Materials Organization Usability Test

Graspable Math UX Project

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This document describes a prototype design that was created to improve how Graspable Math stores and retrieves saved materials. It incidentally includes some changes to improve the use of real estate on the canvas editing page.

The analysis documents upon which the prototype was based are in the project folder here (view-only link):
https://drive.google.com/drive/folders/17HVo-iWgD_Q-x3VKmu5-NIXtMlWCqKhc?usp=sharing

Note that in some earlier analysis it was suggested that "materials" refer to published canvases and activities, and unpublished materials should be "documents". In design we decided to avoid introducing that new term, and we use "materials" whether the canvas is public or shared or private.

Test Methodology

The prototype was implemented in Adobe XD. It is stored in Adobe's cloud, but some backups from different time periods are stored in the "XD Backups" subfolder.

The prototype is designed to approximate the size of an Apple iPad. This is a compromise. From our survey we know that smartphones are an important device to support, but the tested functionality is targeted primarily at teachers, and we expect them to have access to tablet-sized devices or larger.

A Usability Test Protocol document was shared with the test participants and reviewed with them before they started their tasks. It can be found in the project folder.

The usability test was conducted with one pilot tester and three classroom teachers. The classroom teachers were volunteers, recruited from our teacher survey. They were told that test sessions would last no longer than two hours, and offered compensation accordingly. The participants all completed the test tasks in about 20 minutes. One participant was unable to reach the Adobe XD prototype via their school's Internet connection: we rescheduled the test session so they could complete it from their home instead.

Participants were asked to share their screen display (via Zoom) and think aloud while they completed the following tasks with the prototype:

1. Find a published material that students can use to practice introductory algebra on an iPad.
2. Save a copy of the material from task #1 for your personal use, and find it in your personal materials folders.
3. Display an information panel for the material you created in task #2.

All of the test sessions were recorded and stored in the "Test Sessions" subfolder.

The test was conducted using an informal [RITE method](), where RITE stands for Rapid Iterative Testing and Evaluation. In practice, this means the prototype was updated after each test session based on the participants' input.

Home Page
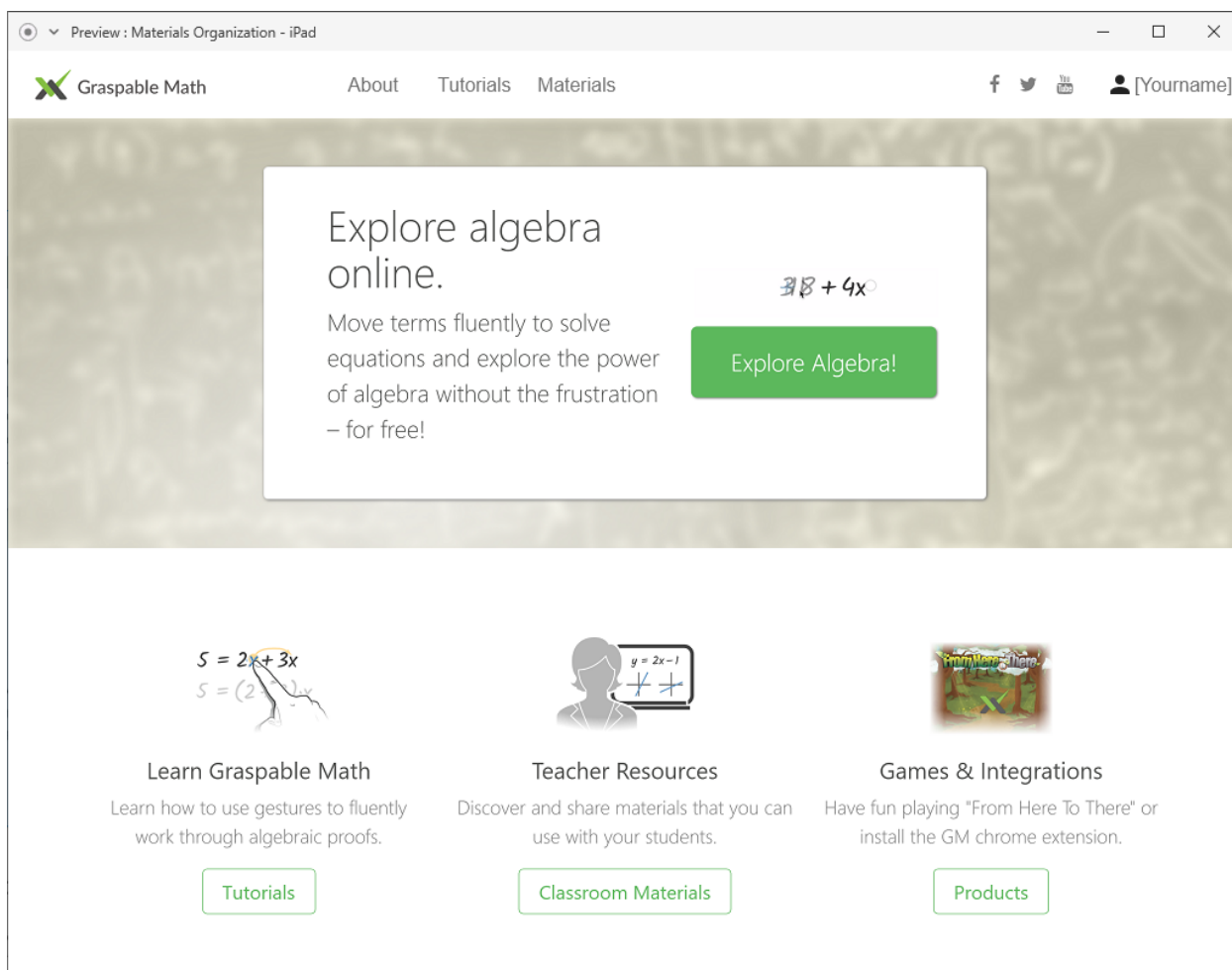
The "Tutorials" link in the header bar replaces the existing "Learn" link. This makes it more consistent with the "Tutorials" button further down the page, and addresses concerns that users may confuse it with some other purpose (e.g. "learn how you can get Graspable Math"). This was changed after testing was complete, so we don't know if the change is effective.

The "Materials" link in the header bar replaces the existing "Teachers" link. It goes to the new Materials page. (As does the Classroom Materials button.)

