Increasing parent engagement in student learning using an Intelligent Tutoring System with Automated Messages

by

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Abstract

This study explores the ability of an Intelligent Tutoring System (ITS) to increase parental engagement in student learning. A parental notification feature was developed for the web-based ASSISTments ITS that allows parents to log into their own accounts and access detailed data about their students' performance. Parents from a local middle school were then invited to create accounts and answer a survey assessing how engaged they felt they were in their students' education. A randomized controlled experiment was run during which weekly automated messages were sent home to parents regarding their students' assignments and how they were performing. After having them take a post-survey, it was found that access to this data caused parents to become more involved in their students' education. Additionally, this led to increased student performance in the form of higher homework completion rates. Qualitative feedback from parents was very positive.

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Chapter 1

Introduction

1.1 Background

Our intuition and experience suggest that parents[1] play an important role in a student's education. We believe parental support can be critical to keeping a child on the right track and instilling in them the importance of performing well in school. Research on this subject, meta-analyzed in Cotton & Wikelund, 1989, showed that parental involvement leads to improvement in student achievement in a multitude of different areas. A more recent meta-analysis by Fan & Chen, 2001 found less of a consensus but still reported a strong correlation between some forms of involvement and student well-being. We also suspect that even if such involvement does not directly influence performance, it may nonetheless be desirable based on the potential for indirect benefits. For example, a key meta-analysis of studies on homework by Cooper, Robinson, & Patall, 2006 found that it had a net positive impact on student learning. Homework

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[1] We are sensitive to the fact that students have a variety of familial arrangements outside of the traditional two-parent household. We use the term "parents" for the purposes of clarity and brevity, with the understanding that it includes both single and multiple parents, step-parents, legal guardians, and any other family members or persons who might be responsible for a student's well-being.

completion is one area we believe parental involvement has enormous potential to improve, as parents have the ability to make sure their students complete their homework in a timely fashion.

This ability is contingent, however, upon access to information related to their students' performance, such as what topics are being covered in class, whether or not they are completing their schoolwork, and how they are behaving in class. Unfortunately, students have been known to be less than forthcoming with this information. Often the only feedback parents receive is a report card once every semester, and the ability to successfully monitor and guide a student's progress on this information alone is questionable. E-mails and phone calls home from teachers can provide more frequent data but are time consuming for the teacher. Additionally, these reports generally lack the detailed data necessary to contextualize[2] the feedback.

Intelligent Tutoring Systems (ITS) offer a potential solution to this problem. The purpose of an ITS is to provide in software the services of a private tutor at least as well if not better than a human (Corbett, A. T., Koedinger, K. R., & Anderson, J. R., 1997). Among many reasons, this is desirable because software is much more cost effective and scalable than hiring an army of human tutors for every student. ITS typically have students solve problems and then provide direct feedback on their performance, as well as assistance if required. Often cognitive models of each student are built using the learning data collected by the system in order to provide individualized instruction. Unlike teachers using pencil and paper assignments, ITS are able to electronically record significant amounts of detailed data related to student performance and make that data available in meaningful ways, all automatically. This has the potential to increase

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[2] When we use the term "context" in relation to parent-teacher correspondence, we are referring to learning data that provides evidence for the assertions made in the correspondence. For example, if a teacher informs a parent that their student is struggling with Pythagorean Theorem, "contextualizing" that message would refer to including copies of a student's work that demonstrates their difficulty in grasping this particular skill.

parental engagement in student learning by simply making this data accessible to parents, and with minimal effort. ITS can also provide teachers with the facilities to send contextualized messages home that reference this data, reducing the time required to communicate directly with parents. Such messages can be sent by the ITS automatically as well, providing parents with feedback at a frequency and level of detail a teacher cannot.

There are a variety of popular ITS in existence today, including Carnegie Learning's Cognitive Tutor (Carnegie Learning, 2010), the Andes physics tutor (University of Pittsburgh, 2010), and the IMMEX system (UCLA, 2010). While all of these software systems collect and analyze considerable amounts of data on student learning, none of them provide comprehensive facilities for parents to access this data. Similarly, there is an abundance of software packages for schools meant to keep parents and teachers informed of student progress, such as Pearson's PowerSchool (Pearson School Systems, 2010). However, these programs are not ITS. While they do provide access to data, monitor trends, and alert parents and teachers when these trends indicate a problem, the data used has to be entered by the teacher manually. Furthermore, this data consists primarily of what one might find in grade books—averages on important assignments and tests. It would be next to impossible for a teacher to manually enter the fine-grained, problem-level[3] data from all assignments and homework that ITS automatically provide.

Additionally, there is a class of electronic assessment tools that seek to mimic the traditional offline assessment model using software. Some of them, including the popular Study Island (Archipelago Learning, 2010), attempt to combine the fine-grained data collection

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[3] "Fine-grained" and "problem level" merit further explanation. Data collected by teachers for their gradebook typically consist of just the percentage of problems answered correctly for a given assignment. ITS also record which particular problems in the assignment were answered (in)correctly, what the student answered, how many attempts they made, how much tutoring they requested, how much time they spent on the problem, and other such minor but important details that are near impossible for a teacher to record manually.

inherent in electronic assessments with the parental notification facilities found in student management systems. However, these are not classified as Intelligent Tutoring Systems—they are not "intelligent," meaning they do not attempt to reproduce the assistance of a human tutor by building cognitive models of student learning and responding with individualized instruction. They simply replicate the assessment, not the tutor. On the opposite side of that spectrum, there is at least one system (Lahart, Kelly & Tangney, 2007) that attempts to replicate the services of a tutor, but for the parent rather than the student. While certainly a promising approach, we are more interested in exploring whether or not we can increase parental engagement by taking advantage of the data collection facilities provided by *student* Intelligent Tutoring Systems.

In order to do this, we developed a parental notification feature for the ASSISTments ITS and conducted a study to explore its effectiveness at increasing parental engagement. The ASSISTments system (www.assistments.org) is a free, web-based ITS developed at Worcester Polytechnic Institute and used by thousands of students in the greater Worcester area. It provides a virtual classroom environment where students sign up for accounts and enroll in classes created by their teachers, who also have their own accounts. Teachers can then assign problem sets and monitor their students' progress using the system's extensive reporting functionality. These reports display the considerable amount of fine-grained data collected by the system in ways that inform teachers and students how they need to adjust their teaching and learning, respectively. While using the system, students are being assessed while they are learning, saving valuable classroom time as described in Feng & Heffernan, 2007. The ASSISTments project uses this assessment data to perform research on student learning, such as detecting when and why

students game the system as described in Baker, Walonoski, Heffernan, Roll, Corbett & Koedinger, 2008.

The exploratory study was run during the 2009-2010 school year and the results were promising for several reasons. First, they indicated that the parental notification feature we developed for ASSISTments did cause parents to feel more engaged in their students' education. Qualitative feedback from both teachers and parents was very positive overall. Secondly, the study showed that parents utilized the data provided to them by the ITS more frequently if they were reminded to check in on their students by messages sent home from their teacher. Unfortunately, we were limited by the fact that teachers can only send home so many personalized messages to their students. Thus, the frequency and breadth of the intervention was minimal and few of our results were statistically reliable, including those that actually demonstrated any effect on student performance and homework completion rates. Informal trends indicated, however, that a stronger experimental design with a more potent intervention may be able to detect a reliable effect.

In response to the lessons learned from the exploratory study, we added an additional feature to the parental notification component of ASSISTments. This feature enabled the system to send out automated messages to parents similar to those sent by the teacher, containing information about their students' performance, homework completion and upcoming assignments. While these messages were not intended to replace a personal message from the teacher, they would serve the purpose of reminding parents to check on their students' data without burdening the teacher. This would allow us to significantly increase the frequency of reminders as well as provide them to all parents, thus considerably increasing the strength of the

intervention. We performed a randomized controlled experiment during the fall of 2010 to test

the effectiveness of this new feature. Our hope was that with a more potent intervention and

stronger experimental design, we would be able to reliably detect any effect a parental

notification component of an ITS might have on parental involvement in student learning, and

any effect that involvement may have on student performance.

