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# Apps for Africa

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# Apps for Africa

**Cade Dopp**

**Design & Development Project Report  
Instructional Psychology & Technology, Brigham Young University**

## Product Description

I designed a prototype for an app that teachers in Ghana can use to prepare lesson notes prior to teaching their classes. The prototype makes use of Google Forms and Google Sheets to (a) organize lesson preparation materials, (b) suggest relevant lesson materials during planning, (c) record lesson plans, (d) share lesson plans with teachers and administrators, and (e) share feedback from administrators on lesson plans.. The purpose of this app is twofold: to allow teachers to create their lesson plans more quickly and easily than in the past, and to introduce them to using digital tools for education. All teachers using the prototype access it on their Android-powered smartphones. Figure 1 represents a series of lesson plans created by a teacher

	A	B	C	D	E	F
1	Timestamp	Week Ending	Day	Math Topics	Objective	Activities
2	1/15/2018 8:25:17	1/15/2018	1/19/2018	1.5 Length and Area	1.5.2 solve problems on circumference of a circle	Revise parts of a circle and the idea that circumference is the perimeter of a circle using real objects like; Milk tin, Milo tin, etc. Pupils can be encouraged to use the calculator to check the value of $C = d$ or $C = 2r$ (since $d = 2r$ )
3	1/15/2018 8:41:49	1/13/2018	1/19/2018	1.8 Relations	1.8.3 identify the co-domain domain and range of a relation for a given domain	Assist pupils to identify the domain as the set of elements in the first set from the direction of the matching diagram E.g. from the relation "is half of" the domain is the set $D = \{2, 3, 4, 5\}$ , Assist pupils to identify the co-domain as the set of elements in the second set from the direction of the mapping diagram. E.g. from the relation "was born on" the co-domain is {Monday, Friday, Saturday, Sunday}, Guide pupils to identify the range as a subset of the Co-domain E.g. the range for the relation "was born on" is the set $R = \{\text{Monday, Friday, Sunday}\}$
4	1/15/2018 8:57:48			1.10 Capacity, Mass, Time, and Money	1.10.4 solve word problems involving time	Guide pupils to solve word problems involving the relationship between the various units of time.

Figure 1. Review of completed lesson plans.

The app works by organizing content from government-issued syllabi for teachers. Rather than searching for and transcribing content from the paper syllabi, teachers use the app to create lesson plans by tapping on content that is dynamically displayed on their phones. For example, a teacher can tap on "Math" and their grade level to see the units they will be required to teach during the year. Teachers can then tap on a unit such as "Working with Fractions" to see all of the objectives, activities, and evaluation points that are included in that unit. The options they tap on are automatically compiled into a lesson plan that they can view and share with other teachers in their school. (See the [video walkthrough](#) in the Appendix for a more detailed description of the app.)

My motivation for this project developed as I spent time in Ghana working with students. I was trying to work directly with students to bypass many of the known inefficiencies in Ghanaian schools such as high student-to-teacher ratios. However, as I met with teachers throughout the country I was impressed with their devotion and concern for their students and felt that I could increase my influence by empowering teachers rather than ignoring them. Teachers commonly have access to smartphones and internet even in the most remote areas of the country, but they

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do not typically use either for educational purposes. I decided to create a product that would be simple to use and persuade them of the benefits of using technology. After observing incredible inefficiency in the lesson planning process, I decided to create an app that could save them a lot of time every day.

## Design Process

My design efforts were influenced by my previous experience with rapid prototyping, lean manufacturing, and lean startup. Those philosophies encourage simplicity, elimination of waste, validation of the design by getting products to customers early, and iteration. Informed by those philosophies, I did minimal preliminary analysis and focused more on prototype production and evaluation. I believe that getting prototypes to customers early, evaluating their experience, and iterating designs is an efficient and productive design strategy.

## Preliminary Analysis

At the beginning of the project, I traveled to Ghana to pilot a different project and to learn more about the setting I was working in. I interviewed teachers, students, and parents; took inventory of physical resources in schools; and looked at the types of student records that were maintained in the schools. My design was informed by what I learned during this trip. See [Learner Analysis](#) and [Environment Analysis](#) in the appendix for more details.

Some of the important things I learned include:

- Computers are exceptionally rare in schools
- Smartphones are ubiquitous among teachers
- There is a wide spectrum of access to technology among students in their homes
- Student grades, exam scores, and attendance records are kept in schools
- Teachers would be expected to pay for any new resources they use in the classroom
- Teachers would be willing to pay about \$0.25 per week for a mobile app to assist them in their responsibilities
- Technology literacy among most Ghanaians is low

I would have liked to perform a more detailed preliminary analysis, but it was not possible because of my limited time on the ground in Ghana and the difficulty of remote communication with Ghanaians. I spent most of my time on the ground working on a separate project and was only able to perform an analysis for this project with spare time. I attempted to do some interviews remotely, but it proved too difficult with network issues and a language barrier. One of the most significant issues that arose from a limited analysis was that I designed my app with the erroneous belief that the syllabus was the only resource teachers needed for lesson planning. It was not until the pilot that I learned that teachers needed access to additional resources.

While I recognize that I would have avoided some mistakes if I had performed a better analysis, I also think that being able to get a prototype to users quickly allowed me to learn through failure. I am more confident in what I learn through failure than what I speculate from preliminary analysis. There seems to be a delicate balance to achieve between analysis and prototyping. I anticipate that achieving that balance will require constant attention throughout my career.

## Initial Design and Development

After completing my preliminary analysis, I immediately began working on the design and development of the app. Because I did not have funding or a specific client yet, I chose to work with free prototyping tools and made gradual progress. I also decided to prepare content for only a few core academic subjects to reduce the scope of the project and to be able to get a prototype to users more quickly.

