Mathspace

Design & Evaluation of User Experience Enhancement

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INFO H554: User Experience Research Topics Under Independent Study
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Proposal

Course Background

The independent study on Mathspace (https://mathspace.co) user experience analysis will be taken up as a group project under the curriculum of Human-Computer Interaction, Indiana University, as a 1 credit hour Independent Study. The group consists of the following 3 students, all pursuing the same academic program.

Introduction to Team

● Malvika Bansal: 2nd year Masters (HCI). Malvika holds a Bachelor's degree in Computer Engineering from the University of Pune, India and has also worked as a software developer in the field of Information Technology. At IU, she is pursuing both design-oriented and research studies with a strong focus toward the study of user experience design with Natural User Interfaces (using gestural interactions), ubiquitous applications and also, front end design for web apps and websites. She is currently a part of the Philanthropic Informatics Research Lab and is collaborating on a project at the Advanced Visualization Lab.

● Shivin Saxena: 2nd year Masters (HCI). With a background in Computer Science, he has briefly worked as a Software Engineer and is now pursuing studies in HCI to shift his focus to Human-Centered Computing and Interaction Design. Specifically, Shivin's research interests lie in designing for minimalist yet enhanced and intuitive user experience with Web & Touchless interfaces. At IUPUI, he is a part of the Philanthropic Informatics Research Lab and is currently contributing to a research study at the Advanced Visualization Lab.

● Ryan Ahmed: 2nd year Masters (HCI). Ryan is pursuing both design and research track in user experience. He has a Bachelors' degree in Computer Graphics and Interactive Media and has 8 years of work experience designing social media platforms in Bangladesh before joining the Masters' program at Indiana University. During summer of 2014 Ryan has also worked with Pearson as a User Experience Research Intern, conducting user tests and writing test scripts and findings reports. Other areas of research that Ryan is involved in includes designing for information overload and tangible user interfaces.

Requirements for Independent Study

Constraints

The scope of the project will be limited by time as the course accounts for 5 week's work from each team member working 9 hours per week. In the 15 available weeks during the Fall semester, we propose a tentative schedule broken down in following 2 phases:
  ● Phase 1 - Sept 1 through Sept 12 (2 work weeks): This phase will include problem space analysis and offering proposal for potential projects to Mathspace.
  ● Phase 2 - Oct 27 through Nov 14 (3 work weeks): Following selection of specific topic, this phase will include research, user tests and reporting findings followed by design recommendations as UI wireframes.

Methodology

The project will follow a typical research and design methodology followed by defining the problem space surrounding a specific topic within the Mathspace application. The workflow is structured as an iterative process involving the following stages: *Expert Evaluation* $\rightarrow$ *Conduct Research* $\rightarrow$ *Design Recommendations*.

Summary of Proposals

Following are our recommendations for topics to explore during the course of this group project. Due to time constraints, only one of the proposed topics below can be nominated for research. Mathspace team is requested to provide insights and feedback on the following proposals in order to design a study most beneficial for either ongoing or future development of the application. A more detailed proposal will be prepared after initial selection of topic.

Existing and planned feature evaluation

Topic 1: Efficacy of video tutorials

This research will focus on the video tutorials available from within Mathspace guiding students and instructors on how to use the Mathspace interface. Based on the findings report on test conducted on 07/22/2014, users mentioned of a general attitude to skip video tutorials with expectation of the UI to be learnable by exploration. However, the novel writing system of Mathspace was not easily discovered by the users who had not watched the video, although all later acknowledged its usefulness. While open for suggestions from Mathspace team, some of the areas this research can explore are as follows:
- Possibility of integration of the video tutorial within the workspace to maximize viewership
- Investigate clarity and usefulness of the tutorial
- Identify appropriate contexts for presenting the tutorials

Findings from the research will lead to recommendations and UI wireframe designs catering to optimal solutions.