A user account / sign in control has been added to the header bar, showing that the user is currently signed in. This is necessary so users have access to their own materials on the Materials page. During testing, clicking on this control took users directly to the My Materials page: participants frequently used this functionality. After testing, the prototype was updated so the control has a dropdown menu, with a "My
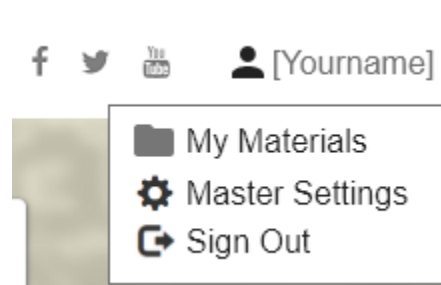
Materials" menu item that goes to the My Materials page. The same menu is used on the canvas header bar. Note that the term "Sign" (as "Sign Out") is used instead of "Log", for better consistency with Google Account terminology.

Tutorial Page

This page is accessible from the "Tutorials" link in the header bar, and the "Tutorials" button on the Home Page. It has the same header bar as the Home Page.

This page was included in some of the tests to explore the idea that relevant Graspable-developed canvases could be referenced from some of the tutorial pages, providing users another opportunity to try out what they learn. One of the test participants did try to use the Learn page to complete the first task, but the prototype wasn't set up correctly. The "Beginner Algebra Practice" material displayed on the page is now linked to the relevant canvas.

Materials Page

This page replaces the existing Materials page.

Materials > Explore: Default View

Materials > Explore: Filtered View

Materials Subheader Bar

Beneath the header bar (the same as on the Home and Tutorials pages) is a subheader bar with three options, which controls what is displayed beneath the subheader bar.

- Explore: Shows public materials available to all GM users (as displayed in the image above). This is the default option.
- Favorites: Shows materials that the signed-in user has Liked, starting with those most recently liked and going back in time. If the user is not signed in, this link would request that they do so. The Favorites page was not implemented in the prototype.
- Mine: Shows materials that belong to the signed-in user. (See My Materials, below.) If the user is not signed in, this link would request that they do so.

The subheader bar is based on similar controls used by GeoGebra for Classroom Resources. The prototype simply colors the selected option green, to be consistent with GM branding colors. It should probably be more strongly differentiated from the unselected options, but the testers didn't have any problems with it.

Material Filters

The Explore page supports several filter controls. Because of limitations of XD, clicking on any of these controls simulated the assignment of multiple filters to help the participant find target materials. However, the filter controls did seem to be clearly understood by all participants.

- A text search field. During testing the gray input prompt text simply said "Search". After testing the following updates were made:
  - On unfiltered pages, the input prompt indicates what fields the search would be applied to.
  - On filtered pages, the text simulates the user typing "practice" into the field.
- A language filter dropdown. This is intended to default to the selected browser language. The user could select any other language, or "Any Language" to remove filtering by language.
- A material type dropdown. This would default to "Any Material Type" but has options for "Canvas" and "Activity".
- A "Featured Materials Only" checkbox. Unchecked by default. Assumes that as materials are approved for public use, the curator would indicate that particularly good materials are "Featured", as indicated by the green tag on some of the material tiles. Not available when the user is looking at their personal materials.
- A list of "Topics" checkboxes. Topics are intended to be small set of subject categories that are curated by Graspable Inc., perhaps based on some standards like Common Core. I believe the GM Use committee was working on such a list. A material could be assigned to multiple topics. (We also recommend that "Gestures" be one of the topics, for Graspable-designed materials that help users learn to use GM.)
- A list of "Devices" checkboxes. This setting allows an author to indicate what sizes of devices work well with the material.

It was not implemented in the prototype, but a control to filter on the material's target age or grade range could also be useful.

# Material Tiles

Materials in the main display area are represented as tiles with the following characteristics:

- Thumbnail: The gray box would show a small image related to the material. It would default to an image of the canvas, but should allow the user to upload an image.
- "Featured" indicator: See Material Filters, above.
- Title
- Doctype: Either "Canvas" or "Activity".
- Author Name
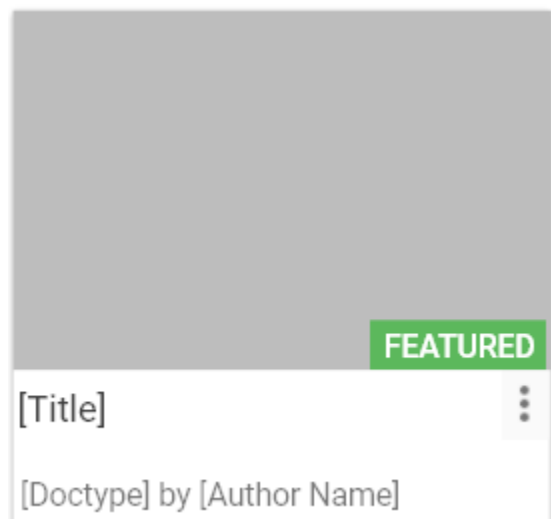
- Context menu (the 3 vertical dots). Test participants understood that these dots could be clicked to summon a context menu for the material, complete their tasks. During testing the prototype did menus were added.
  - Open: Opens the material. See Canvas: Menu.
  - Information: Opens the material and displays its information panel. See Canvas: Menu.
  - Move: Relocate the material to another filter. Not available for public materials.
  - Copy: Opens the material and displays the Save a Copy panel. See Canvas: Menu.
  - Link: Opens the material and displays the Save a Link panel. See Links, below.Not implemented in the prototype.
  - Delete: Moves the material to the user's trash. Not available for public materials. See Trash, below. Not implemented in the prototype.
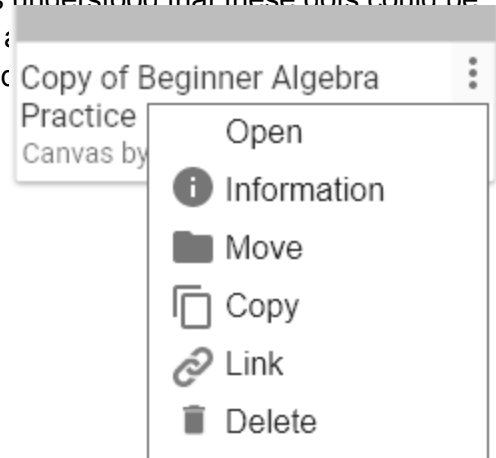
Explore: Default View

The default Explore display shows a small set of featured and popular materials, grouped by topic. The prototype shows materials for the topics "Gestures" and "Counting & Cardinality". Each topic includes a "SHOW ALL" link that would filter the display to display only materials for that topic. This is based on similar controls used by GeoGebra.