I began by making a Google Form to verify that it would be an appropriate tool for my purposes. It allowed for dynamically branching paths and allowed users to click on predefined responses rather than requiring typed responses. After determining that a Google Form would be an appropriate prototyping tool, I began creating a digital repository of the content I would need for the app. This entailed transcribing paper copies of the Ghanaian school syllabi to Google Sheets. Though I could have transcribed the syllabi directly to Google Forms, I anticipated that having the syllabi in Sheets would allow for more flexibility to use the content at a later time in future projects.

With the syllabi transcription complete, I copied all of the content into Google Forms, organized as similarly as possible to the paper syllabi. I created eight forms, one for each of the four core subjects (English, Math, Science, and Social Studies) for both years of junior high school. Each form contained the complete corresponding syllabus. I designed the form in such a way that users would complete it as similarly as possible to how they previously completed their lesson plans. A user would start by selecting the date and topic and would then be presented with a list of objectives and activities suited to their selection (see Figure 2 and Figure 3).

**Lesson Notes**

Daily lesson notes for teachers

**Week Ending**  
Date  
mm/dd/yyyy

**Day**  
Date  
mm/dd/yyyy

**Subject**  
Choose

**NEXT**

Never submit passwords through Google Forms.

Figure 2. First screen on app.

**Lesson Notes**

**1.1.1 Count and write numerals up to 100,000,000**

**Activity**

- Guide pupils to revise counting and writing numerals in ten thousands, hundred thousands and millions.
- Using the idea of counting in millions, guide pupils to recognize the number of millions in ten million as (10,000,000 = 10 1,000,000)
- Using the non-proportional structured materials like the abacus or colour-coded materials, guide pupils to count in ten millions.
- Show, for example, 54,621,242 on a place value chart.
- Point out that the commas between periods make it easier to read numerals.
- Assist pupils to read number names of given numerals (E.g. 54,621,242) as; Fifty four million, six hundred and twenty one thousand, two hundred and forty two.
- Other:

Figure 3. Activity selection on app.

My next step was to create a Google Sheet to display the information recorded in the form. I used a script to organize the output of the form so that teachers and administrators would be able to review their lesson notes. This required that I make a unique form and sheet for every user, a time-consuming task which limited the number of users I could feasibly support for my first pilot. I decided to support three schools, each with one complete set of forms, making a total of twenty-four teachers and three headmasters.

The final step prior to piloting was to create a page with important information and links (see Figure 4) that I could email to users (see Figure 5) to help them get started using the prototype as easily as possible. I created a unique page for every teacher and headmaster to access their own forms and sheets. I also provided instructions for users to save links to the forms and sheets to the homescreen of their phones for easy access and an app-like experience.

**Math JHS 1**

**Record Lesson Notes**

Click [here](#), or type this into the internet to record your lesson notes:

<https://goo.gl/forms/vYmb8OF6jzya9gUZ2>

**View Lesson Notes**

Click [here](#), or type this into the internet to view your lesson notes:

<https://drive.google.com/open?id=1MR4lrQ7ttalna3YKZHQLXrZDOfMgDyMrlwpf1C4ssBU>

Figure 4. Page with links to a form and sheet for a math teacher.

Hello Math Teacher,

this is where you can record and view your lesson notes:

JHS 1:  
[https://drive.google.com/open?id=12A97OUWGcyx4G7ZynqQQt7\\_ucpW4acn6F6hoK-KeYel](https://drive.google.com/open?id=12A97OUWGcyx4G7ZynqQQt7_ucpW4acn6F6hoK-KeYel)

JHS 2:

Thank you,  
Cade Dopp  
[cade.dopp2@gmail.com](mailto:cade.dopp2@gmail.com)  
[+1 801 682 3795](https://wa.me/18016823795) WhatsApp

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Figure 5. Email sent to teachers.

## Design Evolution

One of the most requested features by teachers and headmasters was better support for feedback on lesson plans. To simplify the original prototype, I had instructed users that they would need to use email to communicate with each other about their lesson notes. The most common reason for communication would be for a headmaster to approve or offer suggestions on a teacher's lesson plan. This feedback is a recurring and important part of the lesson planning process, and users expected to be able to complete this process without needing to navigate away from the lesson planning tool.

The easiest way for me to provide this functionality was to give users permission to edit their sheets. I had originally chosen to lock down the sheets to prevent users from inadvertently messing them up. I had also considered using the commenting functionality of Google Sheets, but the way comments are displayed and resolved made me think that the commenting functionality would not be a suitable solution. I also did not have the time or budget to implement a more robust communication solution at this stage of the project, so I decided to give users the ability to edit their sheets. I also added additional columns in the sheet to give teachers and headmasters space to communicate about their lesson plans (see Figure 6). Because of lack of time, I did not take any steps to prevent inadvertent editing. Though I am not aware of any problems that arose from inadvertent editing, I think it would have been worth the time to have a warning display in the Sheet when a user attempted to make any edits.

K	L
<b>Headmaster Approval</b>	<b>Headmaster Feedback</b>
Approved	These notes are fine.

Figure 6. Added space in sheet for headmaster approval and feedback.

By the time I was prepared to roll out this first iteration, complications with the municipality resulted in an early end to the pilot implementation. Though I had made every effort to ensure a solid commitment to the pilot from the municipality, including getting the agreement in writing and travelling to Ghana to start the pilot, the municipal director decided to not finish the pilot without federal approval. I have since learned that he technically should not have even allowed me to meet with the teachers to introduce them to my app without federal approval, so it was fortunate that I got to at least gain some experience with introducing a new technology in Ghanaian schools. I was also able to validate that teachers saw a need for my app and enjoy using it. I was not able to get the new functionality to users in time to test and get feedback. I did

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include the need for in-app communication as an essential feature in the design specifications I later provided to my app developer.