Topic 2: Instructor desktop UI

Following through the instructor test findings, the platform of interaction is proposed for further investigation. While most instructors were comfortable using mobile (tablet) device for creating quizzes on Mathspace, there was a general preference mentioned for desktop interface. An A/B test can be devised to compare performance and comfort level of instructors in using touch controls on a mobile device against mouse-keyboard interaction on traditional desktop platform while identifying any compromise in essential functionality.

Extension of user engagement

Topic 3: Gamification through positive & negative reinforcement

Proposed research is to explore the possibility of introducing gamification for students in solving math problems on Mathspace. The study will test test the impact of positive and negative reinforcements with each step of the problem-solving as well as during progression through the exercises. The research will follow design recommendations based on findings.

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Selected Topic:

Integrating Growth Mindset with Persistent Indication of Reward Status

Based on Topic 3 (Gamification through positive & negative reinforcement) a variation was proposed to have the Mathspace user interface to communicate reinforcements following the concept of Growth Mindset[1].

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Expectation and deliverables

Topic and scope

Generally the course of the project is suggested to start with defining the topic focus. Mathspace team is requested to provide feedback on proposals presented, communicate suggestions fitting within the scope and timeline of the course to help set the premises for research. Following such, test plans will be prepared to conduct interviews and user tests as relevant to the topic. Thereafter the findings reports will be prepared and shared with Mathspace along with design recommendations including UI mockups and wireframes. Approximate milestones proposed are:

- 09/09 - Summary of research proposals shared with Mathspace
- 10/24 - Feedback and response from Mathspace to mutually agree on topic and scope of research
- 11/07 - Test findings to be shared for feedback; *(prompt response will be requested at this stage from Mathspace to incorporate findings and suggestions in design recommendations)*
- 11/14 - Final design mockups / wireframes to be shared

Deliverables

List of documents to be provided throughout the course of the independent study:

- **Proposal** *(this document)***:** A summary outline of the course, team members in the project, suggestions for topics in consideration of scope and constraints of the course timeline.
- **Research plan:** Problem space definition, user test scripts and evaluation criteria.
- **Findings report:** A thorough report of test findings, any identified expert evaluations and recommendations.
- **UI wireframes:** UI design recommendations as applicable to improve or extend existing features.

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[1] Khan, S. (2014, August 19). The Learning Myth: Why I'll Never Tell My Son He's Smart. Retrieved December 12, 2014, from https://www.khanacademy.org/about/blog/post/95208400815/the-learning-myth-why-ill-never-tell-my-son-hes

UI Wireframes

The UI refactoring of the Mathspace environment is proposed based on the following concepts generated on the Growth Mindset and reward structure.

Concept Brief

- Proposed research is to explore the possibility of introducing **gamification** for students in solving math problems on Mathspace. The research will follow design recommendations based on findings.

- Specifically, the study will explore *the use of badges combined with a growth-mindset like approach* to monitor student's progress in solving math problems and motivating them to keep up the hard work.

- The badges and the accompanying language will be designed in a way to appreciate students for their hard work and struggle and motivate them to continue working hard, that is, **praising the action vs the specific attribute**.

- Badges are among the most visible elements of gamification, the use of game-thinking and game mechanics to engage media audiences. Combine them with a growth mindset model that seeks to *praise the person's action to keep them focused on improving that action.*

Implementation of Badges

We propose to use visuals of "badges" to display students' level of achieved mastery, that may be calculated on the following:

- *Milestones*: To recognize milestone achievements such as completing 'X' exercises during lifetime or within a certain category of topics or achieving milestone scores (eg: 100/500/X points).
- *Best Timing*: acknowledging the best recorded time for solving a problem.
- Tracking and acknowledging
    - the *number of problems solved in a single session.*
    - *weekly stats* and progress. For example, best 'weekly points' scored.
    - the user when they *surpass* their friends.
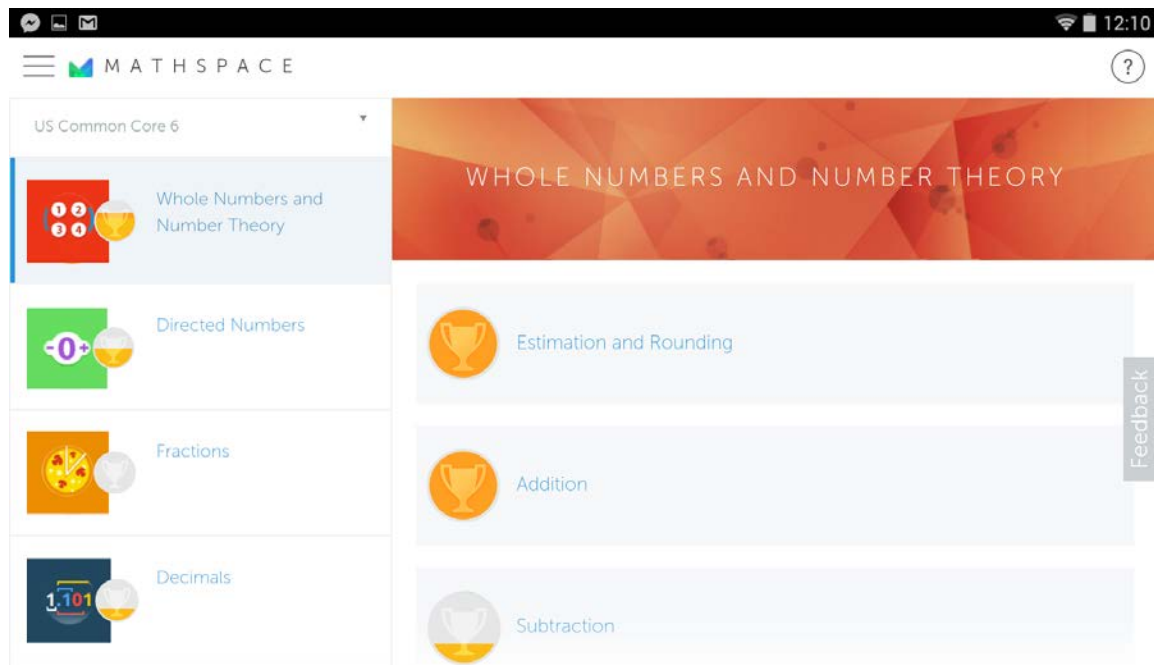   - Number of mistakes/corrections

Interactive Prototype

An interactive prototype of an alternate UI is available at: http://invis.io/GA1QVB5J3

Some screens from the prototype are displayed below:
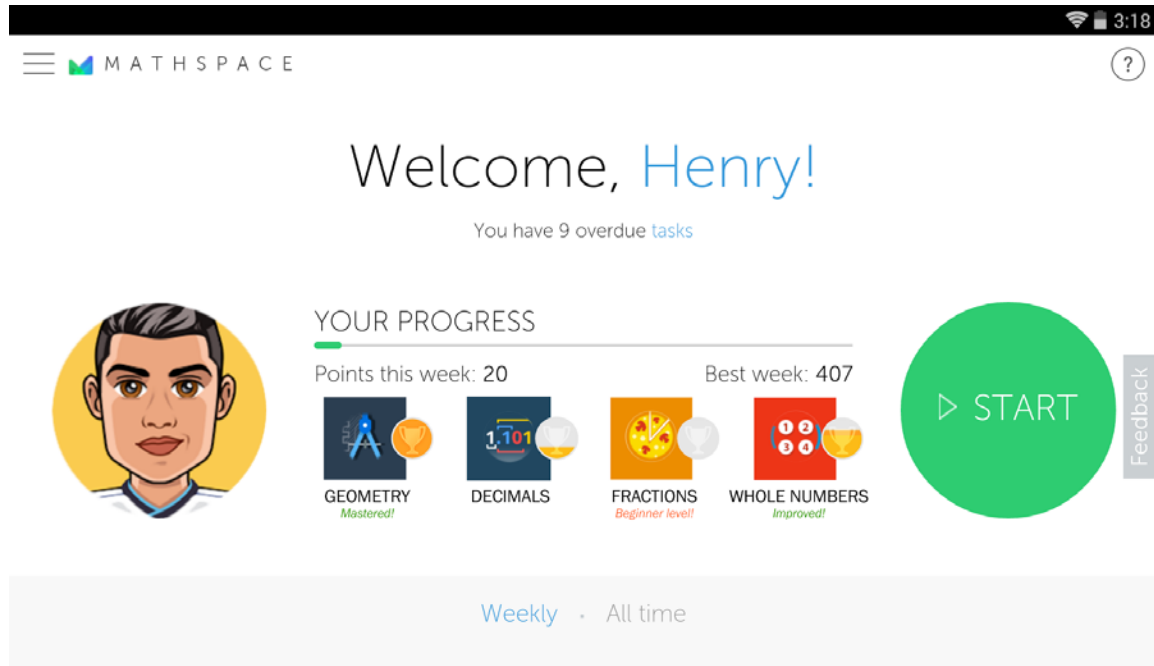
Dashboard: Progress bar replaced with indicator of mastery level with added labels for topics.