1.2 ASSISTments

The ASSISTments system was created in 2003 by Neil Heffernan, a professor in the

computer science department of Worcester Polytechnic Institute. It is a free, online Intelligent

Tutoring System developed and maintained by Professor Heffernan's graduate students and

undergraduate employees. The project is funded by several research grants from government

organizations such as the National Science Foundation and the Department of Education. The

website is currently used by thousands of students and their teachers, primarily in the greater

Worcester area but rapidly expanding to other parts of the country such as Maine. Professor

Heffernan, his graduate students, and the project's many partners use the data collected by

ASSISTments to perform research on student learning, often partnering with local schools using

the system to perform experiments such as the one described in this thesis. This has resulted in

the publication of numerous academic papers and contributed significantly to the learning

science community.

ASSISTments is a tool for what is known as "data-driven instruction" or "formative

assessment." The idea behind these concepts is that in a world where computer programs such as

ITS can collect an enormous amount of very detailed information on student learning, teachers

should be using data to dynamically inform their instruction. Additionally, a significant amount of potential learning time is wasted during the assessment process; generally, when students are taking tests, they are not learning new information. ASSISTments derives its name from the ability to assist while assessing by providing tutoring and feedback during assessments. Between this and its data collection and reporting capabilities, ASSISTments is able to save teachers a considerable amount of time while shaping instruction to be more responsive to student needs (see Popham, 2008; Ainsworth, Almedia, Davies et al. 2007; Marsh, Pane & Hamilton, 2006; Boudett & Steele, 2007; Halverson, Grigg, Prichett & Thomas, 2006; and Park & Datnow, 2009)

ASSISTments is also very much a *teacher-driven* tool. Students cannot simply log on and begin completing assignments given to them by the system. They must first enroll in a virtual class created by their teacher, who then assigns them problem sets of his or her choosing from a large collection of certified content created by WPI. ASSISTments also contains its own full-fledged content creation tool if the teacher wants to create their own problem sets, or they may choose to use content created by other fellow teachers. In this way, ASSISTments is a tool that teachers can integrate into their own curriculums rather than dictating what they need to assign and when. It mimics the classroom environment, allowing teachers to assign problem sets to be done during class using laptops or a computer lab, or completed for homework on students' own computers (assuming the school is located in a community with widespread internet access).

When students log into ASSISTments, they are presented with a list of assignments given to them by their teacher, usually with a due date attached to them. Students click on these assignments to launch the ASSISTments runtime (commonly referred to as the "Tutor"), where they are presented with a set of problems one at a time that they must solve. These problems

consist of a question and a means of answering it, usually multiple choice options or algebraic fill-in. Open response questions are also supported, though they must be graded by the teacher. Oftentimes, especially with nightly homework assignments, the question is found in the students' textbooks and the answer inputted into ASSISTments in order to receive the benefits of an ITS while using existing materials. One of these benefits is instant feedback, where the students are told if they are correct or not after answering each problem. If the student answers incorrectly, they are often given tutoring in the form of hints or "scaffolding," a series of sub-problems that help students break down the original problem into smaller steps.

My Teacher's Assignments

1 - Multiplication - Fractions: Positive and Negative (Problem Set 5964)

2 - Multiplication Fractions - THE SKILL BUILDING SET (Problem Set 11829)

3 - Pattern Finding - THE SKILL BUILDING SET (Problem Set 10833)

4 - Subtracting Fractions - LEVEL 2 SKILL BUILDING (Problem Set 6913)

5 - G.4.7 Plotting points (4 items) (Problem Set 2849)

6 - V&P 1.1 (Problem Set 11549)   (Was due on: September 21, 2010 08:00 AM)

7 - V&P 1.2 (Problem Set 11551)   (Was due on: September 22, 2010 08:00 AM)

8 - V&P 1.4 (Problem Set 11553)

9 - V&P 1.5 (Problem Set 11554)

Figure 1.1. Student assignment list on ASSISTments.

The scatterplot below shows the ages and heights of 11 players on the school football team Each dot represents one player.

What is the total number of 14-year-olds who are more than 60 inches tall?

Ages and Heights of Players
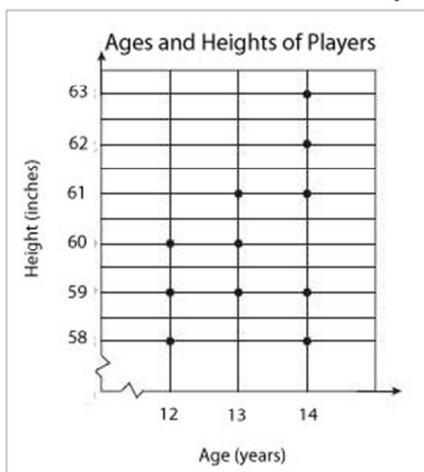
Comment on this question

Break this problem into steps

Type your answer below (mathematical expression):

3

Submit Answer   ✔ Correct!

Figure 1.2. Example problem being solved in the Tutor

In addition to traditional linear problem sets, there are also Skill Building assignments. These assignments focus on one particular skill or group of related skills and present students with similar, random problems until they reach a mastery criterion, which is typically answering three consecutive problems correctly. Theoretically, once students have reached this criterion they have sufficiently demonstrate mastery of the skill in question and can move on, while

student who have not are given more problems. Skill Building assignments are another way in which ASSISTments responds to differing student needs based on performance data.

While students are completing problems in the Tutor, ASSISTments is recording data about their every action in real time. This includes which problems they are given, what answers they give and whether they are correct or incorrect, whether they ask for tutoring and how they respond to it, etc. This data is then made available to teachers, also in real time, through various reports generated by the system. The most common is the Item Report, which is described in detail in the next section. It is simply a matrix of students and questions for a given assignment, with cells containing each student's answer. Additional metadata is displayed in the column headers, allowing teachers to instantly see average scores, which students were struggling, which problems were the most difficult, and common wrong answers resulting from misconceptions. Ideally, teachers will use this data to identify problems and adjust their instruction to address them.

Student/Problem [Unanonymize]	Average	#68704 Details Data driven	#68705 Details Data driven	#68707 Details Data driven	#68708 Details Data driven	#70262 Details Data driven	#70263 Details Data driven	#70265 Details Data driven
Problem average	60%	83%	74%	75%	79%	61%	32%	23%
Help requested		0%	0%	2%	4%	6%	8%	8%
Common Wrong Answers		Louis, 100%	Mali, 100%	10.8, 26%	25, 35%	970.2, 22%	6.5, 20% 6.468, 18%	135828, 23% 93, 10%
XXXXX *	80%	✔ Kareem	✔ Rolanda	✔ 30	✔ 9	✔ 9702	✘ 6.468	✔ 372
XXXXX *	60%	✔ Kareem	✔ Rolanda	✘ 10.8	✔ 9	✔ 9702	✘ 6.4	✘ 33597
XXXXX * 2 DAYS LATE	60%	✔ Kareem	✔ Rolanda	✔ 30	✔ 9	✘ 9599.1	✘ 6.4	✘ 135828

Figure 1.3. Teacher Item Report

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Chapter 2

Parental Notification Component

During the summer prior to the 2009-2010 school year, a parental notification component was implemented for ASSISTments. This component adds a parent role to the system, allowing parents to sign up for accounts on the website. In order to do this, however, a teacher has to enable the feature for a particular class. Students are then prompted to enter their parents' email addresses into the system, and these addresses show up in the teacher's digital roster. From there, the teacher can invite parents to sign up for accounts, which causes the system to send out an email to the address specified by the student containing a link to a special sign-up page.

The parents' accounts are automatically linked to their students' accounts, allowing parents to log in at any time and from any web-ready device and check-in on their students' performance. The system exposes several important pieces of functionality that provide parents with data about their students' progress. When parents first log in, they are presented with the Summary view, which displays upcoming, completed, and past-due assignments within a customizable window of time. This page also shows any new messages sent by the students' teachers and a list of daily reports. These reports contain a detailed breakdown of every problem that students worked on in a given day, including what answers students gave and what the correct answer actually was if students answered the problem incorrectly. These reports give

parents a temporal sense of their students' activity and enable them to enforce good time

management, an area we feel parental involvement has the potential to be particularly beneficial.