I do not think my experience with the municipality was uncommon for a westerner. My entrepreneurship advisor and other students who have worked in Ghana warned me that any arrangements I made in Ghana would be liable to change at any time. Commitments seem to have less significance in Ghana than westerners are culturally accustomed to. While my setback with the municipality was an annoyance, it was not a total surprise, and I will be able to continue my work at other locations.

## Product Implementation

I started the pilot by conducting an in-person training with all of the piloting users. Despite the high cost of travel to Ghana, I opted to conduct training in-person because the pilot group lacked familiarity with mobile phone apps and digital tools like Google Forms and Google Sheets. We gathered in a Pentecostal church on the grounds of a local school for four hours of explanation, encouragement, and training. I demonstrated how to use the app, ensured that every teacher was able to access the app, gave teachers time to experiment and ask questions, and explained how they would be able to provide feedback about their experiences.

In anticipation of users encountering bugs or having difficulty using the app, I provided my direct contact information so they could obtain quick support. They were able to email me, or to call or text me on WhatsApp. I did not provide any additional resources or instructional documents besides the initial email I sent to all users that had basic instructions to access their forms and sheets. If I had more time, I would have created help documents and more detailed instructions.

The only requirements to use the app were a smartphone and an internet connection. I selected teachers for the pilot who had access to both. I also provided teachers with a vouchers for a small amount of mobile data to remove the cost of internet use as a barrier. It was too complicated to try to provide smaller vouchers on a regular basis, so I gave users their full voucher at the beginning of the pilot with the risk that they would use all of the data too quickly for irrelevant purposes.

I had originally planned for teachers to use the app to complete all of their lesson planning. Headmasters would use their Google Sheets to review the teachers' lesson plans and to provide feedback via written note or email. Because the municipality decided to not allow teachers to forego paper-based lesson planning, teachers ended up having to make their plans on paper in addition to in the app. Teachers continued to double-plan for a couple of weeks because they were excited about the app and hopeful it would be approved for official use. Understandably, teachers eventually grew tired of double planning and stopped using the app.

## Evaluation

I evaluated the app using responses from surveys that I sent to users and feedback that I received from staff at universities and private schools. I initially intended to rely heavily on user feedback, but because of a shortened pilot I was not able to receive as much feedback as



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planned. I subsequently conducted interviews with university and private school staff to enhance my evaluation.

## Criteria

The major criteria I used to evaluate the app were positivity of user perception, time saved, and scope of services. These criteria were selected in accordance with my project goal to create an app that teachers would be willing to pay for to increase their efficiency. It was essential for users to have positive perceptions if they were going to be willing to continually pay for the app. It was also important to help teachers save time on lesson planning so that they could spend more time on activities that benefit students. I learned from the earliest prototype that if teachers were not able to complete an entire workflow in the app that they were less likely to use it, so it became important to increase the scope of services within the app.

## Procedures

I attempted to formatively evaluate the app by using feedback I collected from users in surveys. The survey had questions that attempted to gauge user perception and usage (see [Evaluation Instruments](#) in Appendix). I also completed a more summative evaluation prior to sending design specifications to my app developer. My summative evaluation consisted of my personal review of the app based on my evaluation criteria, feedback from users, and feedback from additional non-user teachers.

## Evidence

- Eighty percent of users said they preferred to use the app for lesson planning over the paper-based alternative (see Figure 7).
- The twenty percent of users that preferred the paper alternative experienced network issues that prevented them from using the app consistently (see Figure 8).
- Users asked for offline usability and additional resources in-app.
- Users reported that the app was easy to use and made them more efficient with their time.
- Users commonly asked for the app to be officially approved for use in schools despite its limitations.
- Other users requested access to the prototype.

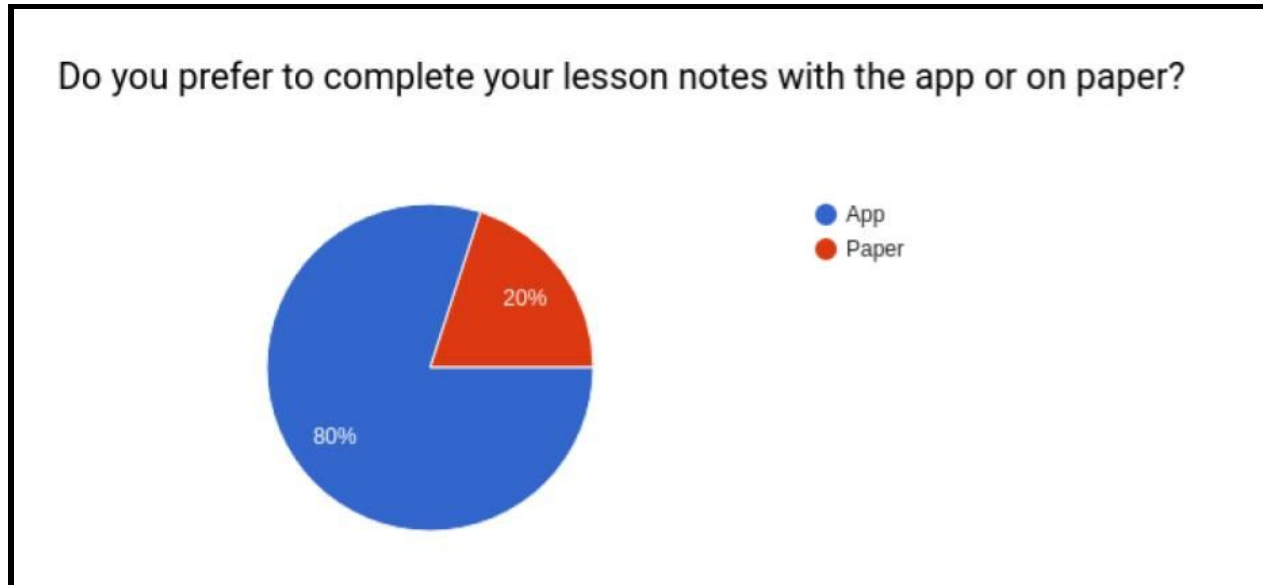


Figure 7. Most users preferred lesson planning with the app.

