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**Reducing Students' Cognitive Load Using Smartphones**

The variety, number, and access to educational opportunities has exploded as more traditional institutions of higher education have expanded their educational catalogs and degree-seeking programs, both in-seat and online. As such, many adults, are either returning to higher education to continue their education, or entering higher education for the first time after a long absence from formal education.[1] As educational opportunities have expanded, so too has the problem of student attrition. The factors that cause students to leave their education programs and courses prior to completing them are hotly debated, but there appear to be some consistent factors for in-seat and online students who are adult learners.

As discussed in reviews of literature by Florence Brawer (Brawer F. B., 1996) and Carolyn Hart (Hart, 2012), there are three common issues that disrupt adult students: full-time work, family commitments, and financial concerns. Beyond time constraints and the stress these factors can cause, there is the additional dimension of cognitive load. When adult learners start a new program of study or a new course, they are already preoccupied with personal concerns. The addition of classwork for these students may increase their cognitive load, to the point where they cannot keep track of their assignments. My project focused on building an application to assist student with assignment tracking as a means of reducing their cognitive load.

**What is Cognitive Load?**

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[1] While this research may also apply to massively open online courses (MOOCs), the focus of this paper are students in degree-seeking programs from accredited institutions of higher learning.

As discussed by Paul Kirschner, Cognitive Load Theory (CLT) presupposes that people have a limited working memory that is involved in the processing of new information, (or in this case, instruction) which is then later transferred to long term memory. Working, or short-term memory is limited to about seven elements of information at any given time. The application of CLT to instruction addresses promoting learning while not exceeding the limits of students' working memory. (Kirschner P. A., 2012). The crux of this theory as it applies here holds that a student's working memory is already close to "full" with concerns about work, family, and money, there is limited room for learning. Therefore, one possible way to keep students in a course and learning is to minimize what they have to retain at any given moment so they have time to process what they have learned or as in this project, what they have to do to manage workload.

Especially for working students and non-traditional students, cognitive load appears to play an important role. On top of keeping track of work schedules and family obligations, students need to keep track of schoolwork and deadlines. In a traditional face to face environment, where students meet with their instructor on at least a weekly basis, the routine of that meeting time acts as a reminder that something is probably due and students need to check their syllabus to find out what that is. For online only students, that routine doesn't exist (Tyler-Smith & Keith, n.d.). Another problem with tracking tests and assignments for both face to face and online only students is accessibility to a syllabus or other method to track assignments. While most courses today have syllabi posted somewhere online, it is not always in a format designed with mobile in mind. For the course I teach online, the syllabus is only available as a PDF or as a series of pages not designed to work with mobile. To this end, I chose to focus on creating a system of better accessibility for mobile platforms.

In the US alone, the majority of working adults possess a smartphone, but not all have access to computers where they work, or to computers they are allowed to use for personal use such as accessing

class websites. A smartphone with an Internet connection removes this barrier to tracking assignments and hopefully reducing their cognitive load.

**Approach**

The approach was to focus on creating a smartphone app that could feature:

1. A week-by-week checklist of assignments. As students checked each item off, it would retain state.

2. A one-click process so students could easily add calendar reminders for due dates

3. A notes section, so students could quickly write down notes relevant to the assignments that week or the content that week.

**Development Process**

The mobile app was developed using the Xamarin mobile development toolset. This allowed me to write in a language I was already familiar with (C#) and simultaneously develop a mobile app for the two major platforms, iOS and Android. All data associated with the app, like notes, and the state of the checklists are stored locally on the device. For each week, a student could see at-a-glance what was due each week, write any notes they wished, and add reminders to their phone's calendar with a click of a button. Once they completed an assignment for a given week, they could switch the item to On, indicating they had finished it. When switching to another page or closing the app, the app would retain student's changes.
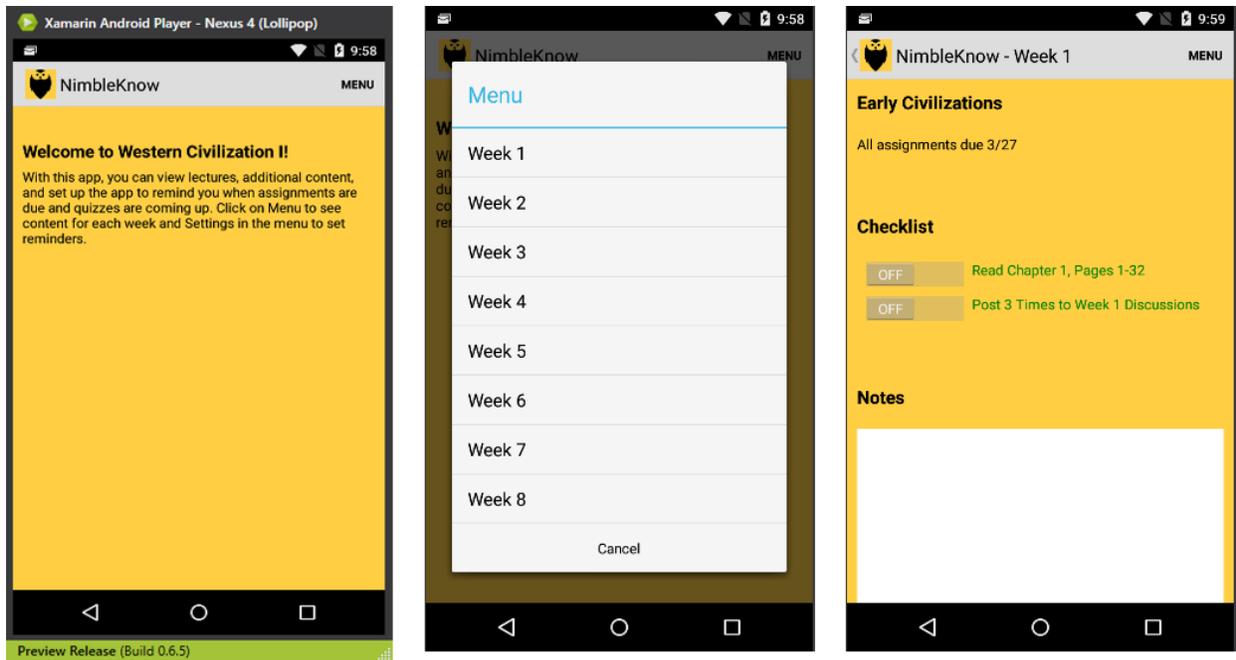
*Figure 1, the NimbleKnow mobile app*