Explore: Filtered View

The test participants arrived at this page by clicking any of the following controls on the Explore default view page: search bar, material type, Topics, Devices. The material the participants needed for their task is listed first.

The material tiles are no longer grouped by topic. Instead, the total number of matching materials is displayed, as well as controls allowing the user to page through the results. The filter terms are also displayed. This is based on Amazon product search mechanisms.

1-6 of 45 results for Canvas : Algebra : Tablet : "practice"   < 1 2 3 4 5 … >

The prototype does not provide any mechanism for sorting the search results. The following options are suggested. Also, any selected sort order should be reversible.

- Most popular to least popular. (Default)
- Most recently updated to least recently updated.
- Alphabetical order by title, increasing.
- Alphabetical order by author, increasing.

My Materials

Preview : Materials Organization - iPad

Graspable Math   About   Tutorials   Materials   f   🐦   ▶️   👤 [Yourname]

Explore   Favorites   Mine

My Materials   🗑 Trash

Search for text in title, descriptions, author name, or tags   🔍

English   ▼   + CREATE NEW   📁 Algebra ⋮   📁 Geometry ⋮

Any Material Type   ▼

Topics
☐ Algebra
☐ Fractions
☐ Functions
☐ Geometry   🔗
☐ Gestures
☐ Operations   [Title]   ⋮   Link to [Title] ⋮   [Title]   ⋮

Devices   [Doctype] by [Author Name]   [Doctype] by [Author Name]   [Doctype] by [Author Name]
☐ Smartboards
☐ Desktop
☐ Laptop
☐ Tablet
☐ Smartphone

Materials > Mine: Default (Root) View

✖ Graspable Math   About   Tutorials   Materials   f 🐦 ▶ 👤 [Yourname]

Explore   Favorites   Mine

My Materials > Algebra   🗑 Trash

Search for text in title, descriptions, author name, or tags   🔍

| English ▼ |

| Any Material Type ▼ |

Topics
☐ Algebra
☐ Fractions
☐ Functions
☐ Geometry
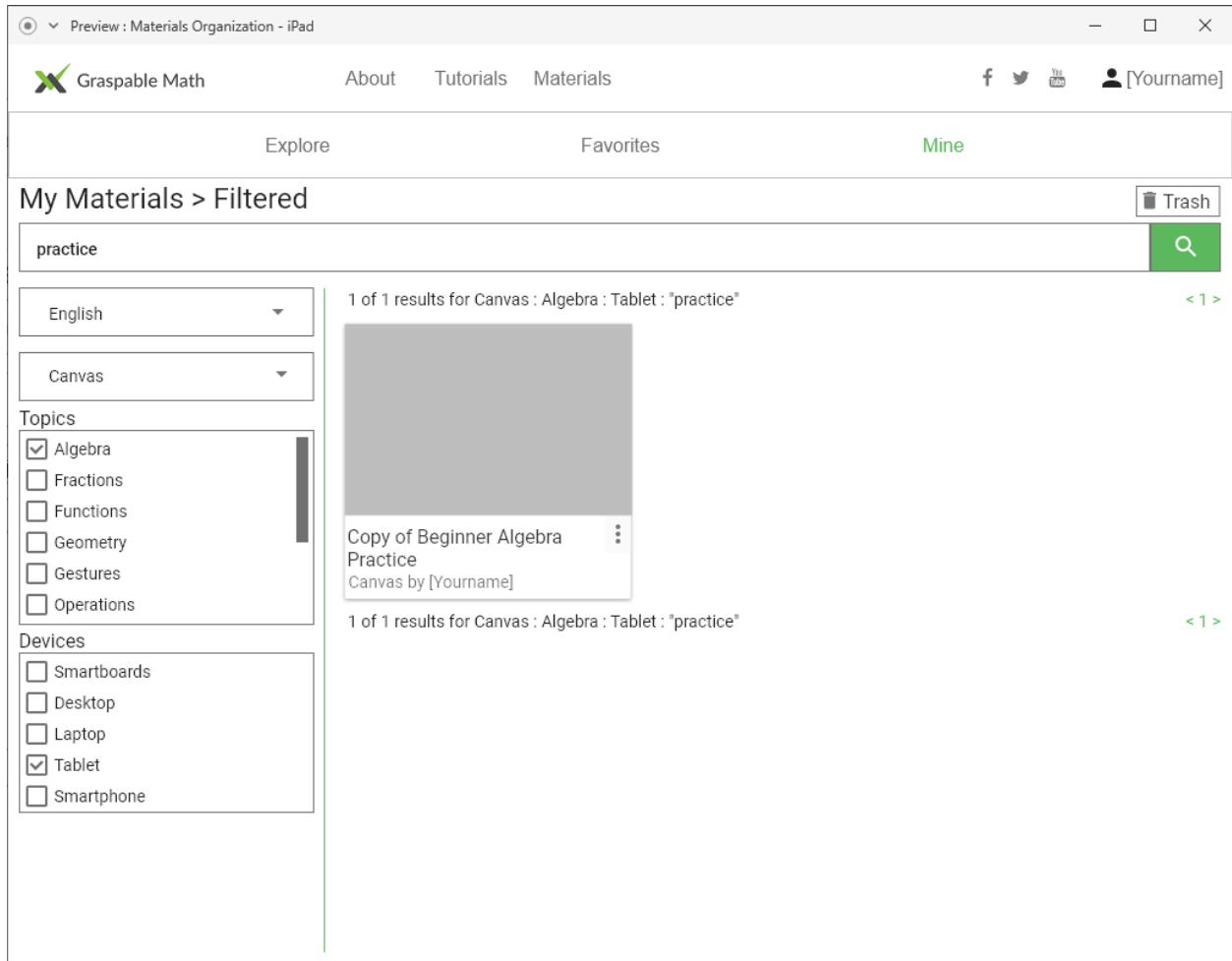☐ Gestures
☐ Operations

Devices
☐ Smartboards
☐ Desktop
☐ Laptop
☐ Tablet
☐ Smartphone

📁 Class One ⋮   📁 Class Two ⋮   📁 Class Three ⋮

Copy of Beginner Algebra Practice   ⋮
Canvas by [Yourname]

Materials > Mine: Algebra Folder

Materials > Mine: Filtered View

Note the following differences between the "My Materials" page and the "Explore" page.