Do you prefer to complete your lesson notes with the app or on paper?

App

Paper

How many times have you tried to use the app and succeeded?

2

How many times have you tried to use the app but were unable to complete your notes because of difficulties?

5

What difficulties prevented you from completing your notes?

Network accessibility

Figure 8. A user who preferred paper also indicated inability to use the app.

## Outcomes

The overall determination of my evaluation is that the app meets a need that teachers have, but it needs further development to be usable more generally. I determined that the app meets teachers' needs because my survey data indicated that most users preferred to use the app to the historical alternative and because the other teachers I interviewed unanimously indicated that they believed the app would be helpful or requested immediate access to the prototype. The minority of users who preferred to not use the app did not have a chance to use it consistently because of network issues. If offline capability is added, it is possible that some of those teachers would also prefer to use the app.

The prototype that I gave to users was too limited and needs further development. Based on the feedback I received from users and other teachers, I accounted for those limitations in the design specifications I gave to my app developer. The only resource that the prototype allowed teachers to access was the syllabus that the government provides. Teachers needed access to more resources than I accounted for during my preliminary analysis. I could not provide direct access to other textbooks because of copyright concerns, so I added the ability for teachers to use the cameras on their phones to add content from other resources without having to type.

As already mentioned, lack of offline usability is a significant weakness of the app and must be addressed. My budget and timeline did not allow for immediate resolution, so adding offline capability is one of my top priorities going forward. The need for offline functionality is apparent from user feedback, recommendations of other teachers, and the known limited internet access in Ghana.

## Reflection and Critique

This project was beneficial both for my learning and for the development of a useful product. I was able to learn more about the design process, working with schools, and working internationally. I was also able to create a product that will hopefully be useful for teachers in Ghana and other areas of Africa.

## Personal Experience

I learned about the messiness of the design process and gained experience with adapting to changes. One of the things that makes design messy is that there is usually more than one right answer to any problem. Learning to think about multiple right answers runs contrary to most of my multiple-choice-based education where I was trained to figure out whether a, b, c, or d was the "best answer." It is also messy because it entails the generation of solutions rather than only evaluating the goodness of existing solutions. Design is also messy because products and people do not always behave as expected or planned. There is always the possibility of unforeseen circumstances and complications that could necessitate a redesign.

An example of generating an appropriate solution when there were several possibilities was when I needed to figure out how to organize lesson plans based on form submissions. When

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form data is displayed in a sheet, every item from the form gets its own column. Because of the dynamic nature of the form, teachers did not respond to every question, which then left dozens of blank columns on the corresponding sheet. I needed a better way to organize responses but the default functionality of Google's products did not provide me with a clear solution. I decided to write a custom script to modify the normal behavior of my forms and sheets. There was not an appropriate existing option, so I had to create the functionality I needed.

One of the complications that arose during the pilot of my product was that the schools I had partnered with lost their permission to use my product as a replacement for existing workflows. I had attempted to mitigate that risk by getting an agreement in writing from the right people and visiting Ghana to commence my pilot, but that was not enough. Looking back, I wish I had asked the schools to get some skin in the game. I think that because I offered my services for free, they did not value the service as much as if they had been required to make some financial contributions. It is probably easier to neglect something that is free than something you had to pay for. There are also some cultural differences between Ghana and the United States about contracts. In Ghana, contracts seem to hold less weight than they do in the United States. I view a contract as a tool that allows me to trust someone that I do not know well, and count on a contract being honored and enforced. Because of how breakable contracts seem to be for Ghanaians, I wonder if there are different cultural mechanisms for establishing trust that I do not understand yet.

Encountering complications required me to choose to adapt or to give up. I learned that being able to adapt and being persistent enough to adapt are essential characteristics of a successful designer. In my case, I made adaptations with my design and relationships with stakeholders. I adjusted my product to better meet the needs of users, but I also had to find new users that I had not originally intended to use my product: I started working with universities and private schools instead of the poorer public schools I initially set out to assist. I also had to make adaptations to my product based on the skills of the developers I chose to work with.

I experienced the difficulties associated with working in a school among so many stakeholders who sometimes had competing priorities. Though teachers and administrators share the goal to educate students, they do not always share the same priorities or perspectives. I saw that teachers generally wanted greater support and more resources for their classrooms. They thought about stationary, pencils, and books, while administrators seemed to prioritize budgets, policies, and exam scores. It seems natural that people with different roles and different responsibilities should have different priorities as they work together to achieve common goals, but it is difficult to work to satisfy various competing priorities.

It was particularly challenging working in an international setting with time, culture, and language differences. As demanding as any educational design work is, working internationally adds an additional layer of challenge. I am happy to have gained this international experience, but it did stretch the scope of my project beyond what many students would probably want to do for a master's project. It worked for me because I had interest and support in the project beyond just to satisfy graduate requirements, but I would not recommend a similar project to other students unless they had similar support and interest.