Topics: Numbered rings replaced with indicator of mastery level for each subtopic and categories reflect

a cumulative mastery of all subtopics instead of progress bar.

Task (successful completion of problem when resulting in a level up): Added feedback of changed status for the topic.

Research Plan

Plan Summary

The research plan formulated to evaluate the effectiveness of the alternate designs follow usability testing with 4 recruited participants. The test script aims to compare the alternate design against the original using a guided walkthrough and think-aloud protocol. The test sequence is alternated to minimize ordering effect.

Test Script

Mathspace App
User: henrys4
Password: demo1234

Mathspace (new) Prototype
http://invis.io/GA1QVB5J3

Thank you for coming in today to help us improve a product with your valuable feedback. We are going to take a look at "Mathspace" which is a math learning app for students. The app is made for tablet use and offers students practice exercises and test questions to improve their math solving skills. We are going to show you screens from the current version of Mathspace and also an alternate version of the same app.

We would like you to explore these and I will ask you questions related to your understanding of what the app offers and how useful do you find specific features and information presented.

Background questions

Let us start with some background questions before working with the app.
- Would you use an app or software that helps your skill on a subject outside of class? Why or why not?
- Are you familiar with test preparation or learning software for specific subjects?
  (If yes)
  - What was your primary reason for using such tools?
  - Do you feel the tool or tools helped you achieve your goals? How?
  - Of the following, which would you say are the key motivating factors for you to keep using such tools?
    - Visible individual improvement over time *(reflection on self-improvement)*
    - Visible improvement compared to others in your class *(a sense of competition)*
    - Access to hints and resources along the way to help your learning *(a sense of guidance and mentorship)*

■ *(Anything else?)*

Version 1: Original Mathspace (on tablet)

Okay, let's take a look at the current and functional version of the app. Assume you have logged in and this is the starting screen.

I will ask you to spend a minute to navigate and click on the screen to briefly explore the app and familiarize yourself with the basic screens.

Version 2: Alternate Mathspace (prototype on desktop)

Okay, here's the alternate version of the app. The alternate version is a prototype where you'll see essentially screenshots with limited functionality for demo purposes only. Assume you have logged in and this is the starting screen.

I will ask you to spend a minute to navigate and click on the screen to briefly explore the app and familiarize yourself with the basic screens. As I mentioned, not everything is clickable here, so let me know before you try to click.

Comparison questions

Screen 1: Welcome screen

Please let me know briefly what you see here.
- In the original version, what are the circular icons?
  - Do you see the ring around each circular icon? What do they mean?
- In the alternate version, what are the square icons?
  - What does the trophy icon mean? Why are they different for each square icon?
- Do you see anything here and tells you about your progress status and how well you are doing in various math topics?
  - How does this information compare between the 2 versions? Are they presenting different information?
  - Please explain what you think they are displaying in each version.

- Let's see which tasks are incomplete. (You may click).

- What do you see here? How would you prioritize which tasks you should attempt first?
  - (You may scroll down). What do you expect "View all Topics" will show you?