Sarah Cooper at Fake School

Assignments Completed (within 7 ▾ **days - see all** here**):**

2 - Integers- Addition - LEVEL 1 SKILL BUILDING (completed on time)	Mastered
3 - Finding Fractions And Ratios (CMP) (completed on time)	88%

Unfinished Assignments

1 - Adding and Subtracting Reals (CMP)	Due: 18 Nov, 2010, 08:00 AM

Upcoming Assignments

2 - Integers- Addition - LEVEL 1 SKILL BUILDING (completed on time)	Due: 18 Nov, 2010, 10:00 PM
3 - Finding Fractions And Ratios (CMP) (completed on time)	Due: 18 Nov, 2010, 10:00 PM
5 - Adding Reals (CMP)	Due: 19 Nov, 2010, 08:00 AM
4 - Adding and Subtracting Fractions - THE SKILL BUILDING SET	Due: 19 Nov, 2010, 08:00 AM
6 - Addition and Subtraction Integers - THE SKILL BUILDING SET	Due: 20 Nov, 2010, 08:00 AM

Daily Student Reports (see all here**):**   Icon Key: ● Viewed. ○ Not viewed.

○ Report for 18 Nov, 2010

Figure 2.1. Summary page presented to parents upon login.

Clicking on any of the assignments listed in the Summary view brings parents to the Item

Report for that assignment. The Item Report is the ASSISTments system's most commonly used

report, and is accessible by both teachers and students. It provides clear and detailed information

about student performance on a particular assignment. The report consists of a table with a row

for each problem in the assignment, with the first column containing a link allowing parents to

preview the problem themselves and review it with their students. The second column displays

students' responses to the problems and whether or not they were correct. The last column shows

how many hints students requested for those problems. The bottom of the table displays students' grades on the assignment and the class average. Parents can also click on a link to see a second by second breakdown of their students' activity on the assignment, allowing them to detect if their students are getting distracted and wasting time. This report updates in real time, permitting parents to monitor students as they do their homework, regardless of their location.

The parental notification component also exposes new functionality to teachers in the form of a messaging system. This feature allows teachers to easily send messages to the parents of their students through the ASSISTments system, as well as see who viewed them. These messages can be sent to the whole class or to individual students or groups of students. Parents are notified by email when they receive a message. The notification email does not contain the message itself; instead, it contains a link to the parent's inbox on ASSISTments that automatically logs them in. This was a conscious decision designed to encourage parents to utilize the rest of the ASSISTments system by forcing them to log in whenever they wanted to read a message from their students' teachers. Teachers can send messages from a typical email-like interface or they could use the Item Report, allowing them to send contextualized messages tied to relevant data. The teacher's Item Report differs slightly from the parent and student version in that it contains a row for each student in the class, with columns representing the individual problems in the assignment. An additional column is present when the teacher has parental notification enabled, containing a form to send either a generic or custom message to a particular student or the whole class regarding the assignment. This message contains a link to the Item Report of the relevant assignment that automatically logs them in.
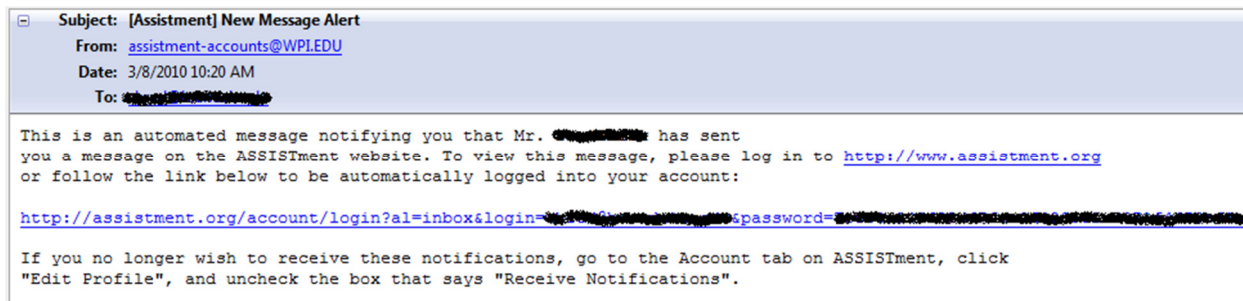
Figure 2.2. Notification email sent to parents upon receipt of a message.

XXXXX *	Select a comment	90%	✓ 6.5	(Ungraded Essay) noi because to find the volume you do L*W*H*1/2 but the hypotenuse is not either of them so it is not needed.	✓ 30
XXXXX *	Select a comment / XXXXX seemed to struggle applying the / Send	63%	✓ 6.5	(Ungraded Essay) You do need to know the length of a for surface area, but not area.	✗ 60
				(Ungraded Essay) no you do not need to find the	

Figure 2.3. Teacher version of the Item Report with comments enabled.

One point to note about the messaging feature is that parents cannot respond to teachers through ASSISTments. This restriction was specifically requested by our partner teachers, and while it may seem counter-intuitive, it serves an important purpose. Teachers are often hesitant to send messages home to parents because it invites further correspondence from the parent, adding even more of a burden to an already time-consuming process. This correspondence is often trivial and argumentative, making the decision to send a message home a daunting one and often discouraging teachers from communicating with parents. Thus, we want communication to

be asymmetrical, with considerably more correspondence flowing from teacher to parent than the other way around. Email and phone cannot provide this asymmetry, but a custom messaging system built into an ITS can. The key is to make it much easier for teachers to send messages than for parents. The parental notification component of ASSISTments provides teachers with a means to send messages home much more efficiently, but does not provide those same facilities to parents. If parents need to communicate with their students' teachers, they can still use email or phone—however, this requires more effort than just clicking a "Reply" button and thus maintains the asymmetry.

It should be noted that the development of the parental notification feature for the ASSISTments ITS was not a difficult task. Most of the important functionality, such as the Item Report, was already implemented and available to students and teachers. Adding this feature simply entailed making such functionality available to parents as well. The minimal effort required to implement this feature suggests that adding such functionality to other ITS could be an equally favorable cost/benefit proposition.

During the summer of 2010, we added an automated messaging feature to the parental notification component in response to the results of the exploratory study. The feature allows teachers to enable the messages for a given class in addition to the regular parental notification functionality. When enabled, any parent that has signed up for an account and has a student enrolled in the class will begin receiving some number of automated emails, depending on their preferences. These emails contain information almost identical to the summary view (see Figure 1), including completed, outstanding, and upcoming assignments. Unlike messages sent by a teacher, these messages contain the relevant information directly in the email and do not force

the parents to log in. We decided on this policy in order to increase the strength of the intervention. While parents may log in to see a personal message from their students' teachers, we predicted they would be unlikely to do so in response to an automated reminder, and may even find it patronizing and annoying. Providing the data in the email itself removes the "nagging" quality and forces parents to view information they might not have logged on to see but nonetheless find important. If parents require more detailed information, they can simply click on an assignment and automatically be logged in and brought to the Item Report.

By default, parents will receive a weekly email containing the information described above every Friday evening. Parents have the option of disabling this email by logging onto ASSISTments and editing their preferences (Figure 4). Here they can also opt to receive one or two nightly emails at a time of their choosing. These emails are identical to the weekly email except that their time frame for completed and upcoming assignments is only a day rather than a week. The motivation behind this system is that it allows parents to receive a nightly email in the afternoon, perhaps when they get home from work, informing them of what their students have for homework. The second nightly email can be set to be delivered later in the evening, perhaps before the students go to sleep for the night, informing them whether or not their students have completed their homework. Parents can opt for one or both of the nightly emails, depending on how closely they want to monitor their students.

Parent Settings

Note: these features may not become active until late October.

☑ I want to receive an email each week summarizing how my student is doing

☑ I want to receive an email when my student's teacher sends me a message on ASSISTments

☐ I want to receive a nightly email informing me what my student has for homework at: 3 PM ▾ 00 ▾

☐ I want to receive a nightly email informing me if my student has completed their homework at: 9 PM ▾ 00 ▾

[Save Preferences]

Figure 2.4. Parent preferences screen

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Chapter 3

Exploratory Study

This chapter contains a write-up of the exploratory study, which was completed prior to the writing of this thesis. Therefore, Chapter 3 should be treated as its own separate study, with an independent Method, Results, and Discussion section. The following overview is provided in order to put the results of the study in context; description of the final experiment begins in Chapter 4.

3.1   Overview of Exploratory Study

An exploratory study was conducted during the 2009-2010 school year after the completion of the parental notification component (but before the implementation of the automated messaging feature). The purpose of the study was to pilot the new component and gauge its potential to increase parental involvement in student learning; as we described in the introduction, using an ITS for parental notification is a new area of research and we were unsure of what to expect. We were curious as to whether or not parents would be able to effectively utilize the abundance of fine-grained data suddenly provided to them by ASSISTments, and whether this utilization would lead to better student performance. We also sought feedback from

parents and teachers so that, if and when we conducted a controlled experiment in the future, we could work out any issues beforehand rather than attempting it blindly.