## Product

I am satisfied with the progress I have made on my app and am excited to continue developing it. While the current iteration of the prototype is too limited for general adoption, I am working with an app developer to build something that will be distributable on a wide scale. I will mention some of the strengths and weaknesses of the app as it is planned to be released by my developer.

One of the most glaring weaknesses of the app is that it will not initially be functional offline. Offline functionality will be extremely important for the long-term viability of the app, but building that functionality is beyond the skill of the developer that I can currently afford. Internet is becoming increasingly ubiquitous in Ghana, so the lack of offline usability will be more of a nuisance than a total barrier to adoption. It would be impossible to distribute the app more widely in Africa though, because my other target countries do not have as common of access to internet. Even in Ghana the nuisance will be significant enough that my number one development priority will be to provide offline usability as soon as possible.

Another weakness of the app is that it requires a functioning and charged mobile phone to use it. I selected mobile phones as the best available platform for providing tools to teachers, but I chose it knowing that a mobile phone is not the ideal platform for creating lesson plans. The screens are small, the devices are easily lost or damaged, it is often impossible to charge them at school, and the current app requires an active subscription with a mobile service provider. I realize that the more difficult and complicated it is to use my app, the less likely it is to be used. However, I am optimistic that it is generally better than the status quo and it will benefit teachers despite its weaknesses.

One of the greatest strengths of the app is that it allows teachers to complete their entire lesson planning process with one tool. It allows them to connect with multiple resources and pull them into a single plan. This is important because of the scarcity of planning materials. Teachers often lack access to books and other resources that they are expected to use in their lessons, and this app helps to address that problem. Teachers can also use the camera on their phones to add their own content that does not already exist in-app.

## Concluding Thought

Though many of the lessons I learned may seem particular to the context of a developing country, I see general applications for all of these lessons. In a creativity and innovation class that I took, I learned that a common design for a handle on a potato peeler was originally intended for people with limited fine-motor control. The oversized, textured grip that works well for people with limited fine-motor control also works better than previous designs for people with normal mobility in their hands. I learned that designing products for people with limitations can result in better designs for everyone. While the particulars of the challenges of my project were specific to Ghana, the lessons I learned can be applied in less challenging contexts just like a potato peeler for disabled people is actually a better potato peeler for anyone.

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Educational design is an invigorating blend of mental and social creativity, involving products and people. It is a constant negotiation between ideals and reality. It is undertaken by people who are ready to invent, willing to fail, and determined to persevere. I am excited by the prospect of becoming a designer. My project in Ghana has helped me to think more like a designer and has been an important milestone on my path to becoming one.

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## Appendix

### Guide to the Appendix

#### [Product Walkthrough](#)

A video walkthrough of the app.

#### [Environment Analysis](#)

The environment analysis describes some of the challenges that Ghanaian teachers face and how they prepare lesson plans.

#### [Learner Analysis](#)

The learner analysis describes teachers' limited familiarity with technology and barriers to adopting technology.

#### [Consulting Products/Precedent](#)

This section describes my rationale for using Google Forms and how my app design was influenced by my experience with other apps.

#### [Literature Review](#)

The literature review contains my summary of literature surrounding technology integration in schools.

#### [Budget and Timeline](#)

This section contains my proposed and actual budget and timeline for this project.

#### [Evaluation Instruments](#)

This section contains my proposed plan for evaluation and the survey questions I sent to users.

### Product Walkthrough

<https://youtu.be/2Y2JyHx4dNo>

### Environment Analysis

Teachers in Ghana's public schools face several challenges that hinder their ability to facilitate student learning. Among these challenges is an inefficient lesson planning process that demands a lot of the teachers' time and returns little benefit toward student learning. Teachers are required to copy information from a government-provided syllabus to their personal lesson notes by hand for every lesson they teach (see Figure 9 for a page from a syllabus). They have to flip between multiple pages in the syllabus to copy things such as descriptions of learning objectives, assessment items, and content-specific diagrams. This process generally takes 20-60 minutes per lesson; teachers present multiple lessons each day.



<b>JUNIOR HIGH SCHOOL 1</b>																																								
<b>UNIT</b>	<b>SPECIFIC OBJECTIVES</b>	<b>CONTENT</b>	<b>TEACHING AND LEARNING ACTIVITIES</b>	<b>EVALUATION</b>																																				
<b>UNIT 1.1 NUMBERS AND NUMERALS</b>	<p>The pupil will be able to:</p> <p>1.1.1 count and write numerals up to 100,000,000</p>	<p>Counting and writing numerals from 10,000,000 to 100,000,000</p>	<p><b>TLMs:</b> Abacus, Colour-coded materials, Place value chart</p> <p>Guide pupils to revise counting and writing numerals in ten thousands, hundred thousands and millions.</p> <p>Using the idea of counting in millions, guide pupils to recognize the number of millions in ten million as <math>(10,000,000 \div 10 \times 1,000,000)</math></p> <p>Using the non-proportional structured materials like the abacus or colour-coded materials, guide pupils to count in ten millions.</p> <p>Show, for example, 54,621,242 on a place value chart.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="3">Millions periods</th> <th colspan="3">Thousands periods</th> <th colspan="3">Hundreds periods</th> </tr> <tr> <th>H</th><th>T</th><th>O</th> <th>H</th><th>T</th><th>O</th> <th>H</th><th>T</th><th>O</th> </tr> </thead> <tbody> <tr> <td></td><td></td><td></td> <td></td><td></td><td></td> <td></td><td></td><td></td> </tr> <tr> <td></td><td>5</td><td>4</td> <td>6</td><td>2</td><td>1</td> <td>2</td><td>4</td><td>2</td> </tr> </tbody> </table> <p>Point out that the commas between periods make it easier to read numerals.</p> <p>Assist pupils to read number names of given numerals (E.g. 54,621,242) as; <i>Fifty four million, six hundred and twenty one thousand, two hundred and forty two.</i></p>	Millions periods			Thousands periods			Hundreds periods			H	T	O	H	T	O	H	T	O											5	4	6	2	1	2	4	2	<p>Let pupils:</p> <p>read and write number names and numerals as teacher calls out the digits in a given numeral (E.g. 72,034,856)</p> <p>bring in news papers or magazines that mention numbers in millions to record)</p> <p>mention numbers they hear on TV and radio reports (this can be taken as projects to be carried out weekly for pupils;</p> <p>investigate types of numbers that appear in government's budgets, elections results, census reports, etc.</p>
	Millions periods			Thousands periods			Hundreds periods																																	
H	T	O	H	T	O	H	T	O																																
	5	4	6	2	1	2	4	2																																
	<p>1.1.2 identify and explain the place values of digits in a numeral up to 100,000,000</p>	<p>Place value</p>	<p>Using the abacus or place value chart guide pupils to find the place value of digits in numerals up to 8-digits.</p> <p>Discuss with pupils the value of digits in given numerals.</p>	<p>write the value of digits in given numerals</p>																																				