○ Okay, let's click there and check it out.

Screen 2: All Topics

Please take a moment to explore this screen

- On the original app, what are the gray and green bars on the left and what are the numbers with green circles on the right?
    ○ Is this useful information for you? Why or why not?
- Now for the alternate version, what do the trophies represent on the left column and right?
- In terms of usefulness and ease of understanding, which of the 2 versions do you prefer?
    ○ In a scale of 1 - 5, how strong is this preference (1: very weak, 5: very strong)

Let's go ahead and start working on your assignments
    ○ *(Menu > Dashboard > Start)*
    ○ *(A moment to check out the assignment cover screen and move on)*

Screen 3a: Exercise screen step 1

This is the exercise area where you can write your answers or steps toward the solution and also access hints along the way. After completing a solution you can click "Check" and move on to the next problem in the assignment.

- Which math topic does the current problem belong to?
    ○ Is it important for you to see this information on this screen?
- Do you see any indication of progress in the current assignment?
    ○ Recall the "All Topics" screen and progress indicators there. Is the same information shown here?
    ○ What do you think the progress status represents *(prompt examples if unclear: completion through assignment, current standing / score, level of mastery)*

- Let's try to solve this problem
    ○ *(Prompt to write answer in the writing area, or just click there for prototype)*
    ○ Ok, let's submit the answer. *(Prompt to click "Check")*

- What do you see here?
    ○ How did this answer change your progress or score?
        ■ Is it important for you to see this information here?
        ■ *(For alternate ver.)* Do you have any comments on how the information is being displayed?
- Ok, let's now move on to the next problem *("Continue")*
    ○ What progress status do you see on this screen?
        ■ (For alternate ver.) How would you find out more details on this status? (Click on yellow box)
            ● Was this easy to find? Would you expect this to displayed differently? How?

Well, that's all for the test. One last overall question,

- In regards to the whole app experience from this session, which version do you prefer?
    - In a scale of 1 -5, how strong is this preference? (1: very weak, 5: very strong)
    - Among the alternate designs, please explain which features - in either version - you found most or least useful.

Findings Report

Findings Summary

The usability tests were conducted to compare participants' understanding of both the original and alternate interfaces of Mathspace.

Participants: Total 4 (2 male, 2 female), graduate students.

Tests: 30 minutes each, scripted comparative study compensated for order effect.

Sessions: Video recorded screens with audio for reference and observation notes.

The tests inform that "status indicators" on both versions are generally interpreted as completion status instead of mastery level. However, some users recognized the "trophy" visualization on the alternate design could also represent some kind of "level" accomplishment whereas the numbers in the original design give an indication of "percentage completed". After explaining the intended purpose as mastery level, participant felt the alternate design makes more sense but preferred to see a clearer communication.

Highlights

● Participants who interpreted shown progress to be toward completion expressed strong preference for status indicators in the original app. This was due mainly due to the values (in scale of 100) displayed next to graphics communicated a more concrete completion status in percentage.
  In the alternate design:

● Trophy icons without text labels are also often misinterpreted as *completion goal* instead of *reward for mastery*.
● Topic icons with visible topic labels are preferred on Dashboard.
● Visualization of differential progress toward mastery (recent progress highlighted with a darker shade of orange) is not clearly visible.
● Topic and status corner box on task section is too small for comfortable viewing of content and the large topic icon in this area is undesirable.
● Flipping the status box and indicative icon to view details lacks affordance of being clickable.
● Pop-up notification of achievement at the end of solving a problem is both useful and inspiring.

Recommendations

Based on the test reports, we would recommend further improvement and evaluation of alternate design. Although the participants appreciated the information addition to the interface, the intended purpose of the trophies to display mastery level was largely misunderstood. Some recommendations are:

● Use mastery level indicators consistently with labels to avoid any confusion with completion status. Using a different graphic than trophy to afford recognition of "mastery" can also be considered.
● Emphasize on topic text labels more than icons especially when combined with graphical status indicator.
● In the task section (problem solving pages), consider more streamlined and readable information in the topic-status box to avoid the need to "flip".