The study was conducted at a local middle school with two teachers who already used ASSISTments extensively in their classrooms. During the fall semester, all of their students' parents were invited to create accounts on the system using the new parental notification component. We were disappointed to find that while most of the parents signed up for accounts, few ever logged in again after doing so to check on their students. We hypothesized that parents were busy and needed to be reminded to log in. We decided that the best way to approach this was to have the teachers send messages to parents through the messaging feature of the parental notification component. Parents would be unlikely to ignore these messages and would be forced to log into the site in order to read them. They would serve as a reminder to check on their students without appearing to nag. The messages would generally be either a global reminder to all parents about upcoming tests and activities in class, or messages to particular parents about their students' individual performance.

We began sending messages to parents during the spring semester. Additionally, we had them complete a survey both at the beginning and end of this period in order to measure their perceived involvement in their students' education. Our server logs indicated that during this time, parents visited the site significantly more frequently to check up on their students and view data related to their performance, excluding visits to those parts of the site related to viewing messages. This suggests that when parents logged into ASSISTments to view their messages, they were reminded to visit other parts of the site to check up on their students, just as we had hypothesized. Additionally, the results from the survey seemed to indicate that parents felt more

involved in their students' education during the period they were receiving messages and checking in more frequently. We attempted to take this one step further and see if we could detect any increase in student performance or homework completion rates as a result of this increased involvement, but we were unable to do so at statistically significant levels.

Based on these results, we were confident that a randomized controlled experiment with a stronger intervention would be able to detect increased parental involvement and possibly even student performance. It was clear to us that having teachers send home messages themselves would not provide a strong enough intervention, as sending such messages to every student frequently is not feasible, especially those personalized messages to particular students that would theoretically have the most effect. This conclusion prompted the development of the automated messaging feature, which would provide every parent with frequent, contextualized reports on their particular student and thus significantly increase potency of the intervention. Additionally, the exploratory study did not have a strong experimental design; it lacked a true control group with the individual student as the unit of selection. This lead us to conduct a randomized controlled experiment using the new automated messaging feature the following school year, as described in the next chapter.

3.2   Methods of Exploratory Study

The parental notification feature was completed in the summer and pilot tested during the fall semester. Two of our partner teachers, both 8th grade math teachers at a local suburban middle school who used the ASSISTments system extensively in their classrooms, participated in this study. At the time, each taught 4 periods of roughly 20 students, 2 honors and 2 non-

honors. When the pilot began, students signed up for accounts on ASSISTments and were instructed to provide their parents' email addresses. Invitations were then sent out to parents to create accounts. Of the 176 students, 127 (72%) of their parents signed up for accounts. We then monitored the server logs in order to measure how frequently parents logged in to check on their students. Unfortunately, participation rates were far lower than expected. Parents rarely logged in to check on their students' performance after they first signed-up. We were quite puzzled as to why parents were not taking advantage of this feature.

We hypothesized that perhaps because parents tend to be busy, they needed some sort of reminder to prompt them to log in and check on their students. We feared that sending out generic reminder emails, however, would not be received well. The messaging feature of the parental notification component offered a promising alternative to spamming parents. A message home from a student's teacher provided an excuse to remind parents to log in, especially since we believed they were unlikely to ignore such a message. Thus, we conducted an exploratory study in the spring semester to answer the following questions. First, does sending home messages via ASSISTments increase parental utilization of the system? Secondly, does use of the parental notification feature result in increased parental engagement[4] in student learning? Lastly, if an increase in engagement is observed, does it actually increase student performance? We compared our results from the spring study to those from the pilot test in the fall in order to answer these questions.

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[4] The notion of parental "engagement" or "involvement" is addressed briefly in the introduction, and is defined and measured primarily by the survey given to parents during the study. Please see the survey description for more information.

One honors and one non-honors class from each teacher was selected to receive messages during the spring, totaling 86 students. A letter was sent out early in January to the parents of these students informing them of the study and prompting them to sign up for a parent account on ASSISTments if they had not already done so in the fall. The letter simply mentioned that they would be receiving messages via the ASSISTments system—we tried not to confound the study by telling them its intent. These parents were also prompted to complete a pre-survey meant to gauge how involved they felt they were in their students' education. The survey contained questions asking how much parents felt they knew about what their students were studying, how well the school was keeping them informed of their students' performance, and how often they checked their students' homework and gave consequences if it was not satisfactory. The students were given a similar survey intended to measure how much they perceived their parents to be involved in their education.

We anticipated that parents might overstate their engagement in their students' learning due to the embarrassment of being perceived as a 'bad parent,' and also that we risked giving away the intent of the study based on the nature of the questions asked. We attempted to avoid this by carefully wording the survey. A preamble was inserted that described junior high school as a transitional period for students and parents, moving from the constant supervision of elementary school to teaching students independence and responsibility in high school. The intent of the survey was described as finding out where in this transition parents were at this stage in their students' education. We hoped this would allow parents to indicate a lack of involvement without feeling guilty, as they were simply trying to teach their students

responsibility for their own education. The survey questions and answers were phrased using this same framework.

Out of the original 86 students, 63 (73%) of their parents signed up or already had accounts on ASSISTments. For 60 days during the spring semester, teachers sent messages home to parents through the parental notification feature of ASSISTments. In total, 46 messages were sent over that time period. Of these messages, 29 of them were sent to the parents of an individual student or a small group of students and contained feedback specific to those students. Not every student received such individualized feedback, as this would have placed an unacceptable burden on the teachers. Students were selected to receive feedback based on need, and often these students' parents were sent more than one message in order to track progress, which was deemed more important than attempting to involve each student at least once. The remaining 17 messages were sent to every parent in a given class and contained general information related to what was going on in the classroom, such as class activities and upcoming exams. After the 60 day messaging period, parents and students were asked to complete a nearly identical post-survey in order to measure changes in their feelings of parental engagement.

3.3   Results of Exploratory Study

Of the 63 parents who signed up for accounts, 47 (75%) of them logged in to check their messages regularly during the study period. While 62 parents completed the pre-survey, participation in the post-survey was disappointingly low, with only 27 parents responding. Of these, 8 had either not completed the pre-survey or did not log into ASSISTments during that

period, even to check their messages, necessitating the discarding of their responses. This left a very small 19 person sample size (out of an original 186) with which to perform analysis.

As suspected, our results seemed to indicate that parents interacted with ASSISTments more frequently during the spring than in the fall. The more important metric, however, was whether or not parents were visiting the other parts of the site in addition to their message inbox. This would have provided strong evidence that they were being reminded to check up on their students' performance in ASSISTments whenever they received a message, as hypothesized.

We devised the following metric to measure whether or not parents were using ASSISTments' reporting functionality more frequently during the period they were receiving messages. Analyzing the server logs, we determined how many unique days each of the 19 active parents made page requests to the non-messaging related portions of the ASSISTments site. This was then normalized by dividing by the number of days between when the parent created their account until the letter was sent home about the study. One way to look at this measure is the probability that a parent would log into ASSISTments and use the reporting functionality on a given day during the fall pilot. Two parents had not created accounts until the start of the study in the spring; their results were discarded, leaving 17. The same measure was then taken for the spring period, during which parents were receiving messages. The probability that they would check in on their students' performance on a given day increased significantly, from 1.5% to 4.6% with $p < 0.03$ and an effect size of 2.05. We believe this strongly indicates that parents checked on their students more frequently during the period when they received messages.

The survey results, which were intended to measure any changes in parental engagement as a result of the messages and increased participation they potentially fostered, were less

pronounced but still promising. The majority of questions on the survey were scored on a scale of 1 to 5, usually representing "Strongly disagree" to "Strongly agree", or some form of frequency ("Once a month", "Once a week", etc). Paired T-tests were performed in order to determine if changes in the responses to any of these questions between the two surveys were significant. A significant change was detected in only one of the questions, with $p \sim 0.05$ and an effect size of 0.35. While the other questions did not have significant p-values, they did indicate some informal trends in parental engagement. A question related to how well parents felt they were informed about their students' performance increased, while the frequency with which parents checked on their students' homework and handed out consequences decreased.