Figure 9. Sample of a Ghana Junior High Syllabus.

After their lesson notes are prepared, teachers are required to obtain a signature of approval on their notes from the headmaster before they can present that lesson to their students. Representatives from the district regularly visit the schools and inspect the teachers' lesson notes to ensure that the teachers and headmaster are carrying out the lesson planning process properly.

To summarize the problem, teachers are currently required to undergo a tedious lesson planning process that siphons time away from more productive activities. The entirely paper-based approach to lesson planning is a major cause of inefficiency in the planning process. I propose that digital tools can decrease the amount of time teachers spend planning lessons, providing them more time to spend preparing students for their exams and engaging in professional development, which could improve outcomes for students. The digital tool I propose is an app that streamlines lesson planning and runs on the Android devices that are ubiquitous among teachers in Ghana.

## Learner Analysis

While working with teachers in Ghana I observed that teachers' use of technology is limited. Many teachers lack access to technology, have low levels of technology literacy, and face significant barriers to adopting new technologies. Financial costs associated with technology use are a significant concern.

Most teachers in public schools in Ghana do not use any digital technologies for scholastic purposes. Many schools do not have electricity to support technology use. Almost every teacher, however, has a smartphone and is capable of downloading and using apps like Facebook and WhatsApp. Their phones and networks are reliable enough to use almost all of the time.

There is a financial barrier for teachers to adopt new technologies because many teachers earn less than \$300 USD per month. Tablets and computers are uncommon because they are unaffordable for most. Schools also lack resources to invest in technology and are often not even able to provide sufficient books and supplies. Teachers are also sensitive about using their smartphones because of the costs associated with using network minutes and data.

## Consulting Products/Precedent

I am unaware of any related or competing products that teachers use for lesson planning in Ghana. As far as I have observed and researched, teachers are only using government-distributed books for lesson planning. Devices and the internet are new to Ghana and are not being used for much more than personal communication and social media.

There may have been related or competing prototyping products that I could have used besides Google Forms. I was already comfortable using Google Forms and was satisfied with the functionality, so in an effort to maximize my productivity I began using them for prototyping without considering any alternatives. Unless I become unsatisfied with Google Forms I will not investigate alternative tools.

Though I did not consult any other specific products while designing my app, I was undoubtedly influenced by many apps and instructional products I have used. For example, my app allows users to click through options similar to how I have clicked through options in apps I use to order food. I also provided space for users to type additional comments for scenarios when the clickable options would not be appropriate, similar to what I have seen on many surveys I have taken. I also made sure the app would display well on mobile devices because of difficult experiences I have had when trying to access web services that were designed for desktop computers while on my phone.

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## Literature Review

I conducted a literature review in order to understand how teachers use apps and what the best practices are for implementing new apps with teachers. I searched ERIC (EBSCO) with the terms *apps*, *teacher*, and *mobile* in abstracts. I limited the search to academic articles published since 2007. Of the seventy-two results, only four were relevant for my purposes.

The majority of articles that were not relevant to my study addressed apps that teachers could share with students, rather than apps for teacher use. Of the articles that did focus on apps for teachers, most were restricted to a single discipline, such as apps for English teachers. Only three articles addressed apps for teachers generally enough for this review; I will discuss their findings.

Preston (2015) looked at the perceptions of school leaders about how teachers interact with technology. Preston found that promoting e-leadership and providing professional development was important for leaders who wanted to encourage teachers to use technology in schools. E-leadership involved tech-literate teachers who promoted technology use at school and assisted other teachers in technology adoption. Preston's research suggests that it is important to identify and train teachers who will become experts and evangelizers of particular technologies in their schools.

Cherner (2014) provided a framework for classifying and choosing apps for teachers to use. Cherner found that apps are not classified well in most app stores, which makes it difficult for teachers to find relevant apps. The framework has three main categories: (a) skill-based apps, (b) content-based apps, and (c) function-based apps. Skill-based apps focused on helping students develop skills like handwriting or fluency. Content-based apps focused on subjects like math or social studies. Function-based apps focused on categories like community and presentation. Cherner does not attempt to inform the development of apps, but seeks to inform the way apps are organized in repositories for teachers.