However, since not all students are not familiar with how to install apps, or have a "feature" phone

which only allows for mobile web browsing, I created a separate web site with a limited set of features,

due to time constraints. The web site listed weekly assignments but did not provide any saving or note-

taking features.[2] The mobile website, NimbleKnow.com was developed in ASP.Net and hosted on an

external server.

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[2] I developed my approach prior to reading Turadg Aleahmad's thesis, however his *Nudge* project is somewhat similar (Aleahmad, 2012).
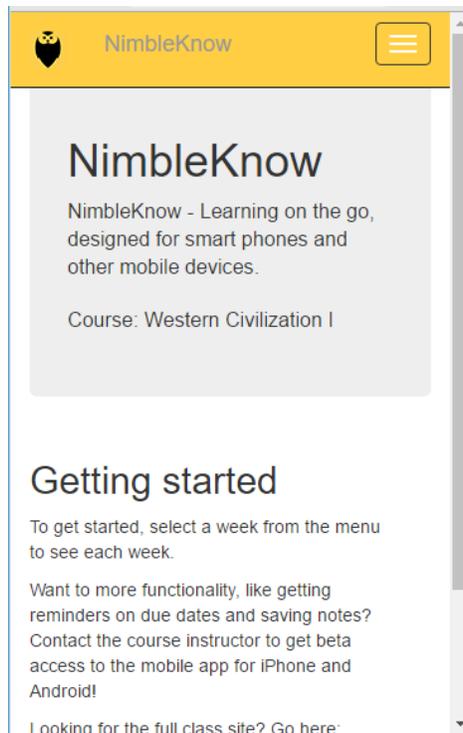
*Figure 2, the NimbleKnow mobile website*

The course content of the mobile app and website was supplied by me, in my capacity as an online instructor as an adjunct history professor for a private college in the Midwest.

**Recruitment**

Students were recruited from a section of an online history class I taught. Each semester is eight weeks long. There were twenty students in this section of the course. In the second week of the course, I posted links to the mobile website and the mobile Android version of the app, so students could access these anonymously. Due the restrictions in beta testing of iOS, if a student decided to the use app, I would have to know their email address. In the fourth week of the course, I posted the survey and asked students to take it. Fourteen students chose to take the survey.

**Survey**

The survey was developed using Survey Planet's online platform. The survey consisted of sixteen questions divided into three sections. The first section (three questions) asked respondents about their college experience, the second section (nine questions) were about issues that could provide some insight into a student's personal cognitive load. The last section and remaining questions were to find out if students had tried either the apps or the mobile website.

**Survey Results**

While the survey sample is too small to be a scientific sample, it does provide some anecdotal insight what some students are dealing with in terms of cognitive load and its effect on their studies. The first two questions only tell us that the majority of students have taken a class in-seat and most have completed at least on online course:

| Q1 | Have you taken any college courses in-seat (in a physical classroom)? | Yes | No |
|---|---|---|---|
| | | 11 | 3 |
| Q2 | Have you completed at least online class as part of a degree-seeking program? | 11 | 3 |

However, the results of question three provide more insight into possible factors that could increase a student's cognitive load. Respondents could select as many as applicable:

| Q3 | Have you ever started an online course but not finished it? If so, what factors have contributed to you dropping an online course? |
|---|---|
| Poor interaction with instructor | 3 |
| Work obligations | 3 |
| Family obligations | 2 |
| Problems with course website | 0 |
| Class was hard to follow | 3 |
| Lack of communication with other students | 0 |
| Too hard to keep track of assignments | 2 |
| Not applicable | 6 |
| Other (books not arriving on time) | 1 |