Table 3.1

Parent responses to pre-survey questions on engagement

Survey Question	Survey Answer Averages			% of parents whose score:		
	Pre	Post	Post - Pre	Increased	Decreased	Neither
I feel I have a good understanding of what is going on in my student's math class.	3.58 (0.90)	3.9 (0.88)	0.32[a]	42%	21%	37%
I feel I have a good understanding of HOW my student is doing in math class.	4.06 (0.80)	4.22 (0.65)	0.17	33%	22%	45%
My child thinks I know how well he or she is performing in math class.	4.33 (0.69)	4.33 (0.59)	0.00	17%	17%	66%
I feel my school is *not* giving me enough information to adequately monitor my student's progress.	1.61 (0.78)	1.78 (0.88)	0.17	28%	28%	44%
In the past week, how frequently did you check up on your student's homework?	2.58 (1.22)	2.16 (0.9)	-0.42	16%	32%	52%
How often do you give consequences (rewards/punishments) for grades and homework completion?	2.42 (1.26)	2.16 (1.21)	-0.26	26%	47%	27%
How often have you interacted with ASSISTments in the last 30 days?	2.16 (1.26)	2.63 (0.9)	0.47	58%	26%	16%
How often did you initiate contact with your student's teacher in the last 30 days?	0.11 (0.32)	0.05 (0.23)	-0.05	5%	11%	84%

Standard deviations are noted in parentheses.
[a] $p \leq 0.05$ (approx.), effect size = 0.35

Another survey question asked how frequently parents interacted with ASSISTments during the study period. We were surprised that this value did not significantly increase, given that participation in the fall was so poor and these particular parents had logged in to view messages frequently in the spring. This seemed to contradict the findings from our analysis of the server logs, which we believed to be more reliable. The Discussion section offers some insight as to why this may have happened.

The student version of the survey did not provide any significant results. Students were asked three questions relating to how informed they thought their parents were about their education. These questions closely matched questions on the parent version of the survey, except they were from the students' perspective. Informal trends again indicated an increase in perceived engagement, but not at statistically reliable levels. What one might consider to be the most tangible form of engagement—parents sitting down and working with their students on ASSISTments—even *decreased* slightly. It should be pointed out that if the averages are compared from the parent and student surveys, it appears parents believed they were more informed about what their students were doing in math class than students did, but students believed parents knew more about *how* they were doing in class than their parents believed they did.

Table 3.2

Student responses to pre-survey questions on engagement

Survey Question	Survey Answer Averages			% of students whose score:		
	Pre	Post	Post - Pre	Increased	Decreased	Neither
I think my parents know what I'm doing in math class.	3.22 (1.06)	3.31 (1.03)	0.08	34%	29%	37%
I think my parents know HOW I'm doing in math class.	4.25 (0.84)	4.34 (0.78)	0.09	28%	21%	51%
My parents say down and helped me with my ASSISTment work this year.	36%	34%	-2%	7%	9%	84%

Standard deviations are noted in parentheses.

While the purpose of the study was to measure increases in parental engagement, analysis was also performed to determine whether or not any observed increase in engagement led to better student performance. Unfortunately, reliable results were not detected, even when we focused on only those students whose parents participated in the study or who had received individualized messages; findings are presented here for completeness. Two different measures of student "performance" were analyzed: homework completion rates and semester grade point averages for the fall and spring. The average gains were computed in each metric between the fall and spring semesters for both the students whose parents received messages and those that did not. Half of the students were used for each measure—that is, one of the teachers used the

"due date" functionality of ASSISTments, making homework completion analysis feasible, while the other provided semester grades for her students.

Homework completion was measured in three ways: percentage of assignments completed by each student by the due date, percentage of assignments completed by the end of the semester, and average number of days late per assignment. Each of these measures had a different sensitivity to certain aspects of the intervention; for example, one of the teachers would occasionally send out messages informing parents that their students had outstanding assignments. These assignments were not completed by the due date, but the message may have prompted students to finish them by the end of the semester under pressure from their parents. On the other hand, if a parent was frequently logging into the Summary view during the intervention, they would have been able to see when their student's assignments were due and could put pressure on their student to complete them on time.

Table 3.3

Changes in Homework Completion Rates Based on Message Reception

Homework Completion Rate	Gain	
	Received Messages	Didn't Receive Messages
Homework completed on time.	-1.06% (14%)	2.13% (20%)
Homework completed by end of semester.	5.09% (22%)	3.77% (13%)
Average days late	-5.84 (9.49)	-4.44 (5.96)

Standard deviation in parentheses.

As the table indicates, none of the measures showed a reliable increase in homework completion rates (or decrease in average days late) versus the group that did not receive any messages; in fact, the group whose parents were sent messages actually decreased its on-time completion rate (though not significantly). That group beat the non-message group on the other metrics, but again not reliably. When focused in on only the non-honors students, however, the results looked more promising. This made sense because the lower knowledge students offered the most room for growth in these areas. As can be seen from the table below, once analysis was limited to only these students, the differences between the two groups became clearer, though still not enough to be statistically reliable.

Table 3.4

Changes in Homework Completion Rates Based on Message Reception (Non-honors Students)

Homework Completion Rate	Gain	
	Received Messages	Didn't Receive Messages
Homework completed on time.	4.38% (16%)	-0.55% (24%)
Homework completed by end of semester.	9.33% (30%)	5.93% (13%)
Average days late	-10.63 (11.27)	-6.78 (6.62)

Standard deviation in parentheses.

When our analysis was focused even further on only those students whose parents actively read their messages, slightly different results were found. The table below shows that when the homework completion rate averages of only those students whose parents received individualized messages were taken into account, there was little difference compared to the non-honors averages. However, when we looked at the correlation between the gains in homework completion rates and the gains in the frequency with which parents logged into non-inbox parts of ASSISTments as outlined previously, there was at least one strong, reliable value. It should be kept in mind though that this included only those students whose parents logged in consistently to check messages.

Table 3.5

Correlation of gains in homework completion rates with frequency of requests by parents for non-inbox pages of ASSISTments

Homework Completion Rate	Gain	
	Average	Correlation
Homework completed on time.	-6.03%	0.78**
Homework completed by end of semester.	10.74%	0.54
Average days late	-9.13	-0.33

**$p \leq 0.01$

Detection of any changes in students' grade point averages seemed even more unlikely, as such a measure can be thought of as another leap down the causal chain from homework completion, which is already a leap down the chain from parental engagement. We predicted that at each leap, reliably detectable results would be diminished without the support of a strong experiment designed to measure those metrics directly. As expected, the difference in grade point averages between the fall and spring semesters for both the groups were not reliably different than 0, even when zoomed in on non-honors and message-receiving students only. The correlation between differences in GPA and increases in parental login frequency was very nearly 0 as well. In effect, the messages appeared to have absolutely no detectable effect on student grades at all.

3.4   Discussion of Exploratory Study

Unfortunately, most of the survey responses did not change significantly. We will discuss in the Future Work section why we believe this could have been the result of a small sample size and a possible ceiling effect. The one question that did reliably change, however, was a very general and important one: "I feel I have a good understanding of what is going on in my student's math class (i.e. topics being covered, upcoming exams, etc)." A possible explanation for this is that all parents received the messages containing information about what was happening in class, while only a small subset of students received individualized feedback. This question maps directly to these more "global" messages, while the others are tied more to individual students. The number of parents who received individualized feedback about their students *and* checked their messages, filled out the pre-survey, and filled out the post-survey was extremely small—in order to get meaningful results on these other questions, teachers would likely have needed to send every parent several individualized messages, which was not feasible for this study.

Particularly interesting among the survey results was the fact that the frequency with which parents checked on their students' homework and gave them consequences for poor performance decreased, though not quite significantly. This was perhaps the result of parents assuming that if they were not receiving messages about their student, then everything must have been in order. As one parent put it, "no news is good news." This is an important point to consider and warrants further study, as there is the possibility that such a feature could actually *decrease* parental engagement due to a false sense of security given to parents by the system. Such a phenomenon would shift more responsibility from the parent to the teacher, which we

believe is not desirable. Ideally, the clerical burdens would be offloaded on the system, with some additional responsibilities shifted to the parent.

The results from analyzing the server logs appeared more conclusive than those from the survey. The data indicated that after parents started receiving messages from their students' teachers, they visited the reporting sections of the site more frequently. Combined with the results from the survey, this would seem to suggest our hypothesis was correct: messages home from a teacher reminded parents to log into ASSISTments and check on their students' progress, and these messages and increased log-ins may have caused parents to feel more engaged in their students' learning.

The lack of results from the student survey was disappointing, but not unexpected. Like the grades and homework completion rates, student perception of parent engagement is a leap down the causal chain from actual parental engagement, and thus harder to detect. As in many of the results, however, the informal trends hinted at a positive result, suggesting that perhaps a stronger future study could uncover them. The discrepancy between parental feelings of engagement and student perception was also interesting. Parents believed that they knew more about what their students were doing in class than their children believed they did, while students thought their parents knew more about *how* they were doing in class than parents believed they themselves did. The latter could simply have been students over-estimating how much their parents are checking up on them using ASSISTments. While students were well aware of the reporting capabilities of ASSISTments, we did not explicitly inform them of the messages their parents would be receiving, which could explain why parents believed they knew more about what was going on in class than their students thought they did.

The analysis of homework completion rates again only provided informal trends, but they as well showed promise for a future study, especially among the low knowledge students. It was surprising to find that those students whose parents received individualized messages (usually about homework) did not differ from the group at large, though by the time it was narrowed down to those particular students the sample size was less than 5. The one reliable result, however, was very promising. The data showed that there was a correlation (0.78, $p < 0.02$) between increases in on-time homework completion rates and increases in parent logins to ASSISTments (excluding the inbox). This supports the hypothesis that parents who logged in more frequently to the Summary page, which displayed when students have assignments due/late, put more pressure on their students to complete their homework on time.

The qualitative feedback from the study was also positive. The teachers found the parent notification feature useful and the experience of sending messages home via ASSISTments promising. The interface allowed them to send messages home efficiently and gave them the ability to contextualize those messages with real data. Most importantly, they did not have to worry about parents flooding them with responses—communication was still open at both ends, but one end had much higher bandwidth, making the prospect of sending a message home less daunting and encouraging them to do so more often. They continued to use this feature in their classrooms well after the study was completed.

Feedback from parents was also positive. The last question on the post-survey instructed parents to write down any thoughts they had about the system or the study. Most indicated they were happy to receive messages from the teacher informing them of their students' progress. Many remarked that the messages did in fact remind them to log in and check up on their

students' performance. There was no negative feedback; at worst, some parents explained that they did not gain any benefit from the messages or ASSISTments, stating that their students were very responsible and as long as they received good grades, their parents would let them be independent. In general, parents liked being more connected to their students' education and felt the parent notification feature was a positive step in that direction.

> The program gives me the ability to observe the quality and quantity of nightly homework. I never have to worry about missing homework. Assistment is always available for past and future work.
>
> I really liked the notes sent by the teacher telling us what they did in class and what you might want to talk about with your child. It gives one more thing to try to connect with them at the dinner table. Thanks.
>
> It is a nice feature and helps us to know better the types of activities being done in class so we can discuss them with our children. I think this program is a positive step toward connecting families with the curriculum.
>
> It is a very good program. In the least, the notifications help you remember your child's school work and I can be an active participant. Usually I wouldn't get involved unless there was a problem, and then it would be too late. This helps me track progress and interact as necessary. I only read the messages. I will look at other areas of the site.

Figure 3.1. Sample parent comments about parental notification from post-survey

One anecdote from the study is worth mentioning as it demonstrates the potential of the system in a way that cannot be captured in quantitative data. Throughout the spring one of the teachers sent 5 messages to one struggling student's parent in particular. While this was originally prompted out of genuine concern for the student's weak performance, it soon became obvious that this correspondence would make a great case study of the system's ability to connect with parents and effect positive change. The first two messages received by this student's parent were actually sent to the parents of several different students, warning them that

their children were falling behind on homework completion. The next two were sent specifically to the one parent, informing her that her student had caught up with his work and had really improved in class. The final message was another warning that the student had become overconfident and was beginning to slip again. While it cannot be known for sure, as this parent did not respond to requests for interview, it is plausible that this student's turn-around was brought about by pressure put on the student by his parent as the result of these messages.

11 Jan, 2010 - Subject: Over due Assignments
Good morning, I am writing to inform you that your child has some outstanding assignments. Please encourage them to come in for extra help if they are having difficulty mastering the work. Thank you, Courtney Mulcahy
To: Multiple recipients

25 Jan, 2010 - Subject: Outstanding Assignments
Your child has several assignments that are outstanding at this point. Please encourage them to be responsible and take initiative to complete assignments that are overdue. Additionally, encourage them to come and see me for extra help if they need clarification so that they can get caught up. Thank you, Courtney Mulcahy
To: Multiple recipients

06 Feb, 2010 - Subject: *****
***** has really had a positive turn around with his work effort and production this week. He is current with his Mastery Learning assignments and is demonstrating much more responsibility. Please continue to encourage him. I am happy with his week at school.
To: *****

22 Feb, 2010 - Subject: *****'s Math Work
Good morning, I just wanted to let you know that I am sitting with ***** right now for extra help during math buddies and he is doing very well. He has a great understanding of the material for Pythagorean Theorem and has an excellent attitude about getting his work done. I have noticed a significant change in his attitude, behavior and effort. Please encourage him to keep up the great work! Thank you, Courtney
To: *****

10 Mar, 2010 - Subject: *****'s Math
Hi *****, I just wanted to let you know that ***** is slowly slipping behind in his work on Assistment. He was all caught up and very proud of himself but is beginning to build a list of overdue assignments. Please encourage him to stay up to date. I don't want him to get too proud and then take it easy. He claims that he didn't know that they were assigned, but I am trying to teach the students accountability and have them respond to the due dates in addition to assigning them for HW. He is not too far behind yet, so it should be relatively easy to catch up. I want him to continue with his good efforts. Thank you, Courtney
To: *****

Figure 3.2. Series of sample messages from teacher to particular student's parent.

3.5   Conclusion of Exploratory Study

As we stated in our introduction, the purpose of this study was largely exploratory. According to our prior research, no one had yet provided parental access to the fine-grained learning data collected by a true ITS. We suspected that providing this data would allow parents to become more engaged in their students' education, which the literature suggested was beneficial to student learning. At the very least, we hoped that providing such information would enable parents to make sure students were completing their homework, which has been shown in prior work to be beneficial as well, and thus be helpful in an indirect manner. However, doing so required the development and deployment of a completely new, untested software component. We were unsure how parents would respond to such a drastic increase in the amount and detail of information on their students' performance. We did not know how or even if they would utilize this data. These questions needed to be addressed before we could reasonably begin forming strong hypotheses and conducting experiments on this topic, which necessitated the work we did here.

The exploratory nature of the study meant that few of our results were statistically reliable, but we believe we were successful in answering many of the questions we set out to and providing clear directions for future research in this area. We hope that both ourselves and others can now conduct more definitive experiments by using what we learned in our study as a guideline. For example, we learned that providing access to data does not mean that it will be utilized. When we first piloted our new feature, participation was very low, despite what we perceived as almost universal support and excitement on the part of parents. Whether they were just too busy and forgot or were overwhelmed by the amount of new information available to

them, parents were just not logging on. We found though that simply reminding parents, in the form of messages from teachers that prompted them to log into the site, was enough to get them to check in on their students. These messages also provided some context to the data, perhaps helping them put it into a more meaningful perspective. We believe any future researchers would benefit from having a similar mechanism, or they may find themselves without sufficient data points. One possibility is to implement a system of automated messages sent by the ASSISTments system to parents. This would take the burden off of the teachers and allow for more frequent reminders—in the form of emails containing relevant data—to every student's parents rather than just a subset. This should generate considerably more data points, potentially allowing the detection of reliable experimental results.

Once we had parents logging in more often, our survey results showed some informal trends indicating that parents did feel more engaged in their students' education when given access to ITS data. We believe that parents have the ability and the desire to take advantage of this information, and that further, more definitive research on this topic is warranted. We recommend using surveys to measure parental engagement in future studies, and with a stronger experimental design and more data points it may be possible to detect reliable results. Our current study has convinced us that this is feasible and worth pursuing.

Finally, we have been assuming based on the literature that parental engagement is in and of itself a beneficial concept, in that it increases student performance or at least indirectly influences it through the development of better learning habits, such as increased homework completion rates. We have shown in this study that ITS make the measurement of metrics such as homework completion rates and performance (grades) fairly straightforward. Once parental

engagement has been established, it is possible to verify whether this engagement was beneficial in the very same experiment. While we were unable to—and did not expect to—detect any reliable results from these metrics, we believe more data points and a stronger design could allow for detection.

We also encountered a fair share of pitfalls that future researchers should seek to avoid. While we already discussed the infrequency with which parents logged into the system after signing up, it was also surprisingly difficult to get parents to even sign up in the first place or complete the online survey. This was particularly unexpected due to the fact that the school was located in an affluent community with almost ubiquitous access to computers and the internet. Yet, participation in the study, especially the post-survey, was extremely disappointing despite persistent efforts. Why this is the case and how to remedy it is unknown. It did, however, result in a very small sample size, which made obtaining statistically significant results difficult. Out of an original 86 parents, only 17 completed all parts of the study necessary to perform analysis.

In addition to the small sample size, the results could have possibly fell victim to a ceiling effect. Apparently, the middle school where our study was performed is quite notable for keeping parents informed about their students. The results from the pre-survey supported this, with parents indicating they felt relatively well engaged even before the intervention was introduced. On many of the questions, which were scored on a scale of 1-5, parents answered an average of approximately 4.0, leaving little room for improvement. Interestingly enough, the only question for which this was not the case, with an average of ~3.5, was the question found to have reliably increased after the intervention. Future studies might benefit from taking place at a school with a higher need for parent-teacher communication.

Finally, we are well aware that multiple tests for statistical significance were performed without using some sort of penalty to correct for it. Had this been done, it is likely that the few reliable results found would become unreliable. This is not a justification for choosing not to use a penalty; it should simply be noted that there is a high possibility of that outcome. The reason for not using such a correction was that this was mainly an exploratory study. Most of the important results consisted of informal trends and qualitative feedback. As we have mentioned, a more robust evaluation would be warranted in the future.

Chapter 4

Methods

The experiment was conducted at the same local middle school as in the exploratory study, but with different teachers. Two 7th grade math teachers at this school participated in the experiment, and during the fall semester of 2010 they both taught 4 periods of roughly 20 students each. Two units from the Connected Math Program were covered during the fall: Variables and Patterns, which deals with the prerequisite skills for linear equations and coordinate geometry, and Stretching and Shrinking, which teaches similar figures, ratios, percent, and proportions. ASSISTments was used throughout the semester for homework; when students were given an assignment from their textbook, they were required as part of their homework to enter their answers into ASSISTments (the benefits of this are described in Mendicino, Razzaq, & Heffernan, 2009). There were roughly 15 of these homework assignments for each unit, and each was assigned a due date in order to determine if a student completed it on time.

The intervention was not introduced until the start of the second unit. At this time, a letter was sent home to all parents informing them that we would be piloting a new parental notification feature and that some of them would be randomly selected to participate in the trial. The letter described the exercise as a pilot in order to conceal from parents as much as possible

the fact that it was actually an experimental study. While we would have preferred to only notify the parents randomly selected for the intervention, it was decided that it would be best to inform all of them in order to preempt inquiries from those not selected that would inevitably arise in such a close-knit community. Additionally, the letter contained a URL to a survey meant to gauge parents' perception of their level of involvement in their students' education. We needed all parents, including those that would eventually be selected for the control condition, to take this survey, and thus we decided to send the letter home to every parent. We also assured them that, assuming the pilot was successful, everyone would be invited to participate in the spring semester.

The survey contained approximately 5 questions asking parents how well-informed they felt they were and how closely they monitored what their student was studying in school and how they were performing. In order to avoid parents answering dishonestly for fear of being perceived as a "bad parent," a preamble was added to the survey describing middle school as a time when parents transition from closely monitoring their students to teaching them independence and responsibility for their own success. This allowed parents to indicate a lack of involvement without feeling guilty, as they could claim they were simply teaching their student to be independent. Additionally, the questions were worded in a manner that implied we were trying to determine if they were being provided with enough information, whether by their school or ASSISTments, thus removing the responsibility from them and putting it on us.

After the letter was sent home, half of the students were randomly selected to have their parents receive the intervention. This was done by going through each teacher's roster alphabetically and selecting every other student. Several students who were excused from using

ASSISTments that year, either because they had Individual Education Plan's or were English Language Learners, were skipped over during this process. Those that were selected had invitations emailed to their parents asking them to sign up for accounts on ASSISTments. Of the approximately 76 parents invited to participate, only 14 did not create accounts. The reasons for this are unknown and could be the result of several causes, including parents simply refusing to participate. It is also possible we had incorrect email addresses for them on file, as they were entered by students when they signed up for their own accounts at the start of the school year. Regardless, we were more than satisfied with the participation rate. Approximately half of all parents (80) completed the survey.

The aforementioned process of sending letters home, having parents complete the survey, and signing parents up for accounts took place in the span of one week at the end of the first unit. Assignment data from this week was removed from consideration due to the inconsistency with which parents had access to data during this time. At the beginning of the second unit the following week, automated messages were enabled for all classes. By default, parents received one weekly message each Friday and could enable one or two nightly emails in their preferences if they desired more frequent reports. Approximately 15 parents took advantage of the nightly emails, with 4 opting to receive one per night and the rest choosing two. One parent disabled all emails. Even though parental notification and automated messages were enabled for all classes, only those parents who were invited and chose to create accounts were able to log in or receive emails. This separation automatically provided us with control and experimental groups using students as the unit of selection.

The issue arose of what to do with those parents who were selected for the intervention but did not sign up for accounts for whatever reason. Because they did not sign up for accounts, they were unable to log into the site or receive automated messages, and thus were not exposed to the intervention at all. Adding them into the control group, while tempting, would not be appropriate. There is a possible selection bias introduced by those parents who chose not to create accounts, and thus we would be breaking the experimental design. The other possibilities were to remove them from consideration altogether or continue to count them as being in the experimental group even though they received no intervention. Early analysis indicated that while the difference in homework completion rates and performance between the two subgroups prior to the intervention were not statistically significant, they were still considerable enough that we were uncomfortable removing the non-participants from the experimental group. To satisfy our own curiosity, we performed most of our analyses both with and without the non-participants; any results from the latter will be explicitly noted as such.

At the end of the second unit, a post-survey was emailed to all parents. This survey contained the same 5 questions as the pre-survey, allowing us to measure changes in parent perceptions over time. The post-survey also contained additional questions for parents who had been selected for the "pilot." These included both quantitative and essay questions asking for feedback on the parental notification component and how parents utilized the data it provided them. A total of 82 parents completed the post-survey; the number of parents who completed both surveys came out to 48. A copy of the ASSISTments database was also made at this time—no student data from past this point was considered during analysis, even though parents continued to receive emails and still had access to their accounts.

At the end of each unit, students were given a test assessing their knowledge of the content covered during that unit. These tests were given during class in the traditional pencil and paper format, as ASSISTments is not yet entirely suitable for test-taking. The test for the first unit reflects student knowledge before any intervention took place, while the second unit test reflects their knowledge after parental accounts and automated messaging were introduced. These tests were not cumulative and assessed only the material covered in their respective units. According to our teachers, the material covered in the second unit was considerably more difficult than in the first, as it utilized skills completely new to most 7th grade students. However, the fact that we have pre- and post-intervention test scores for both the control and experimental groups should allow us to perform valid analysis on gains in student performance over time.

4.1   Measures and Areas of Focus

We designed our experiment with the following hypothesis in mind. First, if parents are provided with data from an ITS, they will become more involved in their students' education. Second, if they become more involved, student performance will increase. The hypothesis posits that there is a causal chain from providing parents with data to increased parent involvement, which finally results in better student performance. The intent of the surveys was to measure the first part by asking parents how informed they felt they were about their students' education and how closely they monitored their performance. We addressed the second part by analyzing assignment completion data from the ASSISTments database combined with the aforementioned unit test scores, which as we describe below comprises what can be considered "student performance." We assumed it would be more difficult to detect changes in student performance

than in parent involvement, as performance is hypothesized to be one step down the causal chain from involvement. If we did not detect any change in involvement, it seemed unlikely we would find any difference in performance.

We devised three metrics to measure student performance: percentage of assignments completed, percentage of assignments completed on time, and test scores. These metrics were computed for each unit and for both the control and experimental conditions. Each metric maps roughly to one of the components of the automated messages sent to parents via email. Recall that the messages contain 3 sections: completed assignments, outstanding assignments, and upcoming assignments. The completed assignments section informs parents of how well their students are performing on their assignments, giving them the opportunity to address deficiencies before the unit test. We hypothesized that the utilization of this information would be reflected in students' test scores. The outstanding assignments section tells parents how many and which homework assignments their students have not completed; the effective use of this information would most likely be reflected in the percentage of assignments students completed during a given unit. The upcoming assignments section enables parents to see exactly when assignments are due, which would hypothetically result in students completing a high percentage of assignments on time (as in, before the due date). This would be especially likely if the parent was receiving nightly emails.

We decided before analyzing the results of the experiment to focus on certain subgroups of students who were most likely to benefit from the intervention. These subgroups consisted of students whose parents had opted to receive nightly emails, and those students whose performance in a certain metric during the first unit were below a certain threshold—essentially,

struggling or "low knowledge" students. Those students whose parents were getting nightly

emails were theoretically receiving 7 times the amount of intervention as the others, making it

much more likely we would be able to detect a reliable increase in performance. We

hypothesized that the low knowledge students were the subgroup most likely to benefit from the

intervention, as those students who were already performing well had little to gain from

additional parental involvement.

4.2 Preprocessing

The Google Docs web application was used to collect survey responses and test scores

were provided by the teachers from their grading software. It should be noted before the results

are presented that the school utilizes a standards-based grading system, and the tests are scored

out of 4 rather than 100 or by a letter-based system. We wrote a Ruby script using the

ASSISTments API to extract and process the raw student logs from the database into the metrics

described previously. Several modifications had to be made to the data in order to remove

inconsistencies, inaccuracies and outliers that would have distorted results in a manner that did

not reflect reality; they are described here to maintain the integrity of the experiment.

First, an oversight in the experimental procedure led to one of the teachers not assigning

due dates to all but 2 assignments during the first unit. This resulted in not nearly enough data

points for a valid comparison, and would have forced us to discard that teacher's data. In order to

avoid this, we manually inserted due dates for these assignments into our data processing script,

resulting in our statistics being compiled as if the teacher had in fact assigned them. The dates

were calculated using heuristics that take into account when the majority of students completed the assignment, which we believe to be highly accurate. While inserting these dates after the fact may appear on the surface to be questionable, the manner in which teachers commonly use ASSISTments for assignments makes it a valid strategy. Traditionally, teachers have not utilized the due date functionality of ASSISTments very extensively, perhaps because it is not seen as being necessary. Based on our experience working with teachers using the system, the presence of an assignment in the student's list implies that it has been assigned and is to be completed, usually by the following day. Students do not have access to assignments that they are not supposed to complete, as is the case with other tutoring software. Teachers generally treat assignments on ASSISTments as they do with regular assignments, which do not have electronic due dates associated with them: that is, they express orally when the assignments are to be done. In discussions with the teacher in question, it was apparent that this was the case.

There is one aspect of the due date functionality that could potentially confound the experimental results, but we believe the effect would be minimal if present at all. While an assignment in a student's list implies it is due, if the assignment actually has a due date attached to it the date will appear next to the assignment. If the assignment is late, this date will appear in red. It is possible that the presence of this information would serve to increase students' motivation to complete the assignments, or decrease their motivation for assignments that did not have it. We are confident, however, that based on our extensive knowledge of ASSISTments usage patterns and our discussion with the teacher in question, this is unlikely to have had a significant effect on the results.

We discarded the performance results from several students after we conducted the experiment due to the fact that their data was unlikely a true reflection of reality and could potentially distort our calculations. Two students had accidentally exploited a bug in ASSISTments that allowed them to become their own parents, essentially merging a parent account into their own existing student account. Another student with Tourette's syndrome had difficulty adapting to ASSISTments in the first unit. A few students who had difficulty completing their assignments were excused from entering many of them into ASSISTments during the first unit, but were required to during the second. This likely would have confounded our results, as the improvement in performance would not be caused by the intervention but rather pressure from the teacher. The remaining handful of students did not have internet access at home, and were allowed to complete assignments whenever they were able to obtain computer time. What was distressing about this particular group of students was that they were all in the control group of one of our teacher's classes. Because of this, we were particularly careful to make sure the differences in pre-intervention performance metrics between the two conditions were not statistically reliable, and if they were we explicitly noted so in the results.

Our other teacher had a similar problem in that his 3 lowest-performing students, who rarely completed their homework on time, were all in the control group. We were not going to remove them until we found that they were causing reliable differences in the aforementioned pre-intervention performance metrics due to their concentration in one condition. When they were removed, we no longer had this issue. While this was not our preferred course of action, the fact that they were randomly assigned to the same condition skewed the results so drastically that it was necessary to remove them.

Students with documented vacations or extended periods of sickness had data points for assignments due during those particular dates removed, as they would reflect lateness that was not under the control of the student. Individual absences were not taken into account, as their effect is minimal and distribution normal enough to affect all conditions equally. The question also came up of whether to remove assignments that were meant to be completed in the classroom from consideration. We decided that since there were very few of these assignments, and that they were intended to be completed as homework if they were not done so in class, their data points should be included.

Chapter 5

Results

5.1 Survey Results Across Unit and Condition

The surveys given to parents at the end of each unit were designed to measure involvement in their students' education and any changes that occurred during the intervention. Parental involvement represents the first step in the causal chain and thus if we were to detect any effects, we would expect to see them most strongly reflected in the survey results. Recall that we asked participants 5 questions related to how informed they were about and how closely they monitored their students' education and performance. These questions were scored on a scale of 1 to 5, with 1 denoting "Strongly Disagree" and 5 indicating "Strongly Agree." Table 5.1 summarizes their responses. The ΔGain column represents the difference in gains between the control and experimental groups.

Table 5.1

Parent responses to survey questions on engagement
Scaled 1-5, 1=Strongly Disagree, 5=Strongly Agree

Survey Question	Control			Experiment			ΔGain
	Unit 1	Unit 2	Gain	Unit 1	Unit 2	Gain	
I feel I have a good understanding of what is going on in my student's math class.	3.47 (0.94)	3.94 (0.83)	0.47 (0.87)	3.32 (1.08)	3.77 (0.88)	0.45 (1.03)	-0.02
I feel I have a good understanding of how my student is performing in math class.	3.88 (0.99)	4.29 (0.92)	0.41 (0.94)	3.74 (0.93)	4.10 (0.79)	0.35 (0.80)	-0.06
I feel I am being provided enough information about my student's performance.	4.00 (1.06)	4.18 (0.81)	0.18 (1.01)	4.03 (0.87)	4.23 (0.72)	0.19 (0.91)	0.02
I check to make sure my student has completed their homework at night.	3.59 (1.00)	3.24 (1.30)	-0.35 (1.73)	3.74 (1.34)	3.97 (1.14)	0.23 (1.12)	0.58
I closely monitor my student's performance (as in, check grades on assignments and tests)	4.29 (0.92)	4.06 (1.03)	-0.24 (1.35)	4.19 (0.79)	4.39 (0.76)	0.19 (0.65)	0.43

Standard deviations are noted in parentheses.
N = 48

Unfortunately, none of the differences in gains were significant, and thus any analysis

regarding them is going to be speculative at best. The first 3 questions, which focused on how

informed parents felt they were, showed a nearly 0 difference in gain between the two groups.

However, the gains themselves were not near 0—in fact, on the first 2 questions, they were as

high as 0.4, including the control group that did not receive the interventions. The last two

questions, which inquired about how closely parents monitored their student's homework and

performance, did show a substantial (though not reliable) difference in gains. The reason for this appears to be that the control group actually decreased their scores for these questions, while the experimental group increased them. Additionally, it should be noted that in general the average scores were very high for every question, with half over 4.0 and all but one over 3.5. Analysis of these results can be found in the Discussion section.

As we discussed in the Methods section, we also wanted to focus on students whose parents opted to receive nightly emails, hypothesizing that we were more likely to detect effects in the data of students whose parents received more of the intervention. There was one significant difference in gains on question 4, $t(16) = 2.40$, $p < .05$, which measured how frequently parents checked to make sure their students were completing their homework assignments. On this question the experimental group, representing only those parents who received nightly emails, increased their average response by over a full point between units, while the control group decreased slightly. In contrