users to fill out surveys, interviewing individuals with credible knowledge, etc. All of these methods help the design team understand the user's mental model of the system. The user's mental model is the user's perspective of how a system should operate. Understanding this will help the design team enhance the user's experience with the new application. Section 3.1 describes the individuals the design team wishes to poll, called targets. Questions to ask the targets are listed in section 3.2 Inquiries. Finally, an additional focus group of hockey parents were interviewed with questions listed in section 3.3.

3.1 Inquiry Targets:

Target individuals for contextual inquiry include:

1. People that have experience refereeing a dodgeball game (head ref, assistant ref, shot clock official, or score-table)
2. Dodgeball players (collegiate players and recreational players)
3. People that have officiated a sport or have run a score-table
4. General public

For our surveys and interviews, players, referees, shot keepers, etc, were obvious people to target. These individuals would provide pertinent information about how a referee-application "should" operate - how the application should function in his/her perspective. Additionally, we wanted to get information from individuals who may have a similar perspective. For this reason, dodgeball players, individuals with officiating experience, and the general public should be targeted. With a larger target audience, we were able to obtain more information than if we limited ourselves to just people that were associated with dodgeball.

3.2 Inquiries

A detailed questionnaire appears in Section 9.1 of the Appendix. A brief listing of the questions that appeared in the survey are as follows:

1. My experience as a dodgeball player is…
2. My experience as a Head Referee is…
3. My experience as a Scorekeeper is...
4. What is the most time consuming task?
5. What is the most frequent task?
6. How frequent is that task?
7. What are your most time-critical tasks?
8. What is your most important responsibility
9. Are there any inconveniences you experience as a referee?
10. Additional Comments (What would you like to see a mobile referee application do for you)?

3.3 Additional Observations

A group of hockey parents were interviewed as well for the contextual inquiry. Questions that were asked are similar to the 3.2 Inquiries, only changed slightly to gear their responses toward the purpose of our application. The goal here was to see if there was any additional information we could gather, not captured by the survey, that could tie in with our application..

1. Have any of you been a hockey player?
2. Have any of you been a referee for a sport?
3. Have any of you been a scorekeeper?
4. What is the most time consuming task for the referee?
    a. What is the most time consuming task that could become less time consuming with an app like this?
        i. Why do you think penalties are the most time consuming task?
            1. Would an app that live updated with the game, like the ones for professional sports, be something you would be interested in?
            2. If it cost $1, would you still consider downloading it?
5. What is the most frequent task?
6. What are the most time-critical task?
    a. How is whistling a goal a time critical task?
7. What is the refs largest responsibility?
8. What is the scorekeepers largest responsibility?

Is there anything you would like to suggest?

4. Contextual Analysis

Contextual analysis is the design phase that best helps the design team make informed decisions about how the application should be organized and constructed. During this phase, the design team observed responses of participants of the contextual inquiry (section 4.1). Work roles, or "positions" of the users who are expected to use the application, were constructed during this phase (section 4.2). Additionally, user classes, or relative descriptions of target users of the application were constructed (section 4.3). Using the constructed user classes, personas and scenarios were formulated - where personas (section 4.4) are fictional characters that take on a specific user class and scenarios (section 4.5) are fictional situations involving the personas. Section 4.6 Task Analysis lists proposed tasks a user would perform using the N-DROPP application. Tasks are meant to be fundamental and modular, essentially so the user could understand all aspects of the application. Finally, the work environment is the expected setting in which the N-DROPP application is to be used and it is described in section 4.7.

4.1 Work Activity

4.1.1 Contextual Inquiry Survey Notes

Results from the contextual inquiry are shown in Section 9.2 of the Appendix. This section's purpose is to conduct a summary of the results.

1. 97% of the respondents have played dodgeball before.
2. Of the 97% respondents who have played dodgeball, 77% of them have played college dodgeball.
3. 72% of the respondents have had experience being a referee at some point in their lives.
4. 66% of the respondents have run a score table before.
5. As a dodgeball referee, the respondents of the survey could not agree on the most time consuming task of a game. According to 37%, calling a player out is the most time consuming and the second most time consuming duty is managing the shot clock (29%).
6. Quite similarly as Note 5, 35% and 29% of the respondents thought that calling a player out and managing the shot clock are the most distracting tasks to complete as a dodgeball referee.
7. 46% of individuals deemed managing the shot clock the most frequent task during a game (every few seconds/a few times every minute). A close second was deemed calling players out (38%).
8. Individuals were asked what a referee's most important responsibility was on the court and the majority response was 60% for 'calling players out'.
9. Many responders wanted the application to have a rulebook readily available.
10. A number of respondents agreed that a stopwatch shot-clock would be a great way to ensure that each team's counter is in sync.
11. In the open-response question, many individuals noted that they get distracted from watching the game when players argue certain calls. This re-enforces the statistic that 35% of people think calling a player out causes the most distraction. Having a quick rulebook to settle the issue or a non-arguable whistle blow could help keep referees on task.

12. A respondent had an admirable note that the projected application would be great for tournaments. The in-game history will help referees to remember current-game statistics better.
13. A respondent noted that a rulebook would also be good to have for referee officials to become more familiar with the rules.
14. A few individuals noted that they may be more distracted by a mobile application than benefitted by it while officiating a game. This could lead non-visual options such as vibration and sound, taking less of the referee's visual attention.
15. Some respondents agreed that a built-in whistle would be beneficial, especially for use at practices.
16. A respondent suggested the application include a visual queue of knocked out players to help referees know the order in which players go back on the court when catches are made.
17. A respondent noted that the application's shot clock should be fast and smooth, making it quick and easy for the referee to reset the clock without taking much attention away from the game.
18. In addition to a rulebook, suggested features of rulebook management included search functions, filters, and categorization for easier rule look-up.
19. An answer to a free-response question suggested recording certain game scenarios where discrepancies unveiled. This way, captains and referees could go back and review these situations and make informed decisions. This is similar to the idea of recording event history of a game, however, this implementation would require more detail (and effort on the referee's part).

4.1.2 Hockey Parent Focus Group

1. Most of the dads were hockey players when they were younger, none of the moms were.
2. None of polled individuals had been a referee for any sport.
3. Nearly all of the participants had been a scorekeeper for a hockey game. (*The scorekeeper for the games are always two parents from the home team, because of this the answer was expected.*)
4. Most respondants agreed that faceoffs take the majority of a referee's time
    a. Penalties
        i. The referee has to get the correct player, bring him to the box, report the penalty, then signal what is was.
        ii. "I never even understand what the signal means anyway, it's just stupid"
            1. Participants all agreed if there was a free app that was a live updated of the game with what the ref was doing and the calls he made, they would download it.
            2. Nearly all of the participants said they wouldn't pay $1 for the app.
5. Respondents noted that stopping gameplay is the most frequent task.
    a. When asked to elaborate, calling offsides (*very frequent stoppage of play for hockeys games with younger kids*)
6. Calling a goal was noted as the most time-critical task of a hockey referee
    a. If it isn't blown quickly, the goalie or a player could pull the puck out of the net.
7. According to the focus group, the most important responsibility of the referee is to understand the rules (dads) and ensure the safety of the players (moms).

8. The most important responsibility of the scorekeepers are to write down the correct rulings of the official and correcting any mistakes the ref makes.
    a. When asked about mistakes a ref makes, they said that sometimes a ref will give the goal / assist to a number that isn't on the team.
9. Application Suggestions:
    a. Somehow tie this app into the speaker system of the arena so when the ref makes a call, it is announced to all the spectators.
    b. Secondary app for spectators that updates with what is happening in the game.

4.2 User Work Roles

4.2.1 Head Referee

The head referee is the main referee on the court. He/she is in charge of penalties and making the final decision on any call given by the assistant referee and the shot clock referees.

4.2.2 Assistant Referee

The assistant referee is in charge of calling people out on the court, watching for potential penalties, watching the game clock, and making sure the game runs smoothly. He is second in charge behind the head referee.

4.2.3 Shot Clock Referee

The shot clock referee is in charge of keeping track of the shot clock and making sure at least one person on a team throws the ball before the shot clock is up.

4.2.4 Scorekeeper

The scorekeeper is in charge of keeping track of how many players are eliminated and how many players are currently out of the game. When an entire team is eliminated, they award a point to that team.

4.3 User Classes

4.3.1 Student Referee

Age:	18-23
Gender:	Male / Female
Technology Expertise:	Computer Science Major, very tech-savvy. Uses smart phone on a daily basis.
Domain Expertise:	1-year dodgeball veteran on the GVSU Dodgeball Club.

4.3.2 Dodgeball Alumni Referee

Age:	23-30
Gender:	Male / Female
Technology Expertise:	Familiar with most technical interfaces and able to perform basic operations.
Domain Expertise:	Played NCDA dodgeball for 4 years. Has been a referee several times throughout his/her collegiate career.

4.3.3 Shot Clock Referee

Age:	19-23
Gender:	Male / Female
Technology Expertise:	Basic experience with application, but does not master them. Stays with basic setup and does not explore the advanced uses of the apps.
Domain Expertise:	Spectates games once in a while but does not play.

4.3.4 Dodgeball Score-Keeper

Age:	19-23
Gender:	Male / Female
Technology Expertise:	Relies heavy on technology for daily activities. Able to learn how to new application quickly.
Domain Expertise:	Played dodgeball but has to stop due to injuries.

4.4 Personas

4.4.1 Rufus

Rufus is a 38 year old 20-year dodgeball referee veteran. He has plenty of experience officiating dodgeball games and he has significant experience as a Head Referee. He has always done things the "old school" way, so the introduction of this app has him annoyed and confused. Without a history of using the latest and greatest technological advances, he is a slow learner and stubborn.

4.4.2 Joey

Joey is a 25 year old college graduate that played for the NCDA when he was in college. Playing so much while attending college made him want to be an official of the sport that meant so much to him during college. He is starting out as a shot-clock referee. He is very tech savvy and a quick learner, which allows him to quickly figure out how to use the app.

4.4.3 Olga

Olga is a 20 year old college undergrad. She grew up watching her brothers play dodgeball and loves the sport. Unfortunately, due to her tendonitis, she is not able to play the sport. For the love of the game, she volunteers as a scorekeeper during tournaments and games. Although it is less dangerous than playing, it becomes difficult to write the scores when her hands are inflamed. She relies very heavily on technology to make her life easier.

4.4.4 Gertrude

Gertrude, Olga's older sister, is a 23 year old graduate student. She had attended dodgeball games before to watch her family play, however, she never picked up the sport. She understands the basic rules of the game but never bothered to understand the details. Gertrude is an iPhone user and has little experience with Android devices.

4.5 Scenarios

4.5.1 Rufus

When Rufus picks up the new N-DROPP application to officiate a game he is very familiar with, he gets a little frustrated. He does not use his phone for many other things other than calling and texting. Tasks that were easily written down onto a score log, or simply blowing a whistle around his neck, have turned into menu navigation and push-buttons on a touchscreen device. Despite his inexperience, the application is easy to use and also includes a helpful interactive tutorial so Rufus will quickly learn how to use the application. Come game day, he was asked to use the application for the first time in an actual setting. He set up a new game for the two teams from the main menu. The game progressed and Rufus was handling the application very well when all of a sudden a discrepancy occurred on the court over a rule. Having never used the application's built-in rulebook, Rufus was initially irked because he wasn't sure he knew what to do. He noticed, however, that the application had a quick-access button to the rulebook that also allowed him to search the rulebook. He was able to quickly find the rule in question and make an informed decision on the court. Rufus was overall pleased with the application's ability to deliver the desired functionality with ease.

4.5.2 Joey

Joey, a college graduate who played dodgeball for all 4 years of college, recently became a referee of the NCDA. He uses a smartphone on a daily basis and understands how to navigate through applications with ease. Joey, having graduated from the sport, decided to watch his old team play a game when he was asked to be a referee. He downloaded the N-DROPP application to his phone and immediately started the game. Learning the new N-DROPP application was a breeze for him because the organization of the interface was informative to him. He understood that the "pause", "reset", and "edit" buttons were associated with the game clock and that the "+" and "-" buttons referred to each team's player count. The simple interface allowed Joey to easily perform all of the basic functions of a referee. At one point during the game, a player's misconduct earned himself a penalty. Without hesitation, Joey knew the "penalty" tab of the game screen would take him to a screen where he could issue a penalty card to the offending player.

4.5.3 Olga

Olga has always done a great job of scorekeeping during games. As she ages, her tendonitis has progressed and has debated retiring from the dodgeball industry. She was given hope when the NCDA announced the invention of an smart phone application targeted towards dodgeball officials to use during games. Just before the next game, she downloaded the N-DROPP application to see how it would handle. She took all of the tools and instruments needed to record all of the game data just in case the application didn't work for her. Olga took position as head referee with her Android device in hand. As the game progressed, she was surprised how easy it was for her to record game events such as penalties, shot-clock violations, timeouts, and manage the game clock. Before, when assigning a penalty, she had to pull out a card, blow her whistle to call out the player, and then wave the card at him/her as well as write down all of the player's information. With N-DROPP, she was surprised that everything she needed to do was in the application: the whistle, the card, and penalty assignment. She especially liked how she didn't have to write down the player's team, name, and number for the penalty, the

application had quick, drop-down lists for her to select a player so she didn't have to write the information down.

4.5.4 Gertrude

Gertrude was at one of her brother's dodgeball tournaments, just watching the games. One of the referees needed to leave because of an emergency so the officials asked her if she could fill in as an Assistant Referee. She was reluctant but the other officials insisted that using the N-DROPP application made officiating "a piece of cake." Gertrude eventually agreed and borrowed a friend's Android device to run N-DROPP from. Having little experience with Android, Gertrude thought maybe she would be tripped up with the application but she found that was not the case. Android's "back", "home", and "menu" buttons worked very well with the application and performed exactly how she expected. At one point, she needed to address the rulebook because she is unfamiliar with the rules. She was able to find the rulebook easily at the top of the game screen's navigation tab list. She was surprised to find herself enjoying the application and how easy it was to be a referee. She suggested that if they need a referee again in the future, she would love to help.

4.6 Task Analysis

Task 1. Initialize Game

Goal: To create a new game session

Trigger: A new game is about to start

Actions:

1. Initialize application
   Application opens to main screen
2. Select New Game
   Application opens the game setup screen

Task 2. Reset Current Game

Goal: To reset the current game session

Trigger: Something went wrong with the current game session

Actions:

1. Navigate to application's main screen
2. Select Reset Game
   Application issues dialog box to confirm
3. Select to confirm
   Application opens the game setup screen

Task 3. Upload Team Roster

Goal: Populate the roster for each team

Trigger: Prepare for a new game

Actions:

1. Complete Task 1 or 2
2. Select the option to insert teams
3. Select option to download roster from NCDA website
   Application attempts internet connection. If failed, user returns to the game setup screen. If connection succeeded, a screen appears

with NCDA teams.

4. Select the teams that will be playing
5. Download team rosters to device

Task 4. Manually Insert Team Roster

Goal: Populate the roster for each team manually

Trigger: Prepare for a new game

Actions:

1. Complete Task 1 or 2
2. Select option to insert teams
3. Select option to manually insert roster

   Application opens up text boxes for team names and team rosters.
4. Enter each team's information into the device using hard/soft keyboard

Task 5. Start Game

Goal: Start the current game (confirm game setup)

Trigger: User completed Tasks 3 or 4

Actions:

1. At the game setup screen, select to continue

   Application prompts user, asking if current game setup is correct.
2. Confirm to continue to game screen

   Application moves to game screen (timer screen)

Task 6. Navigate Game Screens

Goal: Move from the current screen to another screen within a game session

Trigger: User wishes to switch to different screens of the application

Actions:

1. Swipe left or right on the screen to move to another game screen

Task 7. Start Game Timer

Goal: Start the game timer

Trigger: Game is about to start

Actions

1. Navigate to timer screen (if needed)
2. Select the Start Timer option

   Game timer starts counting down

Task 8. Pause Game Timer

Goal: Pause the current game timer

Trigger: Gameplay has stopped

Actions:

1. Navigate to the timer screen (if needed)
2. Select the Pause Timer option

   Game timer pauses

Task 9. Reset Game Timer

Goal: To reset the current game timer

Trigger: An issue occurred with the current timer and the clock needs to be reset or a new half is about to begin

Actions:

1. Complete Task 8
2. While the game timer is paused, select the Reset Timer option
   Game timer resets to the default value

Task 10. Resume Game Timer

Goal: To resume the game timer

Trigger: Gameplay is about to resume

Actions:

1. While the game timer is paused, select the Resume Timer option
   Game timer resumes counting from current time

Task 11. Use Generic Whistle

Goal: To use the application's built-in whistle

Trigger: A play occurred during the game that requires referee intervention/input

Actions

1. Navigate to the timer screen (if needed)
2. Select, and hold, the quick access whistle button
   Application plays whistle audio on device's speaker

Task 12. Use Custom Whistle

Goal: To use the application's built-in custom whistle

Trigger: A play occurred during the game that requires referee intervention/input

Actions:

1. Navigate to the timer screen (if needed)
2. Select additional options
   Menu appears on device's screen
3. Select custom whistle type
   Application plays whistle audio on device's speaker

Task 13. Add Points to Team's Score

Goal: To increment a team's score

Trigger: A team scored a point

Actions

1. Navigate to the team score screen (if needed)
2. Select the scoring team
3. Select to increment the corresponding team's score
   Selected team's score is incremented on display

Task 14. Show Penalty Card

Goal: Issue a penalty to a particular player

Trigger: A player purposed offensive action(s)

Actions

1. Select additional options
   Menu appears on device's screen
2. Select penalty card (red or yellow)
   Selected penalty color is displayed on the device's screen.
   Screen timeout occurs after a few seconds go by
   Application prompts user to move to Task 15 or to continue
3. Select to move to Task 15 or to continue
   If Task 15 selected, application moves to Task 15
   If continue selected, application returns to game screen

Task 15. Assign Penalty

Goal: Assign a selected penalty to the offending player

Trigger: A player purposed offensive action(s)

Actions:

1. Complete Task 14
   Application prompts user for offending team
2. Select the team the offending player belongs to
   Application lists roster for the offending team
3. Indicate the player that earned the penalty (player's name or number)

Task 16. Show Roster

Goal: Query the device for the team rosters

Trigger: User wishes to know about the players of a team

Actions

1. Select additional options
   Menu appears on device's screen
2. Select roster option
   Screen displays each team's roster
3. View teams and players

Task 17. Show All Standing Penalties

Goal: Query the device for all standing penalties for the current game

Trigger: User wishes to know which player(s) have penalties

Actions

1. Select additional options
   Menu appears on device's screen
2. Select the penalty review option
   Screen displays issued penalties
3. View a timeline of penalties issued to players throughout the game

Task 18. Show Game History (in-game)

Goal: Query the device for the game's current history

Trigger: User wishes to know what events have occurred during the game

Actions

1. Select additional options
   Menu appears on device's screen
2. Select option to view current game history
   Screen displays timeline of game history
3. View a timeline of all events that occurred during the current game

Task 19. Show Game History (post-game)

Goal: Query the device for a game's history

Trigger: User wishes to know what events transpired during a game

Actions

1. Navigate to application's main screen
2. Select additional information option
   Menu appears on device's screen
3. Select game history option
   Application displays previous game(s)
4. Select game of interest
   Timeline of game events is displayed
5. View a timeline of all events that transpired during the specified game

Task 20. Indicate Game Completion

Goal: Complete the current game session

Trigger: The current game has ended (game timer counted down to 0)

Actions

Application brings up dialog box indicating the end of the game

1. Select the complete game option
   Application prompts user to upload results or to continue
2. Select option
   If upload results option selected, move to Task 21
   If continue option is selected, move to the main screen

Task 21. Upload Game Results

Goal: Upload the completed game's results to the NCDA online server

Trigger: The current game has ended

Actions

1. Complete Task 20
   Application attempts to connect to internet. If successful, game data is posted to NCDA servers. If unsuccessful, user prompted to try again or to abort. On completion or abort, application moves to main screen.

Task 22. Change a Setting (in-game)

Goal: Change a setting in the settings menu

Trigger: User wishes to customize his/her interaction with the application

Actions

1. Select additional options
   Menu displayed on device's screen
2. Select the settings option
   Application moves to settings screen
3. Change desired setting

Task 23. Change a Setting (pre/post game)

Goal: Change a setting in the settings menu

Trigger: User wishes to customize his/her interaction with the application

Actions

1. Navigate to main screen (if needed)
2. Select Settings option
   Menu displayed on device's screen
3. Change desired setting

Task 24. Access the Rulebook (in-game)

Goal: Access the NCDA dodgeball rulebook

Trigger: User wishes to review a rule

Actions

1. Select additional options
   Menu is displayed on device's screen
2. Select rulebook
   Application opens NCDA rulebook
3. View rulebook

Task 25. Access the Rulebook (pre/post game)

Goal: Access the NCDA dodgeball rulebook

Trigger: User wishes to review a rule

Actions

1. Navigate to main screen (if needed)
2. Select information option
   Information menu appears on device's screen
3. Select rulebook option
   Application opens NCDA rulebook
4. View rulebook

4.7 Work Environment

The main work environment for this application will be gymnasiums where an NCDA dodgeball match will take place. It will be used by the referees as well as the scorekeepers/time keepers. The referees will use the application for to keep track of the match's game state at all times: game time, shot clock times, players on the court, timeouts left, etc. Additionally, referees can view the built-in rulebook. The time keepers will be using the application for the shot clocks for each team. NCDA matches are often very noisy events, with shouting players and fans, making a referee's job more difficult to communicate calls. Accompanying this are many distractions, as players and fans bicker at referees, pulling their attention from the game. The application should be designed to accompany such distractions.

The secondary work environment of this application will be during the practices of any dodgeball team. Teams will be able to recreate a game setting, which will allow them to have more successful practice sessions. This environment will be more relaxing and less stressful for referees, hopefully making the referee's job even easier.

5. Design and Prototype I

Conceptual design is the designers' mental model of the application. It is the responsibility of the designers to build a conceptual design in a way such that the average target user can understand. N-DROPP's conceptual design is formulated based on the contextual analysis and functional ideas (section 5.1). Once the conceptual design is formulated, ideation can begin. Ideation (section 5.2) is the process of brainstorming ideas for how the application should look, feel, and operate. During the Design and Prototype phase, concepts produced during ideation are used to construct a low-level prototype. A low-level prototype is an inexpensive, yet descriptive, model of the proposed application. Low-level prototypes are meant to be quick and cheap ways of bringing ideas into fruition and it is often done on paper. During ideation, the team proposed logo ideas (section 5.3) and also application design ideas (section 5.4). During the low-fidelity prototype design, the application guidelines were taken into account (section 5.5).

After the low-fidelity prototype was constructed, formative evaluation of the prototype took place. Formative evaluation (section 5.6) is the early-design testing and analysis of the application using its low-fidelity prototype. Formative evaluation is meant to catch errors in the design early on, understand the user's mental model better, and to see how the current prototype functions in the hands of the user. "Thinking out loud" protocol is used during this session to best gain insight to the user's mental model. As indicated, the "thinking out loud" protocol asks users to speak out their thoughts as they handle the application. Section 5.7 consists of the notes recorded during the formative evaluation. Wrapping up this phase, section 5.8 discusses issues with the low-fidelity prototype and initial design changes.

5.1 Conceptual Design

When thinking about the design of our application, the team wanted the officials to feel as though they were still using the traditional officiating tools. The goal of N-DROPP is to bring many hands-on tasks to the user in a central mobile device. Functions such as blowing a whistle, administering a penalty card, or using a stopwatch should all be built into the handheld application. N-DROPP's game clock should be similar to a normal stopwatch because most, if not all, users understand how stopwatches work. "Start", "stop", and "pause" buttons should appear directly on the game screen to depict these functions to the user. Based on the contextual analysis, target users wanted the whistle, penalties, and a rulebook easily accessible. With these design requirements in mind, and also the issue of visual space on the screen, the design team did not want these functions to be more than a single button-press away. Because of these design constraints, N-DROPP needed to have an informative layout as well as informative images and labels. With these, the application would be able to convey a descriptive mental model to the user without requiring the user to spend an excessive amount of time to learn the application.

5.2 Ideation

N-DROPP's design group greatly enjoyed the ideation phase of this assignment. The meetings were held in the EOS lab in Mackinac Hall between classes. Half of an hour was spent designing the initial project logos. After the first half hour, initial designs were presented and received feedback from the rest of the design team. A similar procedure was used for the early screen designs. Two hours were dedicated to creating separate application designs, where each

team member created low-level prototypes of the application. By making the individual logos and screen designs separately, no designer's perception of the application could influence another designer's perception. This was meant to extract as many raw ideas as possible. Once all designs were completed, the design team was to critique all of the proposed application designs. Critiquing proved very beneficial as each design showed different ways to express certain features and critiquing helped see flaws and perks in each. For both the project logo and screen designs, the team decided to piece together many of the ideas into one final design. The final design of the logo took another half hour and the Balsamiq prototype took two more hours. Working with Balsamiq was very enjoyable. The steps taken in the ideation phase helped greatly in building a more tangible concept design.

5.3 Logo/Icon

Several mockups were drawn and refined to represent the application's logo. Some designs contain aspects of the NCDA's current logo (Figure 1). Although this design idea was taken into account during ideation, the design team didn't want it to limit the possibilities of other logo designs. Subsections 1 and 2 show the stages of the initial logo designs. Subsection 3 depicts the final, digital logos.

Figure 1
Current NCDA logo

5.3.1 Draw Phase I

In the first drawing phase, five logo ideas were presented (Figures 2-6).

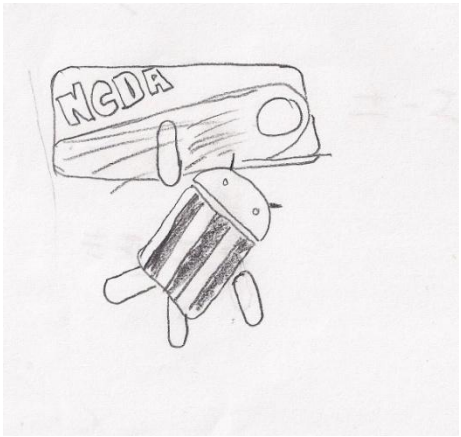


Figure 2
Original NCDA logo with Android Referee

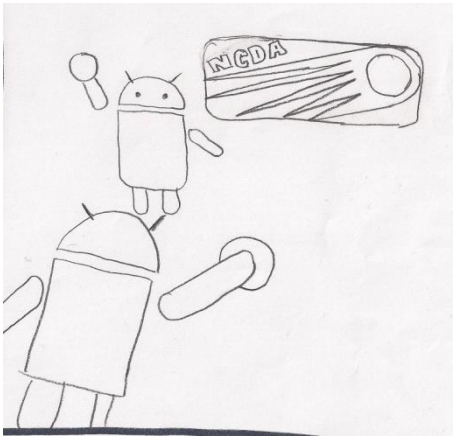


Figure 3
Droids playing dodgeball

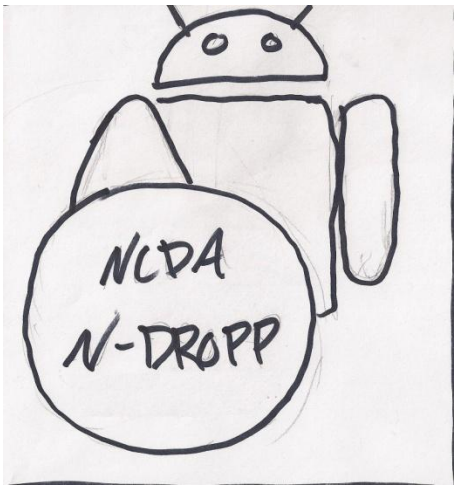


Figure 4
Android palming ball

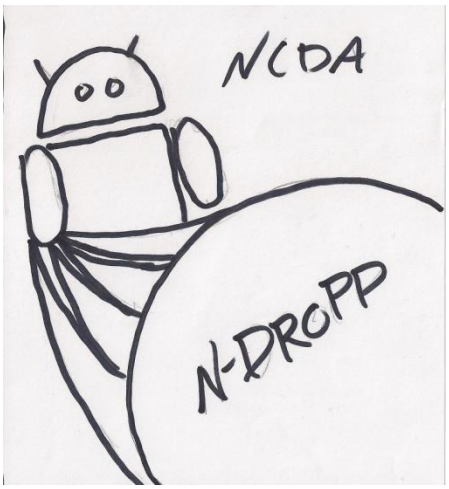


Figure 5
Android throwing ball

Figure 6
Peeking Android

All presented logo ideas portray the use of the Android icon (Andy) in the logo design. The design team really liked the idea of Andy appearing in N-DROPP's logo and decided to continue his appearance in the other design ideas. Figure 6 aims at simplicity and simply adds Andy to the current NCDA logo. Figure 2 and 3's detail takes this idea to the next level. Also in Figure 2, Andy is hinted to be a referee because of his striped torso; this design idea was carried into the next stage of ideation (TBD in section 5.3.2). The team really enjoyed the ideas portrayed in Figures 4 and 5. Figure 4 was enjoyable because it was unique. Figure 5 was enjoyable because it spawned from ideas in the current NCDA logo. Of the proposed drawings, the team decided to run with logo ideas shown in Figures 4 and 5, focussing more so on Figure 4's logo design.

5.3.2 Draw Phase II

During drawing phase 2, refined drawings of Figure 4 logo design were presented. Changes include the text on the ball, a whistle around the Android's neck (Figure 8), and the Android wearing a referee's shirt.

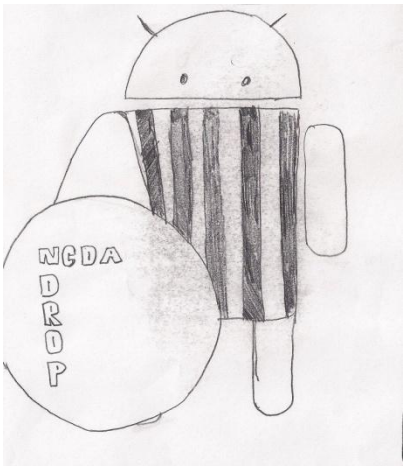


Figure 7
Referee Android palming ball (N-DROPP text)

Figure 8
Referee Android palming ball (Officiating app text)

Figures 7 and 8 both refine the idea presented in the logo of Figure 4. Noticably, both designs show Andy wearing a referee's shirt. The team liked the idea of the whistle on the referee, shown in Figure 8. However, the team had mixed feelings about Andy having fingers.

5.3.3 Draw Phase III

Draw phase 3 consisted of digital designs of the current mockups. It was decided to digitally create the refined Android referee logo (originating idea of Figure 4) and the Android throwing a ball (originating idea of Figure 5).

Figure 9
Referee Android palming ball (digital)

Figure 10
Android throwing ball (digital)

After the digital representations were created, the team liked how the secondary logo (Figure 10) turned out rather than the original focus (Figure 9). The team also liked the simplicity of Figure 10's logo as opposed to the complex alternating patterns shown in Andy's referee shirt of Figure 9. Therefore, the team chose Figure 10 to represent the application.

5.4 Low-Fidelity Prototypes

During the ideation phase, it was proposed that each member draw out his ideas of how the application would be designed. Each member constructed a general program flow and basic screenshots to portray his/her conceptual design of the application. These screenshots were denoted as the low-fidelity prototypes of the application (partially complete implementations) and were constructed using a tool called Balsamiq (balsamiq.com). Each constructed prototype proposed a general application layout, consisting of the following screenshots: main menu, a main game screen, options/settings, and penalty cards. Several screenshots were constructed and many ideas were proposed in each. This section will overview the main priority screenshots, their counterparts, and why a particular design was selected to officially make up the low-fidelity prototype. All designed screenshots appear in section 9.5 of the Appendix.

5.4.1 Settings

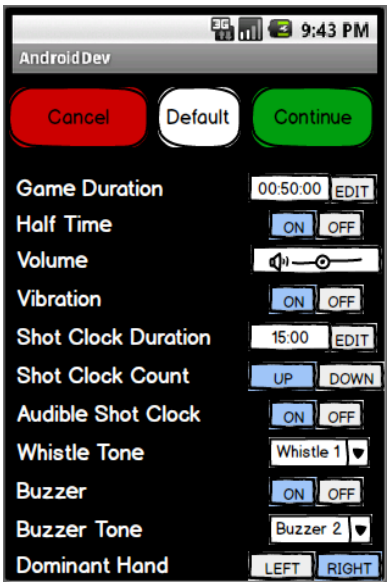


Figure 11
Settings page

Figure 12
Pre-Game Settings

The team wanted the game to be customizable, allowing the user to input settings for the game. Figure 11 shows a basic "Settings" screen whereas Figure 12 shows more of a "Game Setup" screen. The team liked both ideas and decided to include both options in the prototype. In this sense, the user could select a new game and be taken to the Game Setup screen but also have the option of changing additional settings through the settings menu.

5.4.2 Game Screen

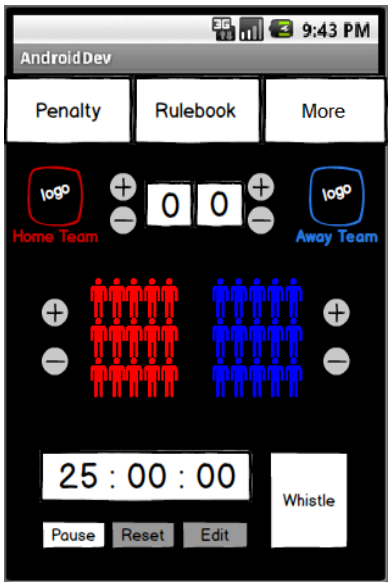


Figure 13
Game Screen I

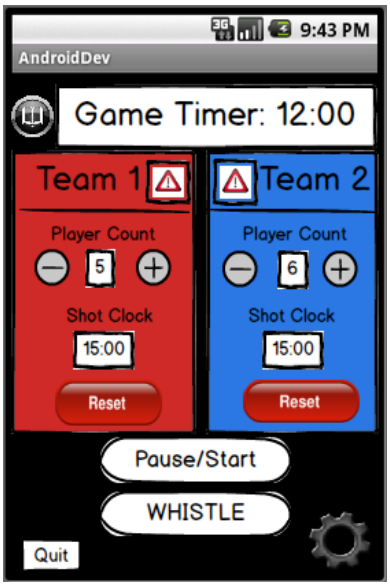


Figure 14
Game Screen II

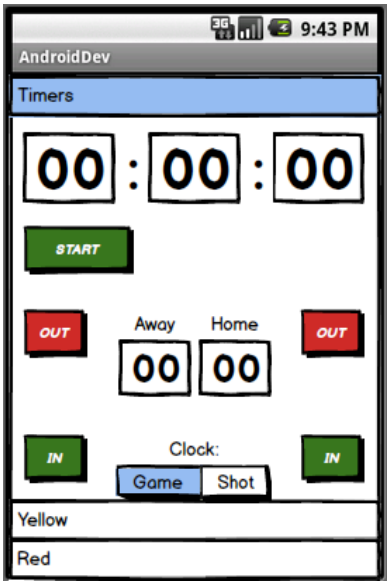


Figure 15
Game Screen III

The team really liked the ideas presented here in each of the Game Screen screenshots. Since the Game Screen is the main screen of the application, and what users would interact with most, all designs needed to be taken into utmost consideration. Each of the Game Screen screenshots had the essentials: a game clock, score, and the ability to assign penalties. The team really liked the idea of having an indicator of the number of players on the court which was depicted best by Figure 13 because of the visual feedback of the players. Figure 14 had a strong

implementation, including functional support for both the head referee and the shot-clock referees. This design would be great for using the application in a team's practice setting because one referee could do all of the work. This setup is impractical, however, for a game setting because there is too much happening on the court for the referee to control both shot clocks, the game clock, and referee the game. It's design is also particularly complex and would be difficult for a rookie referee to learn quickly. Finally, Figure 15 portrayed a very simple environment with large buttons and text. The team liked the simplicity of this design and its overall neatness. Design ideas from this application would be taken into account especially if the user needed to modify the game clock.

After reviewing all of the designs, Figure 13 was chosen to best represent the application for the use of the prototype. In the event of a real application, Figure 14's screenshot would also be used for accommodating the use of the application at practices.

5.4.3 Penalties

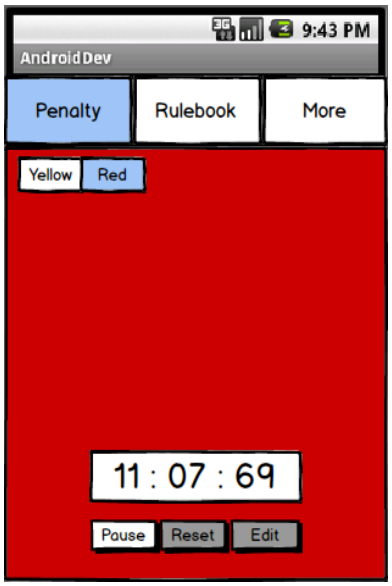


Figure 16
Penalty Card (Red)

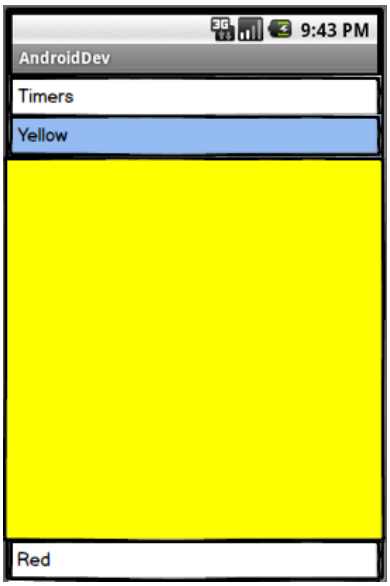


Figure 17
Penalty Card (Yellow)

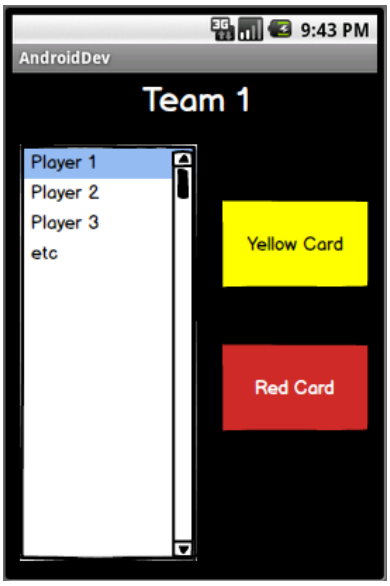


Figure 18
Assigning a penalty

Each of the penalty designs have a unique aspect of design. Figure 16 not only shows the penalty card but also shows the game clock, allowing the referee to modify the game clock while issuing a penalty, if needed. Figure 17 has a nice design aspect which shows a vertical tabular design of the application itself. Figure 18 depicts a screen in which the referee can assign a penalty card to a specific player on the court. Although Figure 18 has great design ideas, the layout seemed too complex for a referee to complete on-the-fly while officiating a game. Figure 17's vertical tabular layout was decided to be the secondary design layout of the application if the horizontal tabular design did not suffice prototype evaluation. Finally, Figure 16 was depicted as the prototype penalty card but additional features (assigning penalty to a player) would be included in a more detailed application.

5.5 Design Guidelines

As the low-fidelity prototype was being designed and implemented using the Balsomiq tool, particular application design guidelines were taken into account. The following design guidelines helped in making GUI layout designs of the N-DROPP application.

Define UI Brand Signatures

By including the same color scheme as the NCDA's official logo, users will be able to recognize the similarities and recall his/her previous experience to the well-known organization. The fact that the NCDA recognizes it as the official app also adds security to the user. [1]

Group Related Elements

After the main menu, the application was divided into the game, rulebook, and settings screens. [2]

Keep It Brief

All of N-DROPP's labels, icons, and description-texts are short and concise. All of these elements are meant to be concise yet also convey the right message of complete functionality. [3]

Design Workflows for Common Tasks

By keeping the main functionality needed by officials on the main game screen, advanced menu navigation and button-clicking is reduced. This allows users to perform the most frequent tasks the fastest. [4]

Words to avoid

Android's developers website lists words to avoid in an application, which will be consulted when creating the application. All current descriptions and text labels are meant to be positive and informative. [3]

Swiping Between Tabs

The horizontal tabs at the top of the screens will allow the user to see where they are when swiping, as well as where they will go. [3]

When to Confirm or Acknowledge User Actions

Guidelines are given about when to have the user confirm the actions they are attempting to do. These guidelines were especially taken into account for for the task of assigning a penalty, confirming a change in game settings, and in shot-clock violations. [3]

Group related settings

The design team wanted N-DROPP to be very customizable. Therefore, the application has a fair amount of settings options, with the possibility of more in the future. Because of this, it is a great idea to group related settings together in a way the user can understand easily. [3]

Multiple choice

Some settings of the application, and game-setup, may have multiple options for the user to pick from. When the design of these options is at hand, the design team will consult the "multiple choice" guideline to keep option descriptions short and descriptive. [3]

Slider

When a slider-option is applicable in the application (mainly the volume settings of the application), the slider should good visual feedback and provide a large hotspot for the user to select the slider. [3]

Let users come to you

This guideline pertains to the help menu and functionality of the application. When the application is first run, it will notify the user if he/she wants to take a brief tutorial. The user can either take the tutorial or opt out. If the user opts out, he/she can still access the tutorial at any time. These guidelines prevent the officials from being distracted from the game by continuous help hints. [3]

5.6 Formative Evaluation

Instructions

Welcome, participant, to the usability testing for the NCDA Dodgeball Referee Officiating aPPlication (N-DROPP). N-DROPP will be an application that will be used by National Collegiate Dodgeball Association, or NCDA, officials to help them officiate games. Today we will be asking you to complete a series of tasks which will allow us to see what works and what doesn't for our application thus far. When you are working on completing the task, we would ask you to say what you are thinking and what you are trying to do. You may ask us questions but be aware that we may not answer then. When you believe the task has been complete, please inform us. After you finish, we may be asking you questions on why you did what you did. Please know that we will not be judging you, rather we will be judging our design of this application. At the end of the testing feel free to tell us what you liked and did not like about the application.

Task 1: Starting a game

You are the head official for an NCDA match and want to start a new game. Create a new game where GVSU is the Home team and MSU is the Away team.

Task 2: Penalty

There has been a rule violation by a player. This has warranted a red card. First use the app's built-in whistle to get the player's attention. Then, please hold up a red card so the players know. After showing the red card, return to the main game screen.

Task 3: Accessing the rulebook

You need to quickly take a look at the rulebook. Please go to the rulebook. After viewing it, return to the main game screen.

Task 4: Change number of players

You are officiating a NCDA match and observe a player from the Home team make a valid catch of a ball thrown by an Away team player. In this situation, the Away team player who threw the ball is ruled out and the Home team player who caught the ball brings in another player. Please make the changes to the game in the specified order: remove an Away team player and add a Home team player.

Task 5: Home team scores

You observe all of the Away team members get eliminated by their opponent. Stop the game clock. Then, make the final changes to the player count and give the Home team a point.

Task 6: Changing settings In-Game

Players are saying that your whistle is too quiet. Change the volume of the whistle to a louder setting.

5.7 Evaluation Notes

During the formative evaluation, multiple volunteers (6) participated in testing the N-DROPP prototype. Most of the volunteers completed the tasks with little to no trouble. Overall, there were only two major problems that participants had while using the N-DROPP application. The first one was the tab navigation on the game screen (Task 2). The second one was when the user was asked to change the whistle volume while in a game (Task 6).

During the formative evaluation, the team immediately noticed a design flaw. Out of the six participants, only one was able to complete Task 2 without getting stuck. The initial design of the tabs on the top of the In-Game Screen (Figure 13) was to act as a toggle. Once the "Penalty" tab was clicked, it would highlight, and if clicked again and the screen would return to the previous screen. However, most users did not know how to go back to the game screen because they did not know the tabs were toggles.

When in-game, it would be very common to need to navigate to the settings and change options on the fly. The design team made a mistake while creating the first prototype, and this was naming the settings tab "More". This caused much conflict when participants were asked to complete Task 6. Task 6 asked the user to increase the in-game whistle volume. This was a problem for most participants as they tried to navigate to a page where they could do this, but there was no tab labeled "help" or "settings", making the participant feel undirected.

5.8 Design Changes I

In the process of creating an application that is user friendly and simple to use, changes have been made to the applications design based on the user experience through formative evaluation as noted in section 5.7.

One change that was made to the application was to the in-game screen (Figure 13). At first, the purpose of the tabs in the header of the screen were used as a toggle. When a user selects "Penalty", they would be taken to the penalty screen (Figure 16) and the tab would highlight in blue, informing the user that it was selected. In order to return to the in-game screen, the user must select the "Penalty" button again. Task 2 outlines this objective for the user. The design team observed during the formative evaluation that the highlighting was almost unnoticeable to the users and only one user was able to figure out how to return to the main game screen. Instead of having the toggled button still read the selected section, the section was relabeled to "Game" to indicate a toggle. For example, Figure 19 shows the penalty screen and its tab relabeled to "Game".

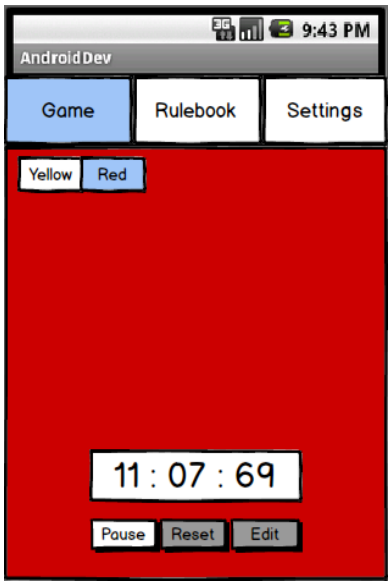


Figure 19
Red Penalty (with Game tab)

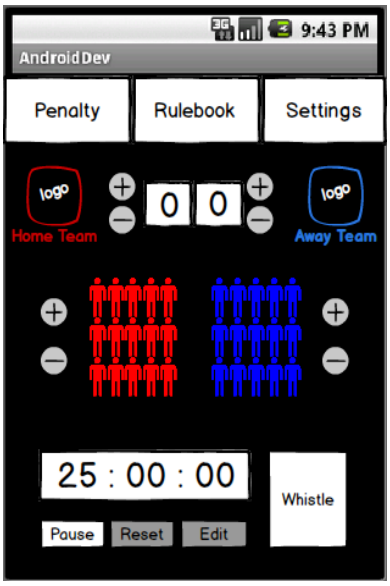


Figure 20
New Game Screen (Settings tab)

Another change that was implemented was also for the main game screen. At first, the screen consisted of three tabs: Penalty, Rulebook, and More (Figure 13). It was noticed during task 6, which asks the user to go to the settings and change the whistle volume, that "More" was a little too vague for the user to know that this would take them to the settings page. To make this easier for the user to find, the label on that tab was changed to "Settings". This is more consistent with other applications and will convey a more clear message to the user.

6. Design & Prototype II

During the second Design and Prototype phase, UX Target Tables (section 6.1) were constructed. Target tables are meant to outline design goals of the N-DROPP application, aspects of the application the team wishes to measure, how the team is to measure application characteristics, and define a target outcome expected of users. This phase also led to the high-fidelity prototype of N-DROPP. The difference between the high-fidelity prototype discussed in this section and the low-fidelity prototype of section 5 is that the high-fidelity prototype is meant to look and feel like an application and has adequate functionality. Details of the high-fidelity prototype design are discussed in section 6.2. Section 6.3 discusses the main design changes between the low-fidelity and the high-fidelity prototypes. Finally, section 6.4 gives an overview of the provided video demo of the N-DROPP application.

6.1 UX Target Table

The following N-DROPP target tables describe the targets of the usability testing session, the goals the team wished for the user to satisfy, and the measurements and tools to determine a target outcome. Notice that the main work role now includes the Head Referee, Assistant Referee, and Score-Keeper. This is because the N-DROPP application encompasses the responsibilities of all of these referees into a single application that is manageable for a single referee to control. The baseline level column of the table describes the current [average] value of the given metric, if any, whereas the target level describes the improvement the team wishes to make with the implementation of N-DROPP.

Table 1

Veteran Referee Target Table

Work Role	UX Goal	UX Measure	Instrument	UX Metric	Baseline Level	Target Level
Head Referee/ Assistant Referee/ Score-Keeper: Veteran Official	Enjoyable interface for application	User's satisfaction of application environment	Post-Evaluation survey	Number correspondence to Likert-scale question (8.10)		Likert scale average of 4
	Quickly and easily able to create a game	User is able to complete a game	Benchmark Task #1 (7.5)	Time spent on task (8.9); perceived confidence of user & user experience (8.8)		10-15 seconds
	Assign penalty to a player quickly and easily	User is able to penalize a player	Benchmark Task #2 (7.5)	Time spent on task (8.9); perceived confidence of user & user experience (8.8)	30 seconds	10-15 seconds
	Quickly able to look up a rule	User is able to find the rulebook, and the rule within the rulebook, quickly	Benchmark Task #4 (7.5)	Time spent on task (8.9); perceived confidence of user & user experience (8.8)	2-4 minutes	30-60 seconds
	Easily able to make game status adjustments (players on the court)	User is able to change the number of players on the court in the application	Benchmark Task #5 (7.5)	Time spent on task (8.9); perceived confidence of user & user experience (8.8)		1-2 seconds
	Easy able to make game clock adjustments	User understands how the shot-clock resembles a stopwatch	Benchmark Task #1 & #6 (7.5)	Time spent on task (8.9); perceived confidence of user & user experience (8.8)	1-2 seconds	1-2 seconds
	User is aware of additional features of the application	User is able to run additional application features besides the main game	Benchmark Task #7 (7.5)	User completes task.		100% completion rate
	Simple and quick navigation throughout the application	User's ability to move in a logical manner through the application's menus/screens	Mishaps conducted by user (7.4); Post-Evaluation Survey	Count the total mishaps and errrors performed by user (8.8)		no more than 1 mishap or error per user for all tasks
	Application presents information well	User is able to use the application well enough to complete tasks	Count the number of tasks completed; Post-Evaluation Survey	Number correspondence to Likert-scale question (8.10)		Likert scale average of 4
	Application performs well		Post-Evaluation survey	Number correspondence to Likert-scale question (8.10)		Likert scale average of 4
	Application performs functions as expected by user		Post-Evaluation survey	Number correspondence to Likert-scale question (8.10)		Likert scale average of 4

Table 2

Inexperienced Referee Target Table

Work Role	UX Goal	UX Measure	Instrument	UX Metric	Baseline Level	Target Level
Head Referee/ Assistant Referee/ Score-Keeper: Inexperienced Official	Enjoyable interface for application	User's satisfaction of application environment	Post-Evaluation survey	Number correspondence to Likert-scale question (8.10)		Likert scale average of 4
	Quickly and easily able to create a game	User is able to complete a game	Benchmark Task #1 (7.5)	Time spent on task (8.9); perceived confidence of user & user experience (8.8)		15-20 seconds
	Assign penalty to a player quickly and easily	User is able to penalize a player	Benchmark Task #2 (7.5)	Time spent on task (8.9); perceived confidence of user & user experience (8.8)	60 seconds	20-30 seconds
	Quickly able to look up a rule	User is able to find the rulebook, and the rule within the rulebook, quickly	Benchmark Task #4 (7.5)	Time spent on task (8.9); perceived confidence of user & user experience (8.8)	5+ minutes	45-60 seconds
	Easily able to make game status adjustments (players on the court)	User is able to change the number of players on the court in the application	Benchmark Task #5 (7.5)	Time spent on task (8.9); perceived confidence of user & user experience (8.8)		1-2 seconds
	Easy able to make game clock adjustments	User understands how the shot-clock resembles a stopwatch	Benchmark Task #1 & #6 (7.5)	Time spent on task (8.9); perceived confidence of user & user experience (8.8)	1-2 seconds	1-2 seconds
	User is aware of additional features of the application	User is able to run additional application features besides the main game	Benchmark Task #7 (7.5)	User completes task.		90% completion rate
	Simple and quick navigation throughout the application	User's ability to move in a logical manner through the application's menus/screens	Mishaps conducted by user (7.4); Post-Evaluation Survey	Count the total mishaps and errrors performed by user (8.8)		No more than 3 mishaps or errors per user for all tasks
	Application presents information well	User is able to use the application well enough to complete tasks	Count the number of tasks completed; Post-Evaluation Survey	Number correspondence to Likert-scale question (8.10)		Likert scale average of 4
	Application performs well		Post-Evaluation survey	Number correspondence to Likert-scale question (8.10)		Likert scale average of 4
	Application performs functions as expected by user		Post-Evaluation survey	Number correspondence to Likert-scale question (8.10)		Likert scale average of 4

6.2 High-Fidelity Prototype

A web application called Balsamiq was used to conduct the low-fidelity prototype of the N-DROPP application. This web application was comprised of many sketched tools that looked similar to a mobile application. This made it quite easy to create a low-fidelity prototype to test N-DROPP on a basic level. Balsamiq included inner links that made it available to navigate through the application as if it were a real working mobile application.

After completing two sessions of low-fidelity prototype testing, the team realized that an easier method for screen navigation was needed - navigation between the Game, Penalty, Rulebook, and Settings screens. Additionally, the application needed to feel and look more realistic. After an additional ideation session after the formative evaluation (sections 5.6-5.7), the team concluded that adding another tab at the top of the application would make navigation during gameplay more intuitive. To make the application feel more real, it was decided to use a package of powerpoint slides for the Android 3.0 system, provided by Keynotopia. With these slides, a real- looking mobile application, with some functionality, could be constructed.

As stated above, Keynotopia was used to implement the high-fidelity N-DROPP prototype. With this tool, the team had access to a library of images that is identical to the Android 3.0 system. This made the application look like a legitimate mobile application. After creating a myriad of slides that looked similar to the low-fidelity prototype, but with more detail and better rendering, slides were linked together to simulate a functional application.

During the formative evaluation session of the low-fidelity prototype, several bugs in the navigation system were discovered. Additionally, some functionality of the application was missing. After coming together as a team and making decisions on what should be cut from the application and what should be added in the high-fidelity prototype, the team decided to change the main game screen to incorporate tabs that navigate easily through the application. This differs from the low-fidelity prototype by not having tabs that act as toggles. The toggled-tab design issue was solved by having dedicated tabs for each screen. This eliminated any confusion in navigating from the game screen to the penalty screen, and back.

Another change in the high-fidelity prototype is the high-end aesthetic changes made to the application. Since the design team was using actual screenshots from an Android 3.0 system, it was possible to make the application look real. This makes the user experience during testing much better and makes them take the application as a whole more seriously.

The design team believes the design differences in the new prototype will be reflected in the test results of the team's upcoming usability testing session. The previous testing session proved that the application had some flaws, and the team believes those have been fixed. The team's goal of making a high-fidelity prototype that looks and functions as if it were a real Android mobile application has been satisfied. By doing this, the team will greatly benefit from the upcoming testing session, in that, the team will be able to see how well the application performs in the hands of the user. The entire N-DROPP team believes the resulting high-fidelity prototype is the best possible prototype of the proposed application and the team is happy with the final result.

6.3 Design Reflection

After completing the low-fidelity test, the design team received some feedback on how the application could be improved. The low-fidelity test provided a surprising amount of information that would not have been detected without formative evaluation. Based on this information, the following design changes were made: addition of a new navigational tab (Game), addition of penalty assignment to a player, removal of the score-adjustment buttons, and the addition of shot clock information. All high-fidelity screenshots can be seen in section 9.11 of the Appendix.

6.3.1 New navigational tab (Game)

During testing, five of six participants struggled with navigating back to the game screen after completing a task like checking the rulebook. To fix this problem, the design team put their heads together and decided on adding a new global tab to the tab list. The new "Game" tab in the top, horizontal tab lists would help users navigate through in-game operations easier. The following screenshot (Figure 21) shows the changes from the low-fidelity prototype and the high-fidelity prototype.

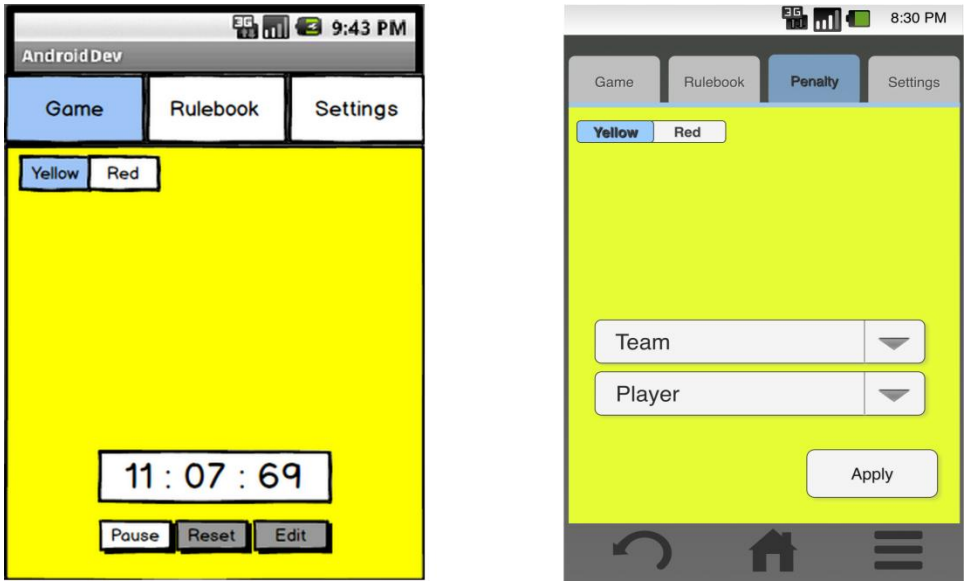


Figure 21

Low-fidelity prototype screenshot (left) versus high-fidelity prototype screenshot (right). Pictured to show navigation tab differences at the top of the view (new "Game" tab).

6.3.2 Penalty assignment

Also shown in Figure 21, the game clock was removed from the penalty screen and replaced with a team and player drop-down menus. The drop-down menus allow the referee to assign a penalty to a specific player on the court. These statistics will be saved into the detailed game history.

6.3.3 Score-adjustment buttons

One of the tests that were used during the first testing session was to decrement all players of a team, and give the opposing team a point. This became difficult with having to stop the timer, decrement the player count and then add the point. The design team decided that it would be easier to make this happen in the background. Now, when the last player of a team is eliminated, the application will automatically increment the point of the opposing team. This makes the process of finishing a round simple and quick. This change can be seen in Figure 22.

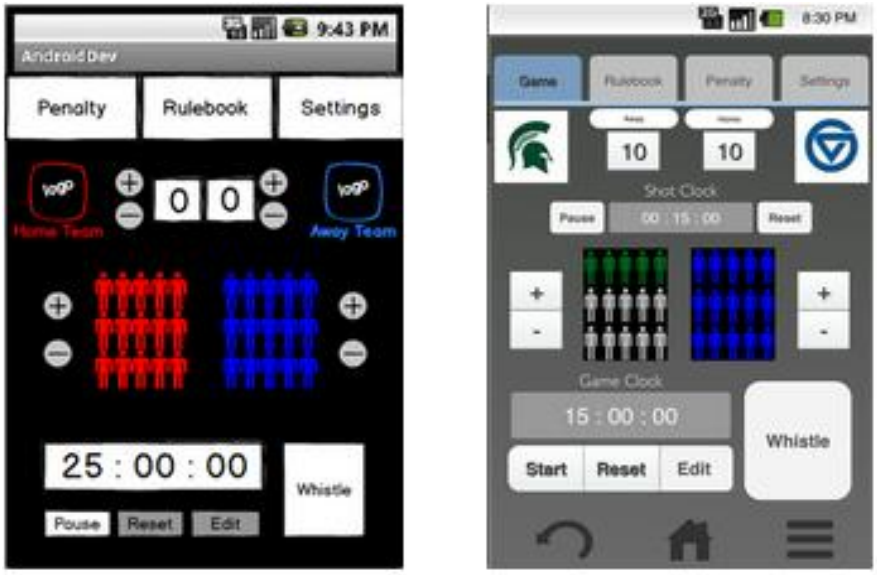


Figure 22

Low-fidelity prototype (left) versus high-fidelity prototype (right). Pictured to show difference in score counters.

6.3.4 Shot Clock Information

Originally, the design was to implement two working models of the application. The first one was to have a head referee be operating the application and keeping track of penalties and eliminations. The second one was to be a shot clock referee who dealt with keeping track of the shot clock. While testing, the first screen asked the user to indicate a shot clock time. This feature wasn't implemented at all in the original game screen. The design team was trying to figure out where to add this feature since all of the screen's real estate was being used on the game screen until the game score issue was resolved. This opened up some space for a simple shot clock with a reset button. This change is shown in Figure 23.

Figure 23

High-fidelity prototype screenshot zoomed in at the top of the Game view to show Shot clock addition.

6.4 Video Demo

A video demo of the high-fidelity N-DROPP prototype was conducted using QuickTime Player on an Apple Macbook device. The video was uploaded to YouTube for interested individuals at the following url (http://www.youtube.com/watch?v=oh7aav3nm3U).

N-DROPP is targeted for an Android device, however, the Macbook provided a clean video capture of the application. This prevented the designers from needing to use a handheld camcorder with lacking sound quality to record the video.

A video demo is a great way to introduce the N-DROPP application to intrigued users. The "About N-DROPP" video provides a detailed, visually interactive explanation of how N-DROPP functions. Users will be able to see how games can be created and started, how to manipulate game data as events occur, and review game history. In addition to these basic app functions, the video will touch on detailed functions which encourage the user to explore the application further. Additional nuances such as vibration features and sound features will be presented to give the user an idea of N-DROPP's immersive ability to communicate and record information.

7. Evaluation Plan

The purpose of this evaluation plan is to thoroughly describe the process of how the proposed N-DROPP application should be evaluated through testing and analysis. This section elaborates on the process of conducting the N-DROPP Usability Testing and Evaluation Session and gathering data throughout the usability testing session. The evaluation plan makes up the summative evaluation of the design phase, where summative evaluation is the analysis of the application in terms of retrospect - how the application performs in the hands of the user, how well the application meets desired goals, etc.

The goal of the N-DROPP Usability Testing and Evaluation Session is to gain insight in the user's experience of the application and their thoughts of the product. Target users for usability testing include referees, players, and alumni of the NCDA. N-DROPP's goal as an application is to exceed current referee practices in functionality, efficiency, and user interaction. In short, the goal of N-DROPP is to revolutionize NCDA matches and provide a smooth, easy-to-use application for referees to easily keep track of, and organize, game data.

Although the actual user environment for the N-DROPP will be in a gym, this particular set of product testing should take place in a classroom setting. The classroom setting is a great place to test N-DROPP because the user will experience a setting with subtle distractions, an ambiance of noise, and yet still not be overwhelmed by the environment to understand the application. The high-fidelity prototype usability testing session should be scheduled before the final revisions are made to the application prior to development/release.

7.1 Prerequisites

In order to perform the usability testing, the following prerequisites should be met:

- Classroom environment with sufficient seating and table arrangements
- Android mobile device (1)
  NOTE: If mobile device fails, the high-fidelity prototype can be tested using a desktop or laptop computer.
    - Application capable of viewing PDF or PPT files
- Printout of all tasks (1 task per page; 1 full set of tasks)
- Printout of Participant Consent and Compensation Form (1 per participant) (section 9.6 of Appendix)
- Printout of Evaluation Facilitator Introduction (1) (section 9.7 of Appendix)
- Printout of Qualitative Data Collector Evaluation Form (1 per task per participant per Qualitative Data Collector) (section 9.8 of Appendix)
- Printout of Quantitative Data Collector Evaluation Form (1 per task per participant per Quantitative Data Collector) (section 9.9 of Appendix)
- Printout of Post Evaluation Survey (1 per participant) (section 9.10 of Appendix)
- Stopwatch (1) (Quantitative Data Collector)
- Pen and/or pencil (minimum 1 per Data Collector)

7.2 Evaluation Roles

7.2.1 Facilitator

Only one facilitator is needed for the usability testing session. The facilitator will be the individual who interacts with the user i.e., welcome the user, ask user to perform tasks, and administer the usability testing session. Before the usability session begins, the facilitator must have a mobile device with internet access that also has a PDF-viewing application. N-DROPP's point-and-click PDF should be loaded onto the device and ready for the user to interact with. When the participant arrives, the facilitator should welcome the participant, introduce himself/herself to the participant, and thank the participant for setting aside time to partake in the usability testing session. Before beginning the usability testing session, the user must sign the Participant Consent and Compensation Form (Appendix 9.6). After the user has agreed to the terms and conditions of the testing session and the user is ready to begin, the facilitator should explain the purpose of the testing session and verbally communicate the general instructions to the user. A suggested introductory statement appears in Appendix 9.7.

After providing the user with instructions, the facilitator should give the user his/her first task. The facilitator should not answer questions from the user that may reveal the intermediate steps to completing the task. It is up to the user to analyze the information provided by the task instructions and the application to complete the task. The facilitator may answer questions about the device itself. For example, if a user asks if the device has internet capabilities, the facilitator should respond positively. The facilitator in this example, however, cannot reveal *how* to access the internet. Tasks should be presented to the user in sequential order and when the user has completed the previous task or voluntarily abandoned the task. Once all tasks are completed, and all questions provided by the Data Collectors have been resolved, the facilitator should end the session with providing the user with a Post Evaluation Survey, a treat of compensation, and a concluding, sincere farewell.

7.2.2 Qualitative Data Collector

A minimum of one Qualitative Data Collector should be present during the testing session. It is the Qualitative Data Collector's responsibility to record subjective data during the testing session. This type of data includes notes pertaining to the user's emotions (facial expression), thought process (think-out-loud), and even perceived confidence. A detailed form for the Qualitative Data Collector appears in Appendix 9.8. Because the Qualitative Data Collector must have line-of-sight with the user, it is best if the data collector observes the user from the side (so he/she can also view task performance) or from the user's front.

7.2.3 Quantitative Data Collector

A minimum of one Quantitative Data Collector should be present during the testing session. Data pertaining to statistical analysis should be collected by the Quantitative Data Collector. This particular data pertains objective measurements, or measurements that are tangible and factual, such as task duration, number of mistakes made, and whether or not the task

was completed. A detailed form for the Quantitative Data Collector appears in Appendix 9.9. The Quantitative Data Collector(s) should sit out of sight of the participant. It is best if the testing device could be screen-recorded for the Quantitative Data Collector to observe remotely. If that isn't feasible, it is sufficient for the data collector to sit behind the participant.

7.3 Participants

Taking into consideration evaluation time, compensation for the staff and participants, evaluation resources, and potential feedback from the participants, an appropriate number of participants is within the range of 5-10 (inclusive). Because this application doesn't allow for un-administered testing to be done easily, there is no good way to have a large number of people test it. With 5-10 people, the team believes there will be a large enough variety within the dodgeball official community to gain valid and valuable data on how the application is thus far.

Prime targets to test the new N-DROPP application include experienced dodgeball referees, novice dodgeball referees, and rookie dodgeball referees. In addition to referees, acceptable targets include current and alumni dodgeball players. These target users will be useful for evaluation testing because they can provide the best feedback based on their previous dodgeball experiences. Therefore, the participants should be associated with the NCDA and fit any of the above descriptions. Targeting participants with direct association of the NCDA is a way to guarantee the validity of their position. The team should ask the NCDA to send volunteer participants of varying age and technological experience so as many demographics as possible can be covered.

7.4 Data Collection

As noted in Evaluation Roles, data collection should consist of both quantitative and qualitative data. Related data-gathering information forms appear in multiple sections of the Appendix (9.8-9.10). Data collectors should use his/her respective forms to fill out during a usability testing session. Remember that several copies of the forms should be printed (one per task). The forms include both objective and subjective data. The subjective data segments should be completed by the data collector as necessary with insightful information about the application itself, the user's perception of the application, and how he/she interacts with the application.

For reference to the data collectors, below are the definitions of a mistake, mishap, and error. Each of the data collectors should know the difference so he/she can create appropriate records.

- Mistake

  Occurs when the user intends to do one thing but accidentally does another. For example, the user intended to select the "Rulebook" tab but accidentally selected the "Penalty" tab instead. This helps measure layout design.

- Mishap
  Occurs when the user selects something intentionally, with the intention of producing an expected result, but the resulting outcome is different from the expected outcome. This is often followed by an action to revert back to the previous state prior to the action. This helps measure the application's ability to convey information.

- Error
  Occurs when the user did not follow all of the given instructions, did not complete a task fully, or abandoned the task. When errors occur, the Qualitative Data Collector should record details as to why the user reached the error and some speculation as to why the error occurred. The data collector may ask questions to gain insight to the user's thought process.

7.4.1 Facilitator Instructions

As the role of Facilitator, he/she must be charismatic, welcoming, and friendly to the participant. The primary job of the facilitator is to make the participant feel welcome, at ease, and comfortable, and comprehensive. Doing so increases the probability of better results from the user.

After welcoming the user to the usability testing area, provide instructions to the user. A suggested introduction for the facilitator to read to the user appears in Appendix 9.6. The document informs the participant of how the session will be conducted and what the user will be asked to do. Once the facilitator has provided the necessary information to the user, he/she should present the user with a single task (recall only one task per page). The tasks should be presented sequentially. During the tasks, the facilitator should "egg" the participant on if they seem stuck or are too quick to give up. A participant simply saying he / she cannot complete the task without trying anything will not provide the data collectors with any meaningful data. When all tasks have been completed, present the participant with the Post Evaluation Survey to complete. Once the user completes the survey, the usability session is officially completed. The facilitator should then provide the participant with the promised compensation treat and a sincere "Thank you for participating" farewell.

7.4.2 Qualitative Data Collector Instructions

Observe the user's facial expression, perceived attitude and confidence, etc. Record anything that stands out in the usability testing session in the provided Qualitative Data Collector Evaluation Form. If the user performs a mistake, a mishap, or an error, record it and try to explain what happened in the Additional Notes section. Provide additional information as to why the user acted/reacted the way he/she did. If you need additional details or more insight, present the user with a question. A section appears for both positive and negative perceived feedback from the participant; fill in these sections of the form with informative reactions from the user. For example, the user may be talking to himself/herself, perform an action on the

device, and say out loud, “Wow, that was easy!” In cases such as these, you would note the particular action in the positive “Positive Experiences” section of the form.

7.4.3 Quantitative Data Collector Instructions

Fill in the provided Quantitative Data Collector Evaluation Form with the necessary information. The “Time to finish” field should be recorded regardless if the user completes or abandons the task. The other data points should be recorded to up to completion of the task or up to the point of abandonment if it abandonment occurs. The Additional Notes section is provided if the Data Collector wishes to record additional, insightful data.

7.5 Benchmark Tasks

Benchmark Tasks consist of the tasks in which the participant will be asked to complete during the N-DROPP Usability Testing and Evaluation Session. The following seven tasks have been chosen to best test the N-DROPP application’s UI design. Tasks are presented in a logical order to simulate events of an actual NCDA dodgeball match. Recall section 7.1 **which states that each of the tasks should be printed on separate pieces of paper for use during the usability testing session.** All tasks are listed below in *italic* font and are followed by a brief description of the task.

Task 1: Starting a game

You are the head official for an NCDA match and want to start a new game. Open up the N-DROPP application and create a new game. Game settings should be set to have GVSU as the Home team and MSU as the Away team. The game is ready to begin. Start the game clock to officially start the game.

Task 1 is meant to introduce the basic concepts of the application to the user and initiate interaction between the user and N-DROPP. The first thing the user will see when opening the application is the Main Screen. As soon as the user sees this Main Screen, he/she should have an immediate understanding of the basic layout of the application: game segment (New Game), statistical segment (History), and an customization segment (Settings). Upon selecting the intended “New Game” button, the app’s Game Screen should appear. The Game Screen presents a lot of information in a neatly organized and scaled view. Asking the user to start the game clock will result in immediate feedback to the user that the application is functioning properly.

Task 2: Penalty

There has been a rule violation by player #14 from Michigan State’s team. This has warranted a red card. First use the app’s built-in whistle to get the player’s attention. Then, hold up a the simulated red penalty card so the player knows. After showing the red card, return to the main game screen.

N-DROPP features a built-in whistle and built-in penalty cards. The purpose of Task 2 is to get the user familiarized with the Whistle feature as well as the penalty feature of the application. Accessing the penalty feature forces the user to notice the tabs along the top of screen which indicate the multiple views accessible.

Task 3: Changing settings In-Game

Players are saying that your whistle is too quiet. Change the volume of the whistle to a louder setting.

Navigating to N-DROPP's "Settings" tab can mean all the difference between a good user experience and a great user experience. The purpose of Task 3 is to have the user navigate to the Settings Screen so he/she can customize their experience with the application. Although the user is only asked to change a single setting, it is easy for the user to see that multiple aspects of the application can be customized for a more enjoyable experience.

Task 4: Accessing the rulebook

During the game, you need to quickly take a look at the rulebook. Open up the rulebook while the game is still running. After viewing it, return to the main game screen.

The last view to introduce to the user is the Rulebook. Task 4 asks the user to open up the rulebook and see how fast and easy it is to switch between the game and the rulebook.

Task 5: Change number of players

During the game, you observe a player from the Home team make a catch. In this situation, the Away team player who threw the ball is ruled out and the Home team player who caught the ball brings in another player from the sideline. Please make the changes to the game in the specified order: remove an Away team player and add a Home team player.

The purpose of Task 5 is to have the user interact with the screen he/she will spend most time viewing while using N-DROPP. During Task 5, the user should be able to easily understand how to add and remove players from a particular team.

Task 6: Home team scores

You observe all of the Away team members get eliminated by their opponent. Stop the game clock, and make the final changes to the player count.

Task 6 is meant to move the user through an entire point of the game. This allows the user to revisit aspects of Task 5 and to see how the point-system functionality works in the application.

Task 7: End game, View History

Watch that the game has ended and the Home team walks away with the most points! After the game ends, view the device's game history and then return to the N-DROPP Main Menu Screen.

The final task for the user is to end the current game, view the device's game history, and then return to the Main Screen of the application. Triggering the end-game dialog allows the user to see game statistics. Even though the user is given the choice to view the history or not view the history, the participating user is informed/reminded of the application's Game History Screen (also accessible explicitly from the Main Screen).

8. Final Results

8.1 Evaluation Results

Results gathered from usability testing were helpful in determining whether the application met the targets from the target tables (section 6.1). Using the quantitative and qualitative data, the team can verify which goals of the application were met and which could use improvement.

Inexperienced officials were given tasks to accomplish, as described in section 7.5. One of the goals was to create a game quickly and easily. Time to accomplish task was the way to determine if the design accomplished the presented goal when creating a new game. The average time to set up a new game was 40 seconds, which, when compared to our target of 15-20 seconds shows that this feature of the application could use further refinement to make it a faster experience. A possible improvement would be to eliminate some pre-game setup options.

Task 2 was to assign a penalty to a player and our target time was 20-30 seconds. Again, N-DROPP failed to meet the target values with an average time of 39 seconds. However, in this instance, the baseline level of 60 seconds was passed. Although the target value was not reached, an improvement from the baseline value is certainly an accomplishment.

An important part of any application is the settings, the ability for the user to customize their experience. Task 3 introduced this feature to the user. This particular task was meant to introduce the option to the user rather than to test them on how well they could navigate and change settings. Despite this, the design team is pleased to see this task took the least amount of time to achieve out of all of the other tasks, at 23 seconds.

It usually takes an inexperienced referee 5 or more minutes to look up a rule during a game. This is because the rulebook is most often a hard-copy and it is cumbersome to flip through. The average time it took inexperienced officials to access the rulebook using N-DROPP was 27 seconds (Task 4). This is a tremendous improvement and the design team believes this aspect alone will greatly reduce game interruption times.

The 5th benchmark task asked users to make modifications to the player count. After this task was tested once during the evaluation session, the team noticed an issue with the high-fidelity prototype that essentially prevented the user from ever completing the task as intended. For this reason, the task was removed from the duration of the evaluation. Although the task was removed, its intended purpose of familiarizing the user with Player Elimination was duplicated in Task 6. Task 6 asked the user to stop the game clock, adjust players and increase the score after all players were eliminated.

The final benchmark task (7) asked the user to accomplished a task unrelated to gameplay. The target was for users to view the game history with a 90% task completion rate. After the evaluation, the team was happy to see that 100% of inexperienced users were able to successfully view the game history. Resulting completion times of all individual participants appears in Figure 24 and the average completion times are shown in Figure 25.

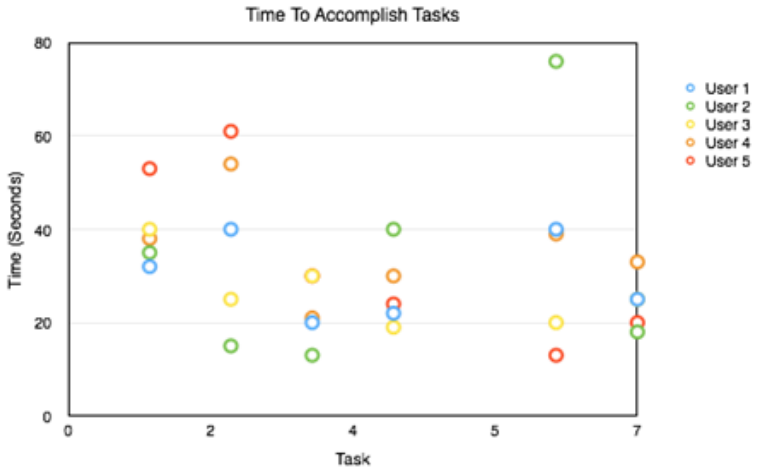


Figure 24

Completion times of all tasks of all participants in the N-DROPP Usability Testing and Evaluation Session.

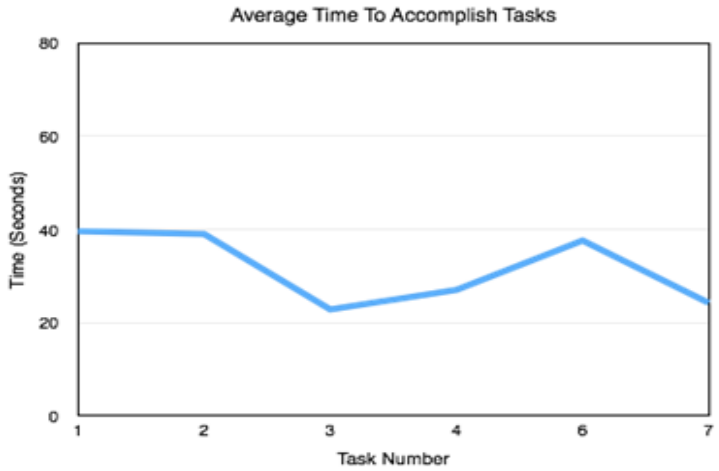


Figure 25

Average completion time of each task in the N-DROPP Usability Testing and Evaluation Session.

While each participant worked through the given tasks, the design team tallied the number of errors and mishaps committed by the user for all tasks. The goal was to keep the combined mishap and error number under three per user for all tasks. This data helped us determine if the application is intuitive to the user and conveys information to the user well. As the bar graph in Figure 26 shows, no user exceeded 3 errors. Additionally, the Likert-scale statement, "It was easy to find the information I needed in order to complete the tasks" received an average of 4.4 (out of 5) from the Post-Evaluation Survey results.

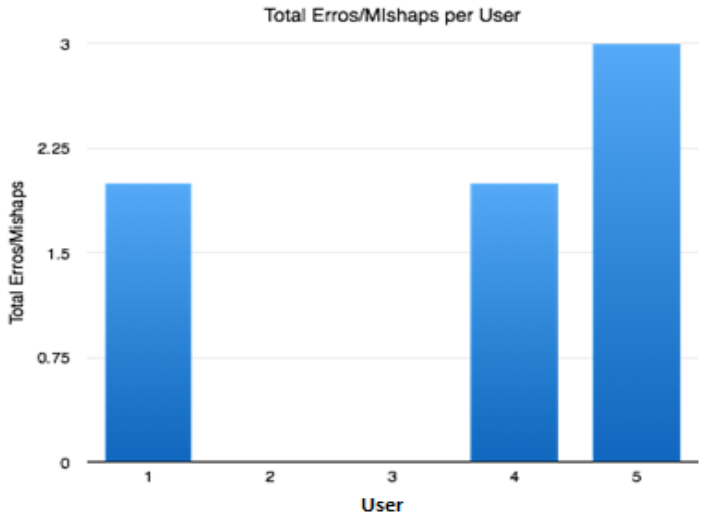


Figure 26

Bar graph depicting total number of combined issues each user experienced over all tasks he/she attempted.

The design team is very pleased with the quantitative data results gathered during the N-DROPP Usability Testing and Evaluation Session. It was especially pleasing to see that, of all users and all tasks attempted, only one task was failed overall (aside from the eliminated Task 5). This shows the design team that the application's organizational layout, images, and labels are descriptive enough to lead the user along the correct path to completing tasks.

After evaluating the quantitative data results, the qualitative data results were reviewed to gather subjective data about the application. More specifically, a survey with Likert-scale questions were given to the participants following the benchmark tasks. The Likert-scale provided (section 9.10) spanned 5 options: Strongly Disagree (1), Disagree (2), Neutral or Non-Applicable (3), Agree (4), and Strongly Agree (5). A target value of 4 (Agree) on the Likert scale was used to evaluate the user's perception of the application, visual appeal, functionality satisfaction, and overall user satisfaction. Enjoyability of the user interface received an average rating of 4.2, visual appeal a 4.0, and overall functionality and support both with a 4.4 (Figure 27).

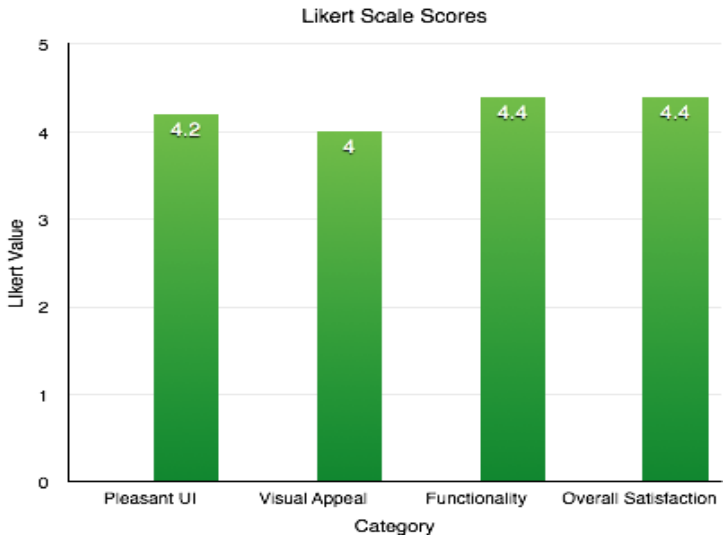


Figure 27

Results of Likert-scale questions that appeared in Post-Evaluation Survey (9.10). Results shown include pleasantry, appeal, functionality, and overall user satisfaction.

Other interesting qualitative information we gathered was that all users felt that they would improve their task performance times if they were given another opportunity. As a team we felt that this was due to the "learning curve" of our application. There have not any known referee applications before and therefore no prior knowledge of any of features N-DROPP offers. After experimentation, it is simple to see that navigation is straight-forward with little room for error.

Finally, the design team asked the Qualitative Data Collector to record the user's perceived confidence level while completing a task as well as the participant's perceived user experience. Figure 28 shows the perceived user confidence per task and Figure 29 shows the perceived user experience results. Although these results are extremely subjective, it is nice to review them. According to Figure 28, users felt quite confident in completing tasks 1, 3, and 7. Less confidence was observed in users when performing tasks 2 and 4, and even less so in task 6. Looking at this data, it helps the designs see where users may have gotten "tripped up" or became hesitant when navigating through the application. Regardless, all users were able to complete the majority of the tasks. Figure 29 indicates a similar trend among the participant's perceived UX.

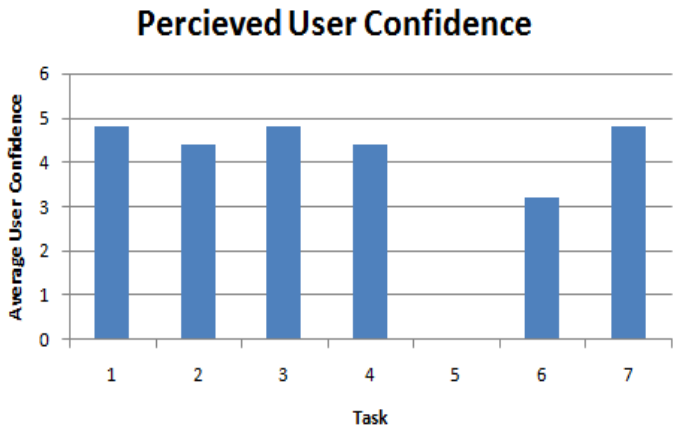


Figure 28

Average perceived user confidence per task, evaluated by Qualitative Data Collector.

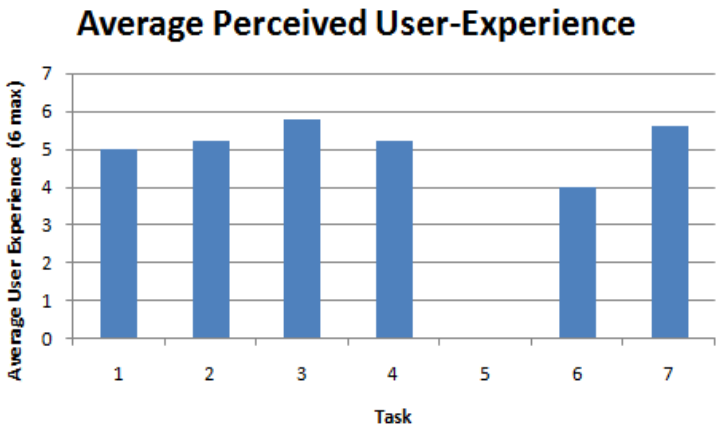


Figure 29

Average perceived user-experience per task (maximum 6), evaluated by Qualitative Data Collector.

8.2 Design Changes II

Team decided not to change pre-game setup options because it is crucial to the overall experience of the application. most often, referees have several minutes prior to the start of a game (during player warm-ups) to initialize a game.

Because some individuals noted that the game screen seemed cluttered, planned changes would remove the shot clock controls at the top of the main game screen and move them over to it's own screen with a similar layout. The plan will be to have two main game screens, one for a Head Referee and another for a Shot-Clock Referee of the same game. The first game screen will be known as the Head Referee's Game Screen and will include the main controls such as: game clock, scorekeeping, player elimination, and the whistle. A comparison between the old

and new main game screens is shown in Figure 30. The second game screen will be known as the Shot-Clock Game Screen (Figure 31) and will have a smaller section that shows what players are in the game, but it isn't interactive. The Shot-Clock referee will not be able to manipulate the game statistics, he/she can only manipulate the shot clocks of the teams. Functional controls for the Shot-Clock referee will include pausing the shot clock, resetting the shot clock, using the whistle, and using the other game screens of the application (Penalty, Rulebook, and Settings). To allow for such a change, the user would be asked if he/she is to take the role of a Head Referee or a Shot-Clock Referee - and the application would take the user to the corresponding game screen. A functional application, run on different devices and by different referees, would communicate wirelessly with the other referees' devices of the same game. By doing this, the Shot-Clock Referee Game Screen would show live updates of game information shown on the Head Referee's game screen, and vice versa.

Figure 30

Comparison between the old referee game screen (left) and the new Head Referee Game Screen (right). The new game screen does not have the shot clock to make room for more visual space. Shot-Clock functionality was moved to a separate screen (Figure 31).

Figure 31

New Shot-Clock Game Screen. The Shot-Clock Referee cannot modify the number of players on the court or the game clock; he/she can only change the shot clocks.

8.3 Conclusion

If our team were to do another round of usability testing with new participants, we believe our design team would be able to perfect our application even more. The first improvement would be in the prototype's functionality; that is, fix the glitch that caused problems with Task 5. Second, we think the design changes (8.2) will result in a completely satisfactory user experience. When creating an application, redesign is a huge part of the usability life-cycle. Our team strives to improve the user's experience of the application and believes that each test session provides valuable data that can be used to better the application. Having monthly updates to fix little bugs, or to add features that users have commented on, are a big part of being a developer, and that's what our team is determined to do.

The most important thing our team will be taking away from this project is the understanding of the importance of the UX design process. When we first began coming up with designs on how our application could work, everything made sense. However, when the designs were put on paper, we saw flaws in the original mental model. Formative evaluation was enlightening because the we could get a glimpse into the user's mental model of the application. Users could explain to us what they were expecting and how they were trying to go about completing the tasks which was very helpful in the design process. Being able to gather what people thought about our application and then make necessary changes greatly helped gear the application to the user's desire, which is the ultimate goal. The team can walk away with the

understanding of the importance of UX design and apply it not only the the applications they design, but also to the applications and systems they interact with on a daily basis.

The second lesson we have taken away is being able to divide group work more evenly and keep track of where everyone in the team is at a particular point in the project. All team members have worked on programming projects in groups before, but this was the first time where we were working with new tools and new materials at each phase in the design. This pushed us to understand what each task would take so we could decide how best to distribute the work.

Overall, the team believes the N-DROPP application design is ready for the production phase. We believe the application has achieved several goals. First, N-DROPP will be the very first NCDA mobile application which is a goal in itself! Secondly, the inception of N-DROPP was based on the notion of providing an easy, useful, and dynamic way of officiating NCDA dodgeball matches. The team believes this goal was satisfied because it packs all of the necessary tools into a single application that has been overall approved by a set of users; not to mention it has the approval of the design team. Finally, we believe the application is ready for implementation because it has been tweaked several times according the needs of the user. After each evaluation of the application prototypes, the application continued to improve. The design team gladly supports N-DROPP and would love to see the application through the full design process and into fruition!

9. Appendix

9.1 Contextual Inquiry - Mobile Referee-Application Survey

The survey was available at the following link on 9/30/2013 to 10/7/2013.
https://docs.google.com/forms/d/1H-eEToVegmnvHqnV_KvlOlKJzo8_5KU1YrVYzXzt1-k/viewform

My experience as a dodgeball player is... *

- I play, or have played, college dodgeball
- I play, or have played, dodgeball in gym class and/or recreational league
- I have never played dodgeball before

My experience as a Head Referee is described as... *

- I've officiated a dodgeball game before
- I have officiated a game before but it wasn't dodgeball
- I have never officiated a sports game before

My experience as a Score Keeper is described as... *

- I have run a score table for a dodgeball game before
- I have run a score table before but not for dodgeball
- I have never run a score table before

As a referee, what is the most time consuming task during a game? *

- Managing the game clock
- Score keeping
- Managing the shot clock
- Issuing a penalty to a player
- Calling a player out
- Other:

As a referee, what is the most distracting task during a game? *

- Managing the game clock
- Score keeping
- Managing the shot clock
- Issuing a penalty to a player
- Calling a player out
- Remembering which player(s) have penalties
- Other:

As a referee, what is the most frequent task during a game? *

- Managing the game clock
- Score keeping
- Managing the shot clock
- Calling a player out
- Other:

How frequent do you perform this task? *
(in reference to the previous question)

- Every few seconds
- A few times every minute
- Once a minute
- Once every few minutes
- Other:

As a referee, what is your most important responsibility? *

- Managing the game clock
- Score keeping
- Managing the shot clock
- Calling players out
- Remembering which player(s) have penalties
- Other:

As a referee, are there any outstanding inconveniences you experience during a game (other than angry fans and players)?

Final Questions or Comments?
What would you like to see a mobile referee application do for you?

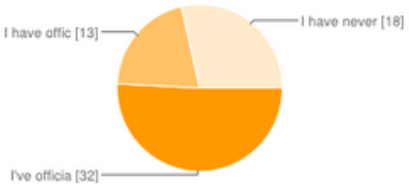
9.2 Contextual Inquiry - Mobile Referee-Application Survey Results

9.2.1 Multiple-Option Results

My experience as a dodgeball player is...

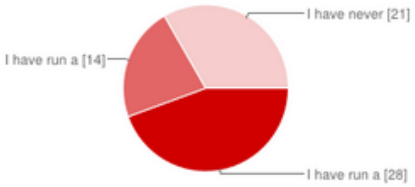
I play, or have played, college dodgeball	47	75%
I play, or have played, dodgeball in gym class and/or recreational league	14	22%
I have never played dodgeball before	2	3%

My experience as a Head Referee is described as...



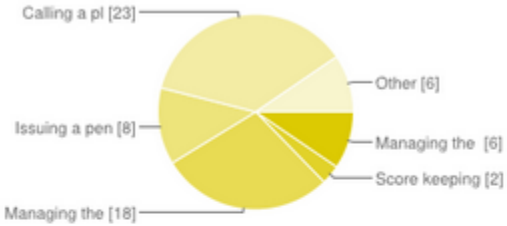
I've officiated a dodgeball game before	32	51%
I have officiated a game before but it wasn't dodgeball	13	21%
I have never officiated a sports game before	18	29%

My experience as a Score Keeper is described as...



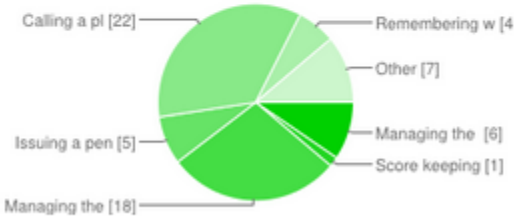
I have run a score table for a dodgeball game before	28	44%
I have run a score table before but not for dodgeball	14	22%
I have never run a score table before	21	33%

As a referee, what is the most time consuming task during a game?



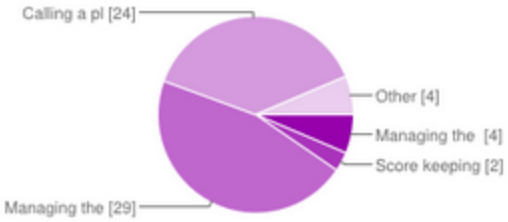
Managing the game clock	6	10%
Score keeping	2	3%
Managing the shot clock	18	29%
Issuing a penalty to a player	8	13%
Calling a player out	23	37%
Other	6	10%
→ 'Null'	5	
'Watching the game'	1	

As a referee, what is the most distracting task during a game?



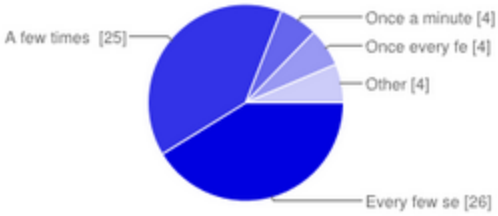
Managing the game clock	6	10%
Score keeping	1	2%
Managing the shot clock	18	29%
Issuing a penalty to a player	5	8%
Calling a player out	22	35%
Remembering which player(s) have penalties	4	6%
Other	7	11%
→ 'Null'	4	
'Arguing players'	2	
'Legit throws'	1	

As a referee, what is the most frequent task during a game?



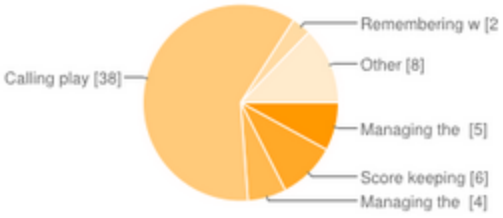
Managing the game clock	4	6%
Score keeping	2	3%
Managing the shot clock	29	46%
Calling a player out	24	38%
Other	4	6%
→ 'Null'	4	

How frequent do you perform this task?



Every few seconds	26	41%
A few times every minute	25	40%
Once a minute	4	6%
Once every few minutes	4	6%
Other	4	6%
→ 'Null'	4	

As a referee, what is your most important responsibility?



Managing the game clock	5	8%
Score keeping	6	10%
Managing the shot clock	4	6%
Calling players out	38	60%
Remembering which player(s) have penalties	2	3%
Other	8	13%
→ 'Null'	4	
'All of the above - equally important'	2	
'Maintaining order on the court'	1	
'Making sure teams play fairly'	1	

9.2.2 Free Response Results

As a referee, are there any outstanding inconveniences you experience during a game?

- Being able to communicate to a player that he or she is out without interrupting the point being played.
- Blown calls, Close plays regarding the ball making contact with the player or the ground first, Determining a good throw to beat the shot clock, The run-up in the beginning of the game.
- Cheating is a big part of the game. Players tend to not go out unless called out and the head ref is the one who owns this activity.
- Dealing with idiots
- Discrepancies with counting
- Distractions from captains and players while you are trying to focus on the game.
- Getting hit.
- Having rules at hand to prove player is out/penalized
- Having to deal with distractions of all sorts while being expected to see EVERYTHING that happens within a game.
- Having to keep track of the number of timeouts used, which players have received yellow cards, how many yellow cards/red cards a team has especially during tournament play.
- Needing to use the rule book. There needs to be an easy access rule book which can expand/minimize for ease of use.
- Having to maintain a steady balance between focus on several aspects of game management, and feeling confident in keeping the game under control (especially in tightly contested matches).
- Lack of overall knowledge from all referees in the current game.
- legit throws
- Not being able to see the whole court
- Not that I have seen or can remember.
- Other than fans or even player who don't agree with my decision?
- I guess if the application is slow or distracts me from the game. I guess one of the biggest problems might be looking to a screen. (Trying to focus on game and sth else)
- People who insist they weren't hit when they were.
- Referees need a whistle. Between the fans and the players screaming the players you are trying to call out honestly can not hear the ref in the intense matches.
- Shot clock counters not making correct calls
- Shot Clock
- Sometimes there is not a 2nd Referee on the other side of the court.
- The highest inconvenience is that the shot clocks are at different paces giving one team an unfair advantage.
- The issue of the Shot Clock Timekeeper not counting in sync with the real game clock is always frustrating. The Rulebook says that they should be using timepieces to make sure they are counting real seconds, so maybe an app like this will help.
- The most outstanding inconvenience in a game is being able to call and tell someone they are out without taking your eyes off the court to watch the rest of the game.
- Too much going on for too few refs
- watching foot faults of the throwers, while at the same time watching the people being thrown at to see if they got hit
- When a call that could cost a team the game comes down to your call
- Yes, as there are typically at most 4 referees during a match, it is hard to keep eyes on all 30 players and 10 balls. Occasionally, a call is missed due to too much action on the court or having to deal with a complaint and play continuing.

Final Questions/Comments? What would you like to see a mobile referee application do for you?

- A good Officiating app definitely has to be easy and simple to use on the fly. Keeping track of timeouts, the game clock, and any penalties would be good. Maybe even a checklist for the pregame would help out.
- A mobile app for a ref may be more distracting than helpful. It is great what you are trying to accomplish *PERSON*. A trial may prove me wrong but just a rule guide with a nice table of contents would help a lot.
- A single click to reset shot clock for 10 and 15 seconds. Most apps have to stop, clear, the reset. A numbered list for the order in which players got out so that they cant come in out of order.
- Answer the rule questions that most people don't know
- Easily keep track of players with penalties and have a shot clock timer that reset every 15 seconds.
- Give a referee and his calls more respect than they have from players now
- have official rules categorized by issue
- I am not sure I understand the question being asked here. I would like the application produce more effective officials for dodgeball games I suppose.
- I want it to be fun and an enjoyable UX
- I'd like to have the app have the official rule book ready to pull up whenever. I also think it would be cool if you could tell it a certain game scenario and have it show you what action that should be taken in that given scenario based on the rulebook.
- If there are counters a running shot clock of some sort would help a significant amount. This would reduce variability between counters and they wouldn't lose track of where they were at, they simply have to press a button to refresh the counter and that's it. There could be multiple settings for regular count/5 man count.
- I'm not sure how a mobile app would help. Interesting idea though
- Keep a consistent shot clock for the refs who are shot clocking. This way, they just need to read from their device.
- Keep me updated on scores, news, standings, game schedules, etc around the NCDA, a rulebook, weekly polls, show the history of the NCDA, team/history profiles, video highlights if/when possible, and of course... advertisements (insert sarcasm here)
- keep score, keep track of time. Maybe keep track of how much behind schedule the games are to know if games need to be played faster.
- In my opinion, the app shouldn't have too much to look at so the referee isn't distracted from watching the game.
- Making the rules more set and a more consistent shot cock system.
- Perhaps have the ability to database particular scenarios, as a means to establish a precedent for future games. This could also be used at captains meetings to review rule changes and be sure they are implemented and interpreted correctly. It can include a detailed account of what happened between team A and team B, what the ruling was, and how that ruling was agreed upon by the crew for that particular game.
- Quick access to the rulebook to quickly settle any disputes. A shot clock feature that can be reset by the press of a button (will keep counters on the same count speed).
- These are of course realistic possibilities, in a different dimension you would be able to select a player by team and number and have him or her transported instantaneously to the out line to prevent having to get their attention or have them walk across the court.
- Quick access to the rulebook to quickly settle any disputes. A shot clock feature that can be reset by the press of a button (will keep counters on the same count speed).
- These are of course realistic possibilities, in a different dimension you would be able to select a player by team and number and have him or her transported instantaneously to the out line to prevent having to get their attention or have them walk across the court.
- Rule book!
- Scorekeeping, shot clock, upload scores, possible recording
- Shot clock counter/timer both for 10 and 5 seconds. Scoreboard function
- Shot clock timer- creates more accurate timing
- Shot clock's obviously most important, must be clearly visible quickly accessible to reset.Game clock is least of the worries, I think because that runs freely. Scoring also must be easily altered in predetermined increments, but also easy to change or correct. Hopefully able to change score of each team simultaneously on the same screen for fast paced scoring games as well?

9.3 Work Roles

9.3.1 Concept Design Phase - (9/9 - 9/18)

Matthew Williams - Technical Writer, Programmer

Matthew Williams is an experienced writer in the field of reports, research papers, and technical write-ups with his background in engineering and business writing. Writing technical papers that are informative, yet understandable to someone reading along who isn't too familiar with the technical details, is very important when developing any product; Matthew excels in this aspect.

Matt Lukasiewicz - User Researcher, Programmer

Matt is involved in many clubs on campus and has connections with many people. He is very sociable and understanding, which makes him the perfect candidate for the role. As User Researcher, Matt's experience with many social groups has given him the understanding and comprehension of how different groups of people operate. Understanding not only how individuals interact but also why they do what they do will be important for this project as Matt will research the audience and approach the project from the user's perspective.

Kyle Peltier - Subject Matter Expert, Programmer

Kyle Peltier is a member of Grand Valley State University's Dodgeball Club. The club joined the NCDA in 2006 and since its participation has won a total of 5 national championships. Kyle has been a member of the team for two of those championships. He is well acquainted to the role as Subject Matter Expert because of his first-hand experiences with the sport and the NCDA. As Subject Matter Expert, he will provide the team with the necessary details about the sport, the roles of the referees, and the duties of the referees. Having been a referee several times in the past, he will also provide personal feedback on the matter to help the design team make the best, easy-to-use dodgeball application on the market.

Mario Galeno - User Interaction Designer, Graphic Designer, Programmer

Mario Galeno has a lot of experience working with different organizations and helping brand themselves. His knowledge of the Adobe suites has allowed him to create wonderful works of art. His artistic knowledge and ability to take on a users perspective allows him to design logos and flyers that appeal to the consumers. He will be in charge of laying out the android application and modularizing it's features as necessary.

9.3.2 Contextual Analysis Phase - (9/19 - 10/7)

Matthew Williams - Graphic Designer, UX Analyst/Evaluator, Programmer

Matthew Williams' main responsibility is to brainstorm and work on a new logo. Also, he is in charge of analyzing how a user would interact with our application. His job is to make sure the user experience is the best it can be.

Matt L. - Interaction Designer Programmer

Matt Lukasiewicz is in charge of designing an interface that satisfies the characteristics of usabilities. It must be easy to use, error proof, function correctly, and perform well.

Kyle Peltier - UX Manager, Technical Writer, Programmer

Kyle Peltier's main responsibility is to ensure that all other members complete their respective tasks correctly and on time. Aside from UX manager, he is in charge of the technical documentation of the potential product.

Mario Galeno - User Researcher, , Programmer

Mario Galeno is charge of gathering further information of the dodgeball community. From the contextual analysis, he can better define or adjust user classes.

9.3.3 Ideation and Design Phase - (10/8 - 11/1)

Matthew Williams - Balsamiq Expert & Technical Writer

Matthew Williams' main responsibility was to design, create, and test low fidelity prototypes for the NCDA application, NDROPP. These were drawn up on paper, and then translated into balsamiq. Matthew was also in charge of contributing to the documentation of evaluation notes, and other sections of this document.

Matt Lukasiewicz - Interaction Designer Programmer

Matt Lukasiewicz is in of the usability testing during class. Also looked up design guidelines to follow when creating the application.

Kyle Peltier - Graphic Design

Mr. Peltier's responsibility was to design and create graphical layouts and logos to represent the application.

Mario Galeno - UX Manager

As UX manager, Mario Galeno must delegate the tasks to group members, provide enough information and make sure deadlines are met.

9.3.4 Evaluation Phase - (11/2 - 11/20)

Mario Galeno - Graphic Designer

Mario, alongside Matthew Williams, worked to create a high fidelity prototype. Specifically, Mario was in charge of adding functionality to all the slides and modifying the low fidelity prototypes to accommodate for the results from the initial user testing.

Matt Lukasiewicz - Technical Writer

Matt's responsibility for this phase was the writing geared towards the evaluation and testing of the high fidelity prototype.

Kyle Peltier - Technical Writer

Kyle's responsibility throughout this phase of the project consisted of advanced technical writing geared toward usability evaluation and usability testing.

Matthew Williams - Graphic Designer

Matthew's main responsibility was to take the low-fidelity prototype, and create a high-fidelity prototype. Matthew was in charge of designing and compiling screens in the application, and putting all the slides contributed by the team together and giving them functionality.

9.4 Team Expectations

- Complete all assigned work at least a day before it's due so the team can review and put together the final product.
- All documents should be uploaded to the group Google Drive account.
- All communications should be emailed to one another or talked about during our meeting times.
- Any conflicts that come up will be disputed to one another in a professional manner, otherwise will be communicated to Professor Grissom.
- We will have a standard set of hours to meet Monday,Wednesday, and Friday between 10:00am and 11:00 am and also from 1:00pm until 2:00 pm. Any other meeting times will be discussed and arranged accordingly.
- If a team member is not completing their assigned work, first it will be addressed by the team. If it persists, we will fill out evaluations at each of our discretion.

9.5 Balsamiq Screen-Shots

Task 1_New Game

Information_KP

Task 1_NewGame

Task 1_T1 Select

Task 1_Settings

Load-Stats_FINAL

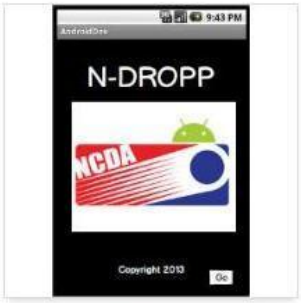
Task 2_Red Card

Task 2_Yellow Card

Task 1_Created new game

Task 4_Remove blue player

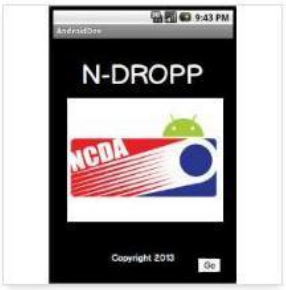
Task 3_Rulebook



Load_Screen_MLW

Game-View_SCR_KP

Shot-Clock-Violation_KP



Load_Screen_MLW

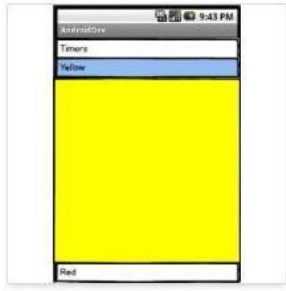
Home_Screen_MLW

In_Game_Settings_MLW

In_Game_MLW

MG_Game_View_TIMER

LoadGame_Stats_MLW



MG_Game_View_YELLOW

MG_Game_View_RED

Penalty-card_list_selected_ML

Penalty

9.6 Participant Consent and Compensation Form

Welcome to the official N-DROPP Usability Testing and Evaluation Session! The Usability Testing and Evaluation session is designed to analyze how well the N-DROPP application provides information as well as a functional service to the user. The testing session provides an opportunity for designers and developers to see their product in the hands of a user and understand how well the product performs its desired function. Please note that this session is an evaluation of the N-DROPP application, not you. It is helpful to understand how you interact with the application to see how well the application meets the design goals and how well the product functions as a whole in the hands of the user.

As a participant of the N-DROPP Usability Testing and Evaluation Session, you agree to not disclose information about the N-DROPP application to any competing organizations. In addition, you agree not to release detailed information about the application to friends, family, and/or acquaintances prior to its release date for the overall protection of the trade secrets of the N-DROPP designers. Violation of the above terms is punishable by law and forfeits any and all elements of compensation of participation. For participating in this usability session, you are expected to attempt each task provided to you by the Evaluation Facilitator. There is no penalty/consequence for abandoning a task (nor completing a task) but it is helpful to the designers if you provide additional feedback about complications with the application.

By participating in the N-DROPP Usability Testing and Evaluation Session, you will be entitled to a treat provided to you at the time of the testing session. We sincerely appreciate your participation and hope you will use the N-DROPP application in the future!

BY SIGNING BELOW, YOU AGREE TO THE ABOVE DESCRIBED TERMS AND CONDITIONS. (We ensure the confidentiality of your provided information as well as the information provided throughout the usability testing session).

_____ _____

Name of Participant (Print) Date

_____

Name of Participant (Signature)

9.7 Evaluation Facilitator Introduction

First of all, we want to thank you, <participant> , for volunteering to test our application. Before we begin, we ask that you read our Participant Consent and Compensation Form Today, you'll be testing an Android application called N-DROPP. N-DROPP is a mobile application designed for a dodgeball league called the NCDA. Its purpose is to assist referees in officiating dodgeball matches by keeping track of the game timer, the scores of both teams, and other game statistics. Other referee applications exist on the market today but none of them are geared toward the sport of dodgeball. With this usability testing session, we hope to see how well the N-DROPP application can fulfil the goals it is proclaimed to accomplish. We hope the application is easy to learn, easy to navigate, and easy to use while refereeing a dodgeball game.

During this usability testing session, we ask that you put yourself into the role of a dodgeball referee. I will give you seven tasks to complete. Aside from the task instructions, I will not provide you with additional information about the application. You may ask me questions about the device itself, but know that my responses may be limited. If you get stuck when pursuing a task, we ask you to think out loud. Say what you're thinking and what questions you're asking yourself as you navigate the application. Often times speaking your thoughts can lead to solving the problem, plus it helps us understand your thought process in solving the problem. If you are unable to complete the task, you may opt out at any time. Please indicate to me when you have completed a task or if you want to opt out of one. You may be asked additional questions throughout the testing session. Although the prototype is detailed, some features have not yet been implemented so I will indicate if you've reached such a point and we can step back through the task.

Once you've gone through all of the tasks, you will be asked to fill out a short survey of what you thought about the product and this usability testing session.

I understand that was quite a bit of information all at once. Do you have any questions before we begin?

9.8 Qualitative Data Collector(s) Evaluation Form

Participant: _____

Task #: _____

Perceived confidence of user during task: Unsure 1 2 3 4 5 Confident

What best describes user's experience during task:

A. Knew exactly what to do
B. Did not know what to do but was able to easily figure it out
C. Initially hesitant in completing the task but was able to progress
D. Confused at more than one stage of the task
E. Confused on the majority of the task
F. Felt undirected; not enough information provided to progress

Positive Experiences:

_____
_____

Negative Experiences

_____
_____

Additional Notes:

_____
_____
_____
_____
_____

9.9 Quantitative Data Collector(s) Evaluation Form

Remember to record the duration of the task!

Participant: _____

Task #: _____

Task Completed: Y N

Time to Finish: _____

Number of Mistakes: _____

Number of Mishaps: _____

Number of Errors: _____

Additional Notes:

_____

_____

9.10 Post Evaluation Survey

Circle "Y" for Yes or "N" for No:

Are you an Android user? Y N

Have you used Android devices before? Y N

Respond to the following questions to the best of your ability:

What did you like about the application?

What did you dislike about the application?

Fill in the appropriate bubble to represent N-DROPP's rating according to the provided statements:

	Disagree				**Agree**
If asked to complete any of the tasks again, you could complete them much faster than the first time.	○	○	○	○	○
It was easy to find the information I needed in order to complete the tasks.	○	○	○	○	○
The visual organization of N-DROPP is informative.	○	○	○	○	○
The visual organization of N-DROPP is appealing.	○	○	○	○	○
N-DROPP's user interface is pleasant.	○	○	○	○	○
N-DROPP has all of the functions and capabilities I expected it would have for the first ever dodgeball referee application.	○	○	○	○	○
Overall, I was satisfied with how easy it was to use N-DROPP.	○	○	○	○	○

9.11 High Fidelity Prototype Screenshots (Keynotopia & Microsoft PPT)

10. References

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