References

- [Interactive prototype of alternate design](#)
- [Test script](#)
- [Video recording of test sessions](#)

Detailed Findings

Background questions

- All participants indicated positive attitude to using skill development software or app outside class
  - All were familiar with using such applications in the past
  - 2 participants mentioned they would be most motivated by indication of self-improvement over comparison with others or learning resource availability. One participant also mentioned professional and career goals as a potential motivating factor for using such applications.

Dashboard (welcome screen)

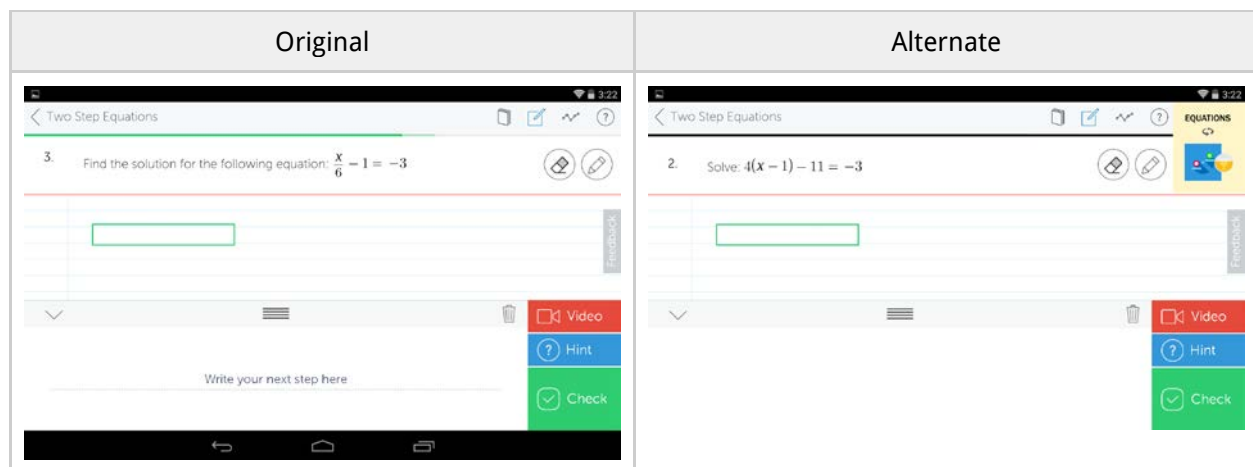| Original	Alternate
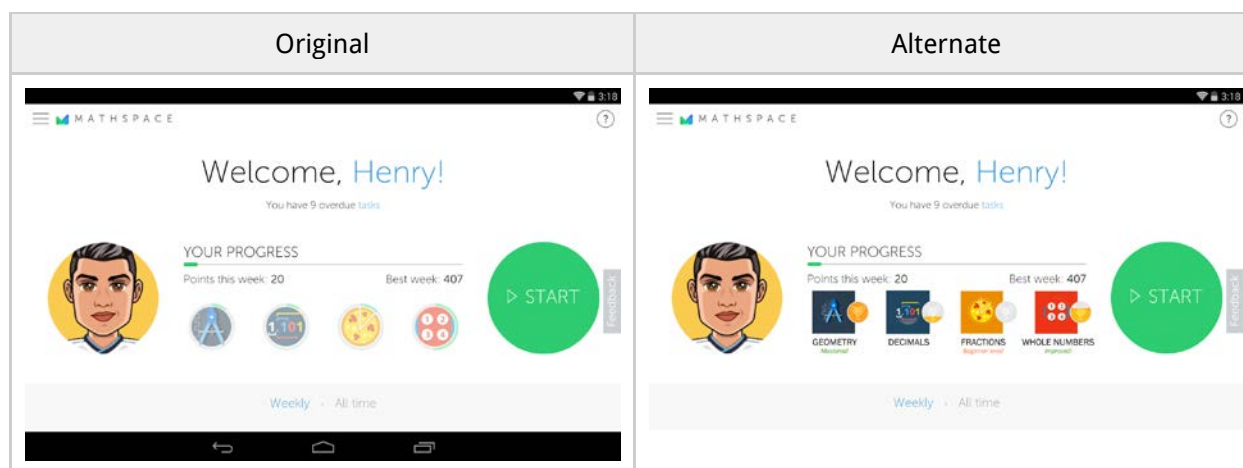
- On original app, participants recognized topic icons to be sections or collections of assignments
  - None were able to determine which topic each icon represented, but mentioned they would click on them to explore when specifically asked how they would find out the details.
  - The ring around the icons were in all cases interpreted as individual progress (toward completion) in each section
- The trophies on the alternate design had mixed reaction:
  - One participant considered this to be completion indicator and understood this to be a different information from the text label at the bottom reading "Mastered", "Beginner" or "Improved" that are clearly indicating mastery status.
  - Three participants identified this as level progress / mastery with some hesitation.
  - One participant (who started with the original app) explained that the alternate design gave an impression of a set goal or highest achievable level in each topic whereas the green ring in the original app was interpreted as something temporary that resets every week or starts again from zero when circle is complete.
- On both the original and alternate versions of the app, one of the participants viewed the information conveyed by the "Your Progress" bar differently and commented that this probably indicates progress towards completion of goals set by the user.

All Topics

Original	Alternate
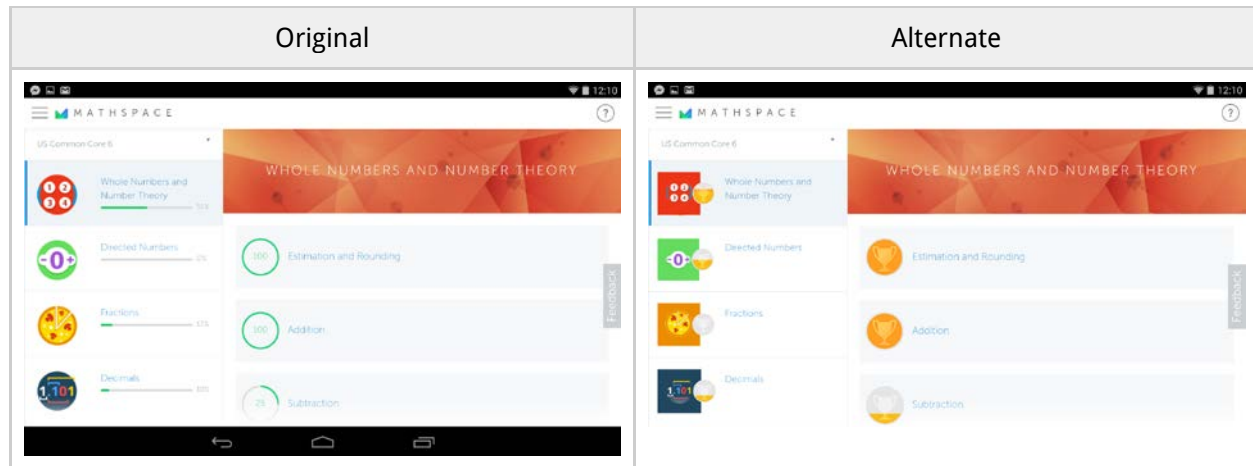
- None of the participants, regardless of test sequence, were able to recognize the status visualization to be reflecting mastery. They assumed the trophies on alternate design to represent percentage of completion same as the bars and circles in the original app.
  - After providing explanation, one user said the alternate design made more sense if mastery is being displayed opposed to original app with status bars and numbered circles that gave her a more prominent impression of "percentage".
  - Two participants mentioned the trophies on Dashboard made sense but on All Topics he would prefer a clearer report (using numbers) of progress status rather than graphical visualization.
- It was clear to all participants on both the versions that the topic status is a cumulative representation of all sub-topic status under it.
- All understood both versions of this page to be displaying the exact same information (status indicators representing completion).