Of the eight respondents who did not finish a prior online course, five selected a combination of "work obligations", family obligations", and "too hard to keep track of assignments". This selection could point to cognitive load being an issue for these particular students and course completion. Continuing on, students were then asked about work and their schedules:

| Q4 | Do you work full time? | Yes | No |
|---|---|---|---|
| | | 13 | 1 |
| Q5 | If you work a paid job, do you work at home or at a place of business? | Business | Home |
| | | 13 | 1 |
| Q6 | Is your work and life schedule Monday-Friday similar from week to week or does it differ greatly? | | | |

| Yes | Mostly | Somewhat | Rarely | Never |
|---|---|---|---|---|
| 7 | 4 | 3 | 0 | 0 |

In addition to the majority of respondents working, a majority also have family obligations:

| Q7 | Do you have dependents who rely on you for daily care? (children, parents, etc.) | Yes | No |
|---|---|---|---|
| | | 10 | 4 |

Most respondents also spend 10 hours a week or less on assignments:

| Q8 | On average, how many hours per week have you spent on course work, for all online classes you have taken? | | | |
|---|---|---|---|---|

| 0-5 hours | 5-10 hours | 11-15 hours | 16-20 hours | More than 20 hours |
|---|---|---|---|---|
| 1 | 7 | 5 | 0 | 1 |

For question 9, "Where do you do most of your course work?", the twelve out of fourteen work on it at home, with other two choosing work as their response. So having accessibility to their assignments in a

mobile format may not be helpful if they are already working on a home computer rather than a phone or other mobile device. However, for question 10:

| Q10 | When you work on course work, how far in advance do you complete it? | | |
|---|---|---|---|
| Less than 24 hours before the due date | Less than 3 days but more than 24 hours before the due date | Less than 7 days but more than 3 days before the due date | More than 7 days before the due date |
| 5 | 8 | 1 | 0 |

Which could indicate that students are only working on assignments when they have access to a computer or that students only access the computer when they have something due, so the results are inconsistent. The last two questions in this section asked respondents about how they track assignments and if they have faced any challenges:

| Q11 | Have you encountered challenges in keeping track of assignments? | Yes | No |
|---|---|---|---|
| | | 10 | 4 |
| Q12 | How do you keep track of assignments? | | |
| Syllabus | Mobile Website | Mobile App | Other |
| 8 | 3 | 1 | 2 |

The majority of respondents indicated that they have faced challenges keeping track of assignments, but also only use the syllabus to keep up with the work. I believe there was some confusion between what students considered the mobile app versus the mobile website, as analytics from the mobile app shows that no students actually downloaded the app. The remaining four questions deal with the students' interaction with the app:

| Q13 | Do you use the mobile website? | Yes | No |
|---|---|---|---|
| | | 9 | 5 |
| Q14 | If you are not using the mobile website, why not? | | |

| Didn't know about it | Don't need help tracking assignments | Track assignments another way | Too complicated to use | Using mobile app instead |
|---|---|---|---|---|
| 2 | 1 | 7 | 0 | 1 |

| Q13 | Do you use the mobile app? | | Yes | | No |
|---|---|---|---|---|---|
| | | | 4 | | 10 |

| Q14 | If you are not using the mobile app, why not? | | | | |
|---|---|---|---|---|---|

| Didn't know about it | Don't need help tracking assignments | Track assignments another way | Too complicated to use | Using mobile app instead |
|---|---|---|---|---|
| 5 | 3 | 0 | 2 | 3 |

Again, since the analytics show that no students downloaded the app, there appears to be some confusion on the app versus the mobile website. Furthermore, according to the analytics embedded into the website, students actually utilized the mobile website from desktop computers and not from mobile devices. The only mobile devices to access the were the ones used during testing, before releasing the site to students.

**Conclusion**

The factors that lead to student attrition remain a problem for adult students. The net effect of some of the aforementioned factors appears to be increased cognitive load, which could reduce the ability of adult students to focus on their studies. While much of the focus on Cognitive Load Theory focuses on instruction, reducing short-term memory requirements on students by helping them keep track of their assignments may prove helpful. However, given the small population size of the project and the inadvertent lack of cooperation by the test subjects in not using the mobile app or using the mobile website on a mobile device does not give any conclusive results. However, despite the survey's sample size being too small to be statistically relevant, it does point to students' busy work and family lives which could contribute to an increased cognitive load.

More research on a larger, more mobile-friendly population sample could provide more insight into the usefulness of the mobile app.  In accomplish this, I would work on emphasizing the usefulness of the app and mobile site in order to encourage more participation. A future version of the app would be dynamic, and work for a variety of courses and semester lengths, which could provide for a more diverse and larger sample pool.

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