- The title bar says "My Materials > [current folder / filtered]". Users can click on a section of the title to navigate back up the folder hierarchy.
- A "Trash" icon. See Trash, below.
- The "Featured Materials" filter is gone.
- The CREATE NEW button above the materials. This would be used to create new materials and folders. It is not functional in the prototype.
- Folders are listed above the materials. See Folders, below.
- A folder may contain a link, as indicated by the green icon. See Links, below.

Materials, links, and folders are referred to collectively as "objects".

The My Materials page should also probably include the ability to filter objects by sharing status: Any (default), Private, Shareable, Public, Featured.

Folders
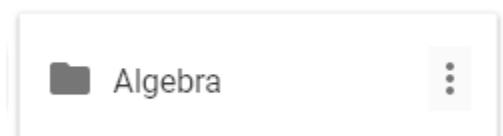
Folders are used to group materials together. They use a paradigm familiar to users from computer operating systems. Test participants were able to find a copied canvas in the Algebra fonder without difficulty.

The folder context menu is not implemented in the prototype. It would allow the user to rename, move, or delete the folder. Allowing the user to select a color for the folder would also be helpful.

Requesting to delete a folder should display the number of objects in the folder, and require confirmation before proceeding.

A major limitation of the folder paradigm is that an object cannot be stored in more than one folder. We suggest using links (see below) to help overcome this limitation.

Links

The Material page in the prototype is largely missing mechanisms to organize materials that are shared with other specific users but not made public. The prototype has a few references to "link" materials, which are intended to be references to canvases or activities that are stored elsewhere: these are intended to help with such sharing, as well as to address limitations of the folder storage paradigm. This is important functionality but was not part of our test protocol, other than the linked material depicted on the My Materials root page (indicated by the green link icon). None of the test participants commented on it.
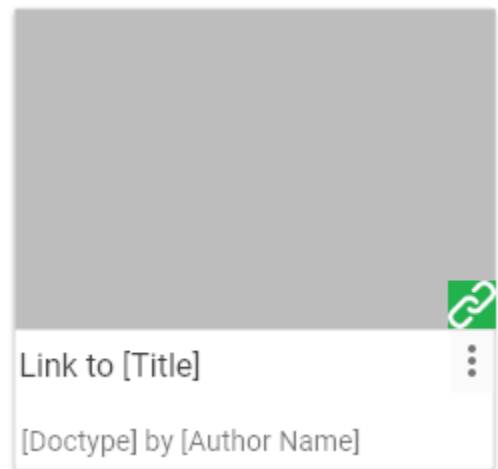
If the user clicks on a link to a material that is deleted or no longer shared, the system must notify them that the material is no longer available.

It may also be helpful to support links to folders that belong to the user or to other users.

Trash

A Trash mechanism, familiar to users from computer operating systems, would allow users to delete materials while minimizing risk of accidental material loss. The trash icon was depicted in the prototype but not implemented or used in testing. None of the test participants commented on it.

Dragging an object (material, link, or folder) to the trash icon on the My Materials page would delete it.

Clicking the trash icon would display all of the user's objects that have been deleted in the past 30 days. They could be restored to the user's root folder. On the 31st day after an object is deleted, it is permanently removed from the system.

Canvas

The prototype includes substantial changes to the controls on the Canvas page, based on the following considerations:

- We needed to introduce new functionality to support organization of materials.
- We wanted to address issues with using the existing canvas menus on tablets.
- We wanted to improve the usability of the canvas menus in general.

Feedback from testing caused us to redesign our initial changes.
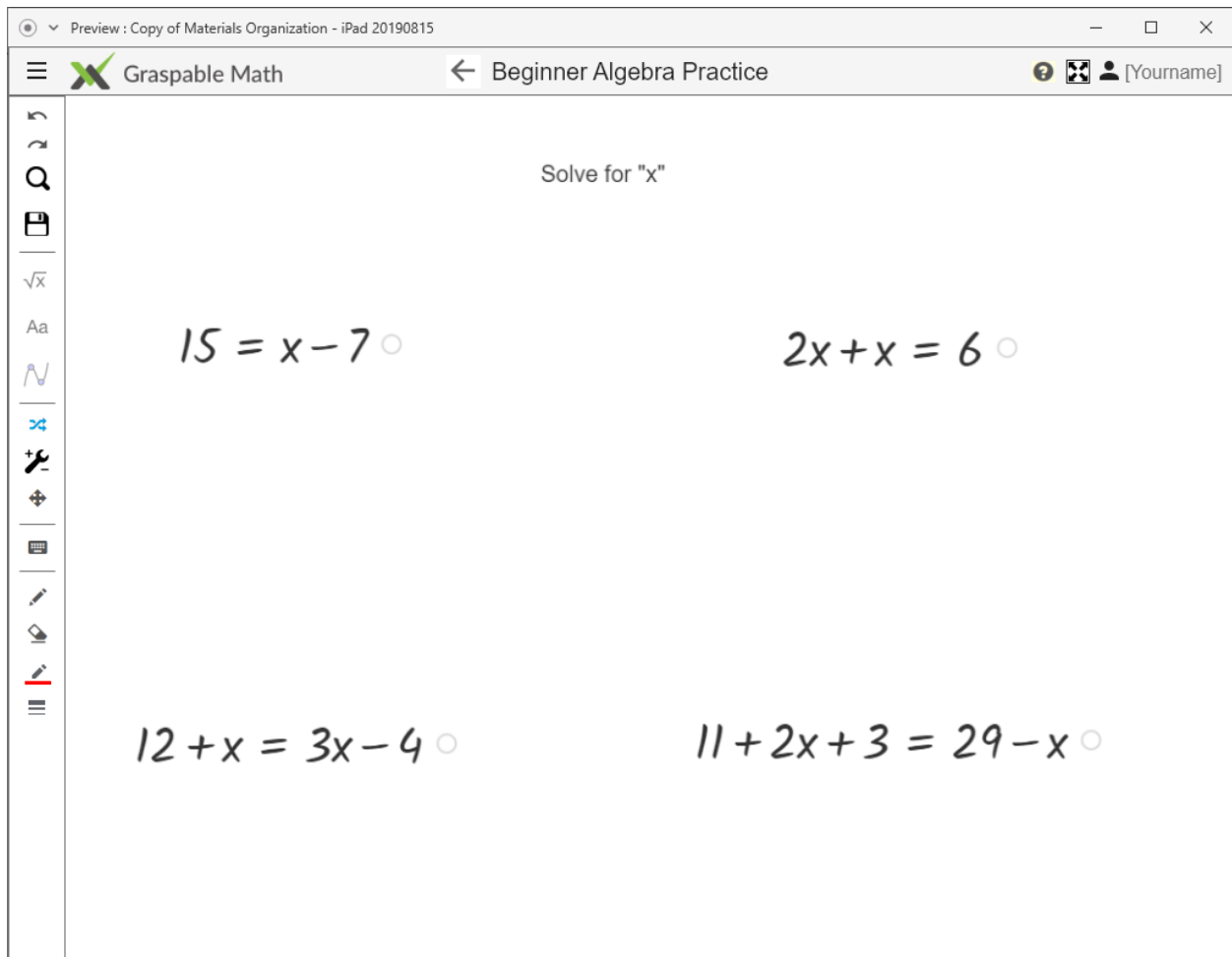
Canvas frame redesign: before testing
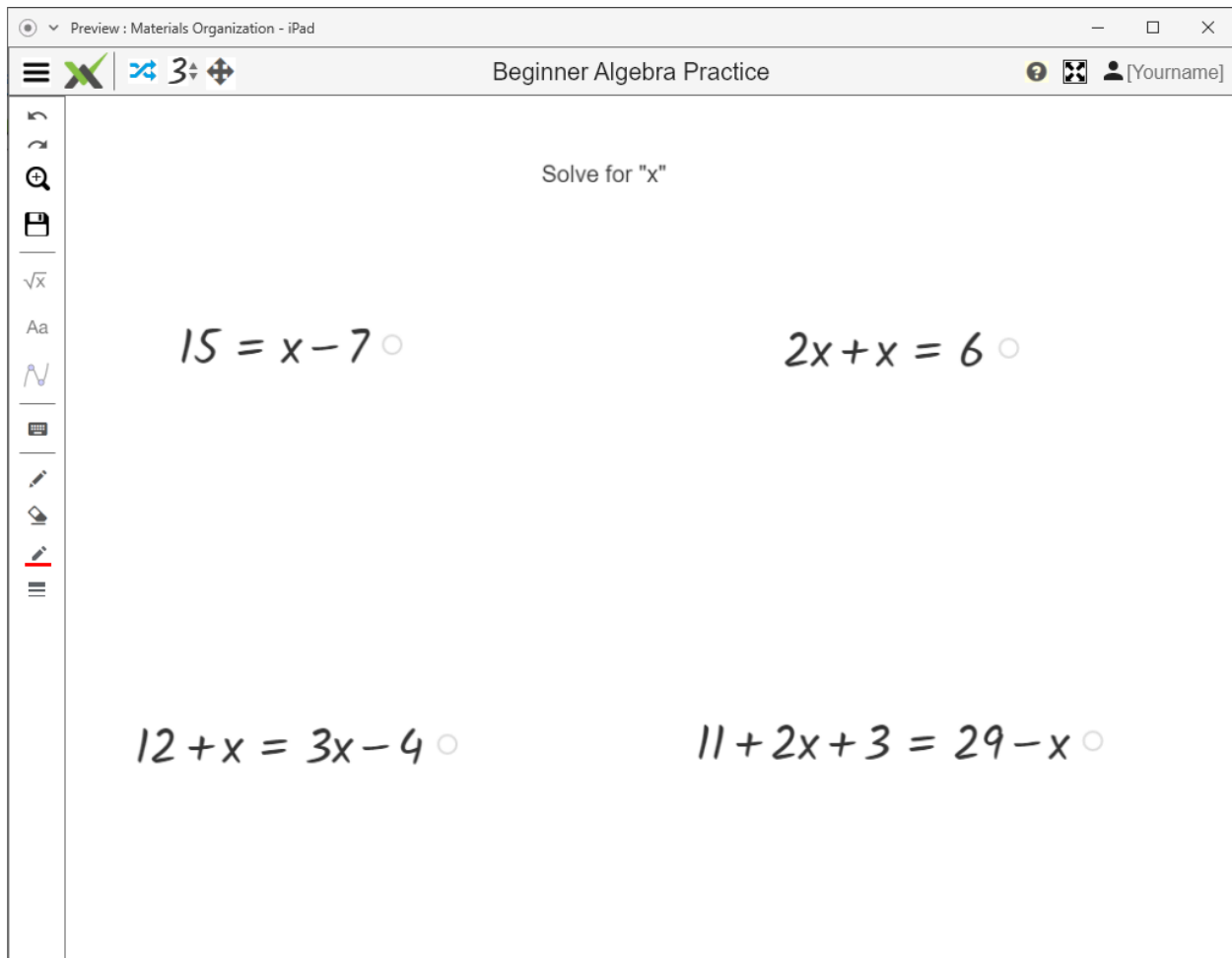
Canvas frame redesign: after testing

Header Bar

Canvas header bar: before testing

Canvas header bar: after testing

The three familiar horizontal lines are commonly referred to as a "hamburger" menu button. They display the full Canvas menu (see Menu). Not all of the test participants noticed the menu button at first, but they were all able to find and use it within a few minutes, without assistance. There was a problem with the prototype such that clicking between the horizontal lines did not display the menu: this has been corrected.

Clicking the Graspable Math logo returned the user to the home page. Test participants were familiar with using it for this purpose. After testing was completed, the text was removed from the logo to make room for the Mode Buttons (see below).

The left arrow icon returned the user to the page from which the canvas was opened. This was based on the design of GeoGebra information pages. In theory, it would offer the user the opportunity to return to the Materials page, in the state it had previously been (i.e. with the previous filters intact). This was easy to implement in XD, and the test participants used this button to navigate the prototype. However, we're concerned that it may be difficult for the actual system to retain such state information. Also, it isn't always applicable for some of the different ways in which a canvas can be opened. (For example, it made no sense when the user was looking at the canvas they created by copying an existing canvas). We have removed the button and recommend the following instead: When a canvas is opened from the Materials page, always open it into a new browser tab. This would also help with another problem we frequently saw in the tests, which was that when the canvas was displayed, participants struggled to find a way back to the Materials page. Unfortunately, simulating the use of multiple browser tabs is problematic in Adobe XD.

The question mark icon would display a help menu. It does nothing in the prototype. Test participants frequently confused it with a button to display the information panel (for task #3), which was actually on the Menu instead (as a circled "i" instead of a circled "?").

The square icon with arrows would put the canvas in full screen mode. It does nothing in the prototype. This was moved to the title bar to maximize space on the canvas. One participant was asked to guess its function, and responded correctly.

The user account / sign in control is the same as on the home page header bar.

Menu Bar

The menu bar displayed during testing had the icon buttons displayed here to the left. None of the buttons were operational. However, two of the test participants, as well as some other stakeholders, were asked to identify them. After testing was complete, the menu bar was updated to the version displayed here to the right.

The menu buttons were intended to represent the following functions:

- **First Group: Frequently Used Commands.**
  - Undo
  - Redo. One participant swapped the identity of these buttons.
  - Zoom. This is proposed as an alternative to the "smaller" and "larger" buttons, which change the size of expressions but not other elements. Participants thought it was a "search" button. A "+" has been added to the icon in hopes of making it more clear.
  - Save. This button is prominently displayed to make it convenient for users to save their work in progress, to minimize the risk of loss. (A better alternative would be to make the canvas autosave at specified intervals.) Participants frequently clicked this button to save a copy of a canvas (for task #2), but all eventually found the Save Copy… item on the menu (see below).
- **Second Group: Insertion Commands.** Because these commands are used so frequently, this design eliminates the need to click an Insert button first. Participants correctly identified these buttons.
  - Insert Math Expression.
  - Insert Text.
  - Insert Graph.
- **Third Group: Mode Buttons.** (See below.)
- **Fourth Group: Keypad.** There didn't seem to be any other commands that were associated with the keypad, but also used frequently enough to justify placement on the menu bar. All participants correctly identified this button, though one commented that the small size of the icon made it difficult to be sure.
- **Fifth Group: Draw Commands**
  - Draw. Participants correctly identified this.
  - Erase. One participant identified this as a highlighter.
  - Draw color selection. Proposed due to frequent user requests. One participant identified it as a highlighter.
  - Draw & erase width selection. Proposed in conjunction with color selection. Participants correctly identified it.
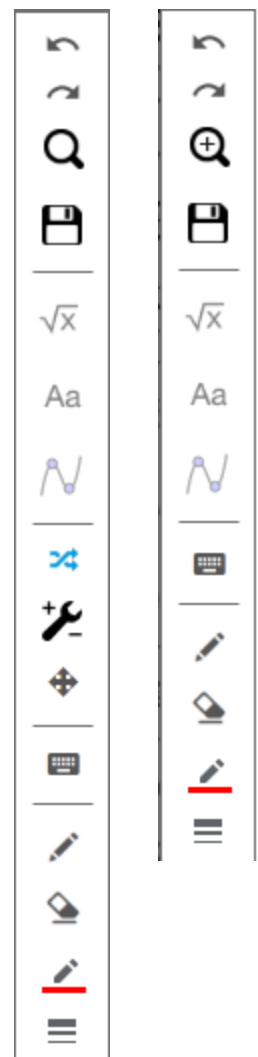
For many of these buttons, after the user clicks the button, the mouse cursor should change to indicate the tool that is currently in use. We were unable to create this effect with the XD prototype.

Hovering over a menu bar button should display the name of the associated command. This doesn't help touchscreen users, but it is still valuable for mouse users. We were unable to create this effect with the XD prototype.

Mode Buttons

During testing, the canvas menu bar included three icon buttons--shown here to the right--for the primary interaction modes:

- Transform
- Scrub
- Arrange

These mutually-exclusive modes completely change how the user interacts with canvas elements. The design intent is to make it more clear which mode is currently selected, by highlighting the selected mode button in blue. The icons are the same icons on the current GM canvas buttons, but + and - symbols were added to the wrench in an attempt to conceptually link it to increasing and decreasing values. The buttons did nothing in the prototype.

When asked, participants were almost entirely unable to identify the purpose of these buttons.

- One participant thought the transform icon looked familiar, but nobody knew what it was for.
- All participants thought the wrench icon was for control of settings. One participant said that Desmos uses a wrench icon for such a purpose.
- One participant identified the arrange icon. One thought it was for panning around the canvas.

After testing, we moved the mode buttons from the side menu to the header bar. Not only does this better reflect their importance, it makes it possible to update the side menu the selected mode. We also changed the Scrub icon to look more like what the mode, and less like a "settings" icon. This icon should also be appropriate if Scrub mode is renamed.

These are not necessarily the only mode buttons that GM should have, nor are they necessarily the best ones. Modes should be used with caution, because it is easy for a user to lose track of which mode they are in, which can result in their actions having unintended and unfortunate consequences.

Menu
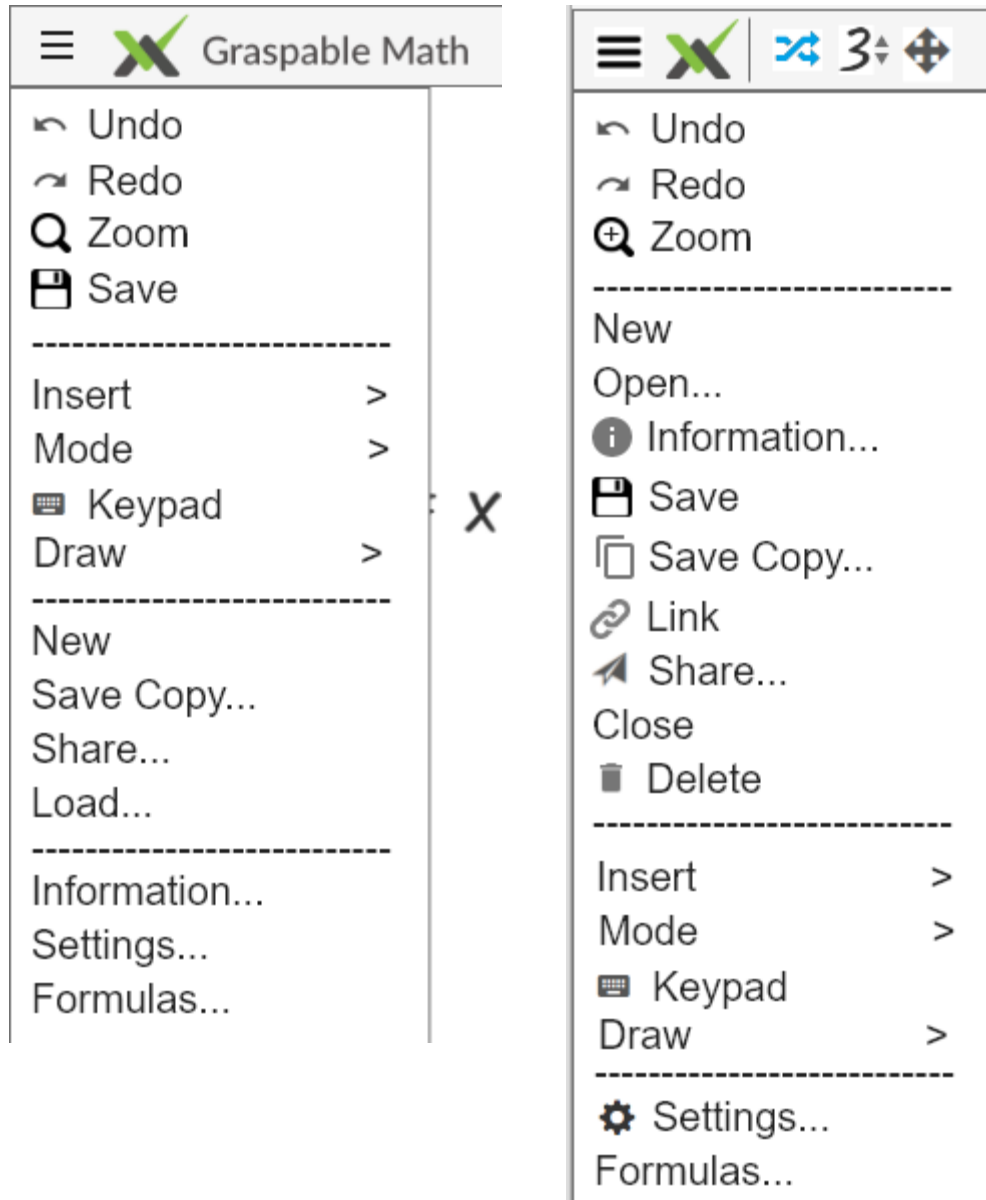
Canvas menu redesign: before testing (left) and after testing (right)

This menu appears when the user clicks the hamburger menu icon. It is intended that every button on the menu bar have a corresponding menu item with the same icon, so that the user can learn from the menu what each button does. This was not fully implemented in the prototype.

Ideally every menu item would have an icon, to assist with quick recognition and to assist non-English-literate users. This was not fully implemented in the prototype.

- **First Group: Frequently Used Commands.** This menu group was intended to mirror the first group on the menu bar. Users frequently clicked on the Save menu item here when attempting to complete task #2. After testing we moved the Save menu item to the

File Commands group so it would be closer to the other similar commands, in the hope that it will help the users notice their other options.

- **Second Group: Editing Commands.** This menu group was intended to provide more specific commands for editing canvas content. Only the Insert submenu was implemented in the prototype (see below), but was not accessible during testing. None of the participants clicked on these menu items during testing.
- **Third Group: File Commands.** This menu group was intended to include all commands related to canvas document management. Several commands have been moved to this group after testing, and it is worth considering if some or all of them should be consolidated into a File submenu instead. The commands are listed in an order roughly corresponding to a document's life cycle: creation, editing, use, deletion.
  - After testing, this menu group was moved higher up the menu list, because most systems provide their File menu before their Edit menu.
  - "New" should create a new canvas in a new browser tab. It was not functional in the prototype.
  - "Save Copy…" was a command required to complete test task #2. (See below.)
  - The "Share…" command is intended to open a dialog that would allow the user to control whether the canvas is shareable or private, send it to other users, and request that it be made public. It was not functional in the prototype. The icon was added after testing.
  - The "Load…" command was intended to replicate the functionality of the Load command on the existing canvas: replace the current canvas in this tab with the contents of a different saved canvas. (The option to insert the contents of a saved canvas into an existing canvas was moved to the Insert submenu, but the feature requires further design.) The name was changed to "Open…" after testing, because that term appears to be more common in consumer software. It was not functional in the prototype during testing. The current prototype simulates opening the user's My Materials page in a new tab.
  - The "Information..." command was difficult for test participants to find during task #3. After testing it was moved to this group, since the Information settings strongly influence document management. The circle-i icon was added as well, which appears to be the most standard "information" symbol worldwide, even though it is language-derived.
  - The "Save" menu item did nothing in the prototype, because we wanted to ensure test participants understood they were saving a copy. However, because the simulation was of looking at a published material that they did not have the rights to change, it would have been better implemented with either of the following options:
    - Disable the Save item while looking at a read-only material.
    - Assume that when looking at a read-only material, the user wants to make a copy, and act accordingly. After testing the prototype was updated to work in this manner.

- ○ The "Link" menu item would allow the user to save a link to the canvas with their documents. (See Materials Page: Links.) This was added after testing.
- ○ The "Close" menu item would simply close the current browser tab, after ensuring the user has saved any pending changes. This was added after testing.
- ○ The "Delete" menu item would only be present for the material's author. After requesting confirmation, it would delete the material and close the tab. (See Materials Page: Trash.) It was added after testing.

- ● Fourth Group: Other Commands. This is intended as a catchall group for other commands.
  - ○ "Information…" was moved to the file group after testing.
  - ○ "Settings..." would show permission and option settings like those on the current design's "Document Settings" dialog. It was not functional in the prototype. The gear icon was added after testing.
  - ○ "Formulas…" would show formulas like those from the current design's "Formulas" menu button. Maybe they should be in the Insert submenu instead.
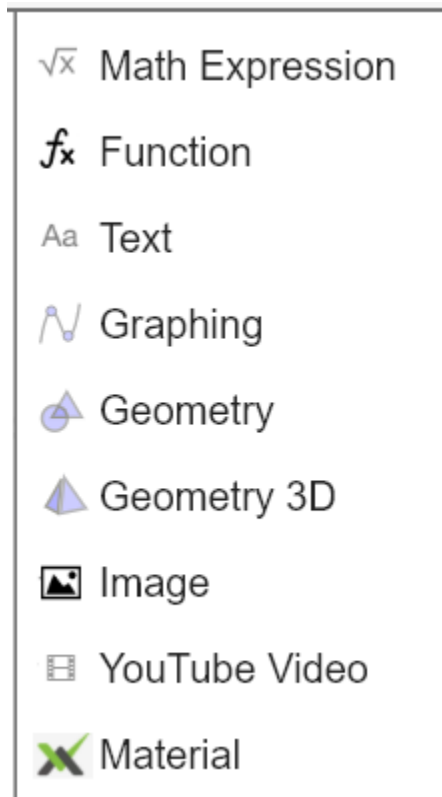
Insert submenu (not available during testing)

Save a Copy
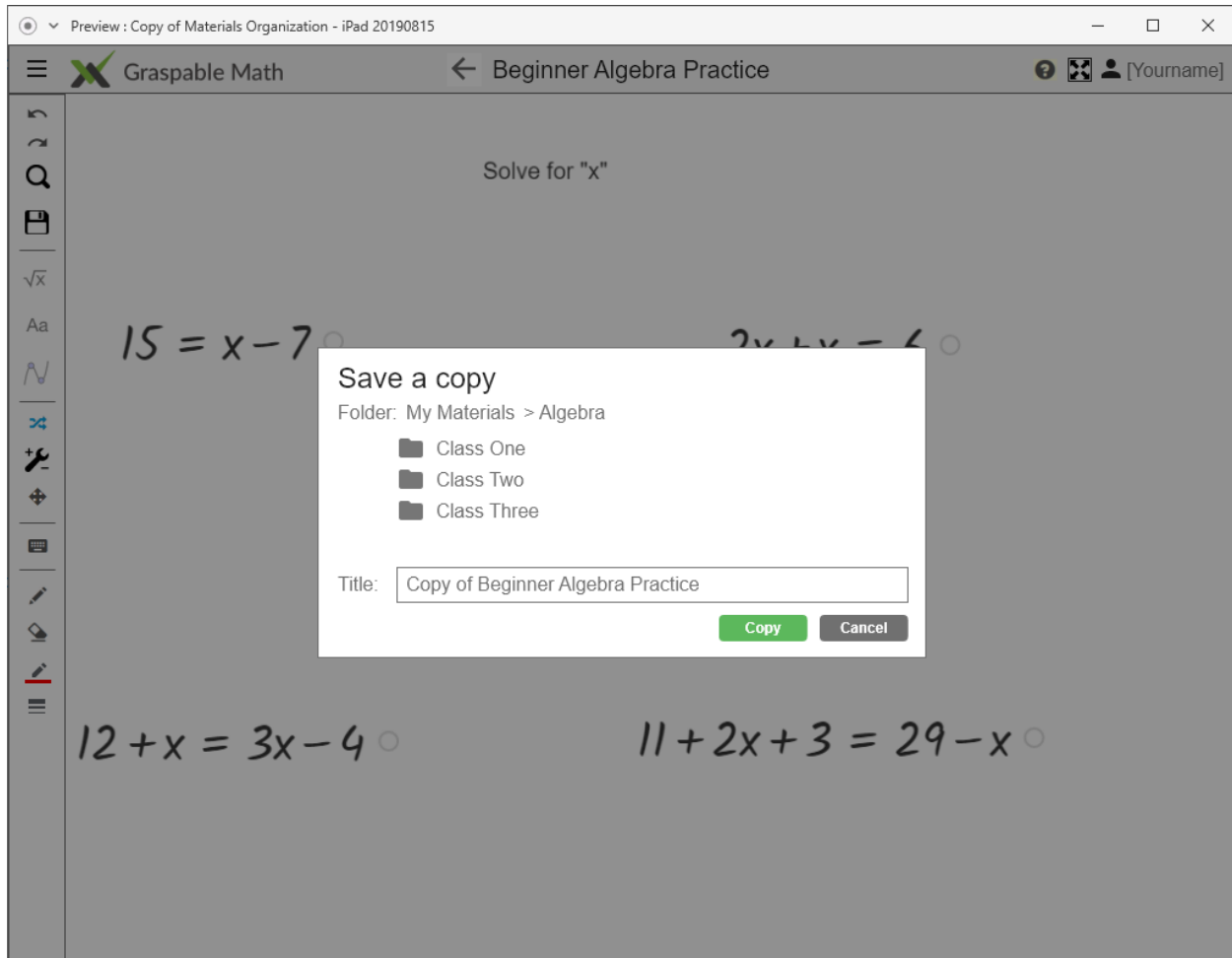
"Save a copy" modal dialog (during testing)

To complete testing task #2, participants had to access this dialog from the canvas's "Save Copy…" menu item. Based on their actions during the test, the dialog is now available from:

- The material's tile context menu. (See Materials Page: Material Tiles.)
- The canvas menu bar's Save icon button.
- The canvas menu's Save menu item.

Test participants were frequently confused after the Copy was complete as to whether they were looking at the original canvas or looking at the copy. The name change was too subtle. It might help if the copied canvas was opened in a new browser tab, while the original remained in the current tab.

Note the lightbox effect to help users see clearly that only the dialog is active, and the other canvas controls are inactive.

The design intent is that the user can click on the folder names to select the destination for the copied material. This was not interactive in the prototype, which forced the user to store the copy into the Algebra folder.

After saving the copy, most participants thought task #2 was complete, and had to be prompted to find their new copied canvas in the My Materials page. This a fault of the task design rather than the interface design. All participants did find the material successfully, either by opening the Algebra folder or by using the filter controls.

Information Panel

Canvas Information panel (after testing)

The main function of this panel is to assign values that would be used to find the material in a filtered search. This design is strongly influenced by similar functionality in GeoGebra. Nothing on the panel is interactive in the prototype, except the upper right "X" control, which closes it.

For this prototype we set up the information panel to display beside the canvas content. Given the amount of information on the panel, that choice should be reconsidered. For example, a free-text description field is "below the fold" on the panel, and thus not visible in the screenshot above.

The default material tile image for the canvas, as displayed in the upper right corner of the information panel, is a thumbnail image of the entire canvas. The camera icon is intended to allow the user to update the thumbnail, or to load a different image.

The intent of the Brief Description field is to provide text that the user sees when their mouse hovers over the material tile. This functionality was not implemented in the prototype.

Other potential features that could be added to this panel:

- A way to Like the material. (This should probably be added to the material tile context menu as well.)
- A way to indicate the target age range for the material.
- When the user is looking at published material: A way to report that the material contains inappropriate content.
- User comments on the material. (Though this would create a need to moderate such comments.)

See the Document Storage Attributes sheet for more thoughts on material attributes: https://docs.google.com/spreadsheets/d/1woQBO1-xZkFiyijxE332sVcFp2-6CNhjvWa-hS3A__I/edit?usp=sharing