Cherner (2016) provided a rubric to help teachers evaluate the quality of teacher-resource apps. The rubric includes three domains: (a) efficiency, (b) functionality, and (c) design. Those categories were divided into several dimensions such as (a) productivity, (b) multipurpose, and (c) ease of use. Cherner's rubric will provide a helpful framework for evaluating my lesson notes app. I will draw from that rubric to create survey questions for the teachers who will use the the lesson notes prototype.

### ***Performance Improvement***

Training and supporting teachers as they learn new technologies is one of the challenges of integrating technology in schools. Glazer (2005) noted that if teachers do not receive adequate support they "seem to become discouraged quickly, tending to abandon the technology" (p. 57). Providing teachers with technology usually does not increase technology adoption if it's not accompanied by effective training and support (p. 58). I employed a just-in-time support strategy in order to meet teachers' needs while they adopted the lesson planning app.

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Some authors have also found that teachers who believe that technology will benefit their students are more likely to successfully integrate technology in the face of external obstacles (Ertmer et al., 2012). In addition to supporting teachers with technical skills, it was also important for me to help them develop a belief that technology would improve their classrooms. Vongkulluksn (2018) claims that those “beliefs likely have the most direct relationship with teachers’ technology integration practice” (p. 71). The teachers I worked with were already extremely optimistic about technology, but I still needed to work to maintain their optimism. In order to influence teacher beliefs I had planned to circulate success stories and quote positive teacher feedback. I planned to send those stories and quotes to teachers when I sent them their regular surveys. Because of an early end to the pilot I did not circulate stories.

One of my motivations for employing a just-in-time support strategy was that it “is overwhelming perceived as more useful” than “isolated instructional sessions” (Granger, 2002, p. 483). Users prefer just-in-time support to isolated training sessions. One of my design challenges in the future will be to integrate just-in-time support into the app. I may accomplish this by providing both in-app instructions as well as in-app discussion boards that will allow teachers to support each other.

I did not include any support features with the first prototype of the app because of temporal and financial constraints. Because only a small group of teachers used the prototype, I provided personal support over the phone and through email. My contact info was available on the first and last screens of the prototype so that teachers could easily contact me. I attempted to identify teachers who were more comfortable with technology to be in-school champions on my behalf. I identified one of those teachers when I visited Ghana in January to start the pilot implementation of the prototype. The teacher owned his own laptop and was able to help other teachers create Google accounts during our meeting.

## Budget and Timeline

I have received grants from the Ballard Center and I-Corps at Brigham Young University totalling \$10,000. I am also seeking additional funding. This grant-based funding represents my total budget for this project. If someone were to be paid a standard salary to complete a similar project they would receive approximately \$12,250. That includes \$8,750 for salary at a quarter time for six months, \$3,000 for travel to Ghana, and \$500 for equipment.

My master’s project is part of a larger project that I started working on during February 2017 and will continue at least through July 2018 and hopefully much longer. I concluded my project in April in preparation to graduate in July. I will outline key dates from September 2017 to April 2018. The differences between my actual and proposed timeline are highlighted in yellow. The major differences were due to an early termination of the pilot which resulted in fewer iterations of the prototype and more work with an app developer. I was not able to do as thorough of an evaluation as I would have liked to because of the early termination of the pilot. Instead of iterating through prototypes, I decided to have a developer begin development of the app based on my evaluation of the initial prototype. Skipping iterations was not ideal and will likely result in more extensive redesign of the finished app at greater cost and complexity. While not ideal, complications like I experienced are often unforeseen, unavoidable, and are simply part of the

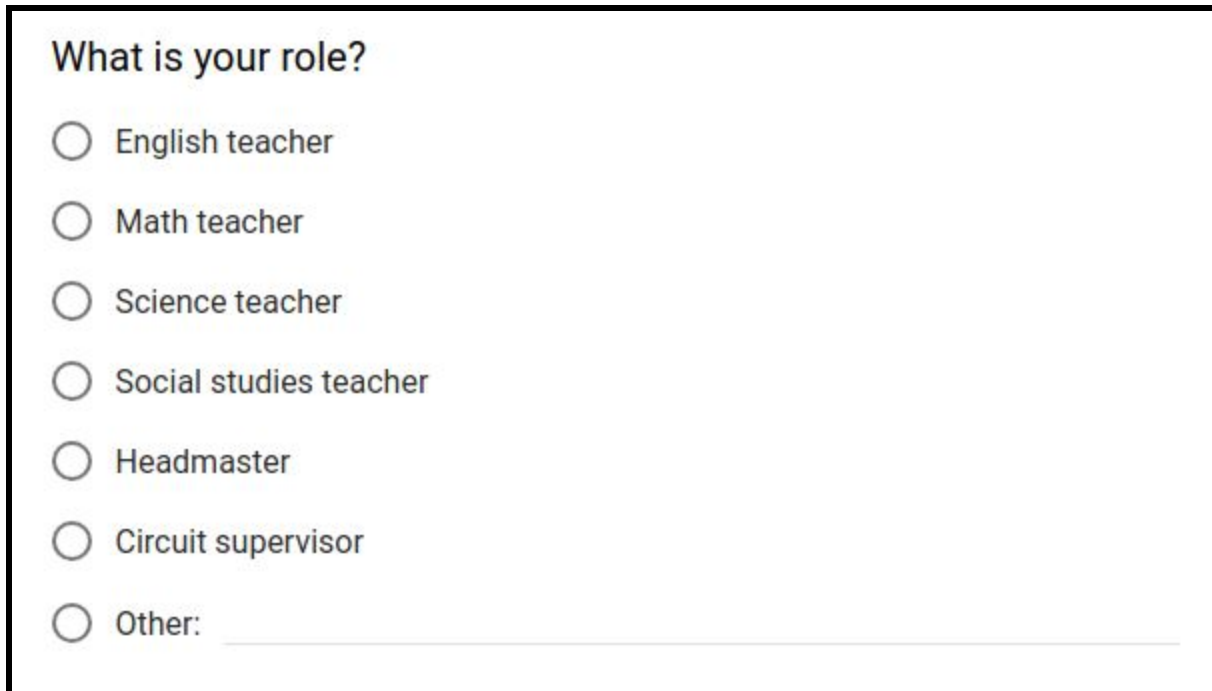
design process. Overall, my project was not detrimentally impacted by the early termination of the pilot.

<b>Actual Timeline</b>	<b>Proposed Timeline</b>
<p><i>September 30, 2017</i></p> <p>I. Complete digitization of all Ghanaian junior high syllabi (50 hours)</p> <p><i>December 31, 2017</i></p> <p>I. Lesson planning prototype 100% complete (40 hours)</p> <p><i>January 1, 2018</i></p> <p>I. Begin piloting instructional materials in the Suhum Municipality of Ghana (50 hours)</p> <p>II. Begin data collection (20 hours)</p> <p>III. Begin formal evaluation (40 hours)</p> <p><i>February 1, 2018</i></p> <p>I. Review feedback to begin first iteration of prototype</p> <p>II. End pilot early due to high attrition among teachers</p> <p><i>March 2018</i></p> <p>I. Work on final iteration of prototype to deliver to my app developer</p> <p><i>April 30, 2018</i></p> <p>I. Complete summative evaluation</p> <p>II. Deliver prototype to app developer</p>	<p><i>September 30, 2017</i></p> <p>I. Complete digitization of all Ghanaian junior high syllabi (50 hours)</p> <p><i>December 31, 2017</i></p> <p>I. Lesson planning prototype 100% complete (40 hours)</p> <p><i>January 1, 2018</i></p> <p>I. Begin piloting instructional materials in the Suhum Municipality of Ghana (50 hours)</p> <p>II. Begin data collection (20 hours)</p> <p>III. Begin formal evaluation (40 hours)</p> <p><i>February 1, 2018</i></p> <p>I. Review feedback to begin second iteration of prototype</p> <p><i>March 1, 2018</i></p> <p>I. Review feedback to begin third iteration of prototype</p> <p><i>March 31, 2018</i></p> <p>I. Complete pilot in Suhum</p> <p>II. Complete data collection</p> <p>III. Complete formal evaluation</p> <p>IV. Begin summative evaluation</p> <p><i>April 30, 2018</i></p> <p>I. Review feedback and evaluations to begin app development</p>

## Evaluation Instruments

The evaluation related to my master's project was predominantly formative. I also performed a quasi-summative evaluation. A truly summative evaluation was not possible because my project will extend beyond my graduation date. My primary evaluation questions were the following: (a) How frequently do teachers use the digital Lesson Notes tool?; (b) How much time do teachers spend preparing lesson notes with the tool?; (c) How much time did teachers spend preparing

lesson plans previously?; and (d) How much do teachers like the Lesson Notes tool? I created a survey to send to users on a regular basis that is represented in Figures 10-13.



**What is your role?**

English teacher

Math teacher

Science teacher

Social studies teacher

Headmaster

Circuit supervisor

Other: \_\_\_\_\_

Figure 10. First evaluation survey question.

### ***Frequency of Use***

My monthly survey was going include the following questions: (a) What do you like about the Lesson Notes tool?; (b) What would you like to be improved about the Lesson Notes tool?; (c) How do you decide if you are going to use the Lesson Notes tool or not?; and (d) How many times did you try to use the Lesson Notes tool but you were unable to do so? Based on the responses, I planned to modify the tool in order to receive fresh feedback the following month. If a teacher used the prototype less than five times in a month I would not have sent them the regular survey in order to avoid survey fatigue. I would have spoken to those teachers on an individual basis. Figure 11 contains the questions I asked users about the frequency of their use of the app.

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**How many times have you tried to use the app and succeeded?**

Your answer \_\_\_\_\_

**How many times have you tried to use the app but were unable to complete your notes because of difficulties?**

Your answer \_\_\_\_\_

**What difficulties prevented you from completing your notes?**

Your answer \_\_\_\_\_

Figure 11. Evaluation survey questions about app use.

### ***Time Spent Planning***

I planned to measure how much time teachers spent using the Lesson Notes tool to determine if the tool improved their efficiency. Teachers were going to self-report how much time they spent planning as part of their monthly survey. I was going to conduct exploratory interviews if after a one month adjustment period teachers had not reduced their lesson planning time by 50%. Because of an early end to the pilot, I did not perform this portion of the evaluation.

### ***Teacher Perception of Tool***

It was important to my project that teachers liked the Lesson Notes tool because I would like to expand to additional schools, as well as provide additional tools, in the future. I sent surveys to teachers about their perceptions so that I could quickly become aware of any negative feelings. I asked teachers to rate how much they liked the tool on a scale of one to five. I also asked if they preferred the digital tool or if they preferred to continue making their lesson plans on paper as they had historically done. Figure 12 contains the questions I asked users about their perceptions of the app. Figure 13 contains questions I asked users in order to solicit feedback that I could use to improve the app.

How good do you think the Lesson Notes app is?

1      2      3      4      5

Very poor                                    Very good

Do you prefer to complete your lesson notes with the app or on paper?

App

Paper

Figure 12. Evaluation survey questions about user perception.

What do you like about the app?

Your answer \_\_\_\_\_

What do you dislike about the app? What would you want to be changed?

Your answer \_\_\_\_\_

Additional comments:

Your answer \_\_\_\_\_

Figure 13. Evaluation survey questions aimed to solicit design suggestions.