Task section

Original	Alternate

- All participants mentioned it was important for them to know which topic the current problem belonged to
  - They were unable to know this on the original app, but easily found the topic heading

on the alternate design.
- Most participants missed the status indicator bar in the original app and the others mentioned it was difficult to find
    - One who saw the alternate design first mentioned she would not notice it if she hadn't seen the alternate design first.
    - One user (who saw the block version of the bar instead of continuous line in original app) was unsure what the blocks meant and assumed all blocks represent right answers but different colors might represent triggers that caused increase in mastery.
    - Status indicator in the alternate design was generally found to be too small
        - 3 out of 4 participants did not guess it is clickable and could not recognize the "flip" icon - one said it looked like "refresh"
        - One participant did not find the topic icon to be important here, instead preferred the status (trophy) and some textual clarification.
        - While all appreciated the additional information in the alternate design, two participants mentioned the visual appearance makes it feel undesirably separated from the rest of the screen and difficult to read.

Original	Alternate
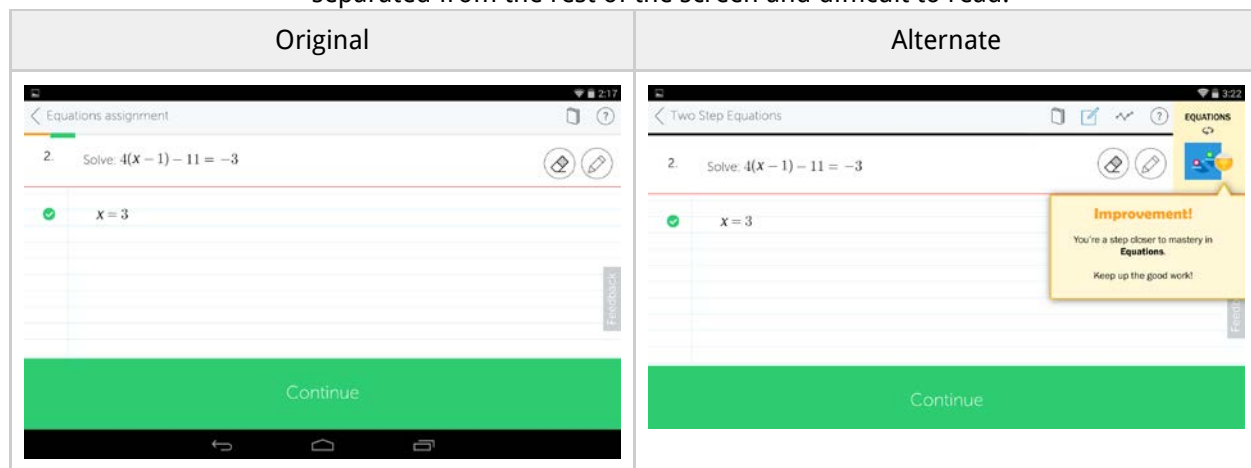
- All appreciated the additional message pop-up in alternate design to notify improvement of mastery.
    - Two participants mentioned it would not be desirable to have this message pop-up at the end of every problem solved.
    - Only one participant was able to notice the differential mastery visualization represented within the trophy icon.

Preference Ratings

Participants were asked to rate their preference between the original app interface and the alternate design on different aspects of the app.

- All Topics: status indicators in terms of usefulness and ease of understanding
    - One participant preferred the alternate design with a preference strength of 3/5.
    - Another participant preferred the original (did not assign strength value) because it offered more concrete representation of "progress" through wider bar and visuals+value combined. The user interpreted the status to be progress toward completion in both designs.
    - One participant strongly preferred (4/5) the original version's representation of "progress" through colored bars and numbers (assuming progress is shown for completion).

○ One participant was unsure of any preference.
- Overall navigation and experience
    - ○ Two participants preferred the alternate design with an average strength of 4.25/5.
    - ○ One preferred the original app experience with strength 4/5.
    - ○ Other participants had mixed opinions about different components and were unable to form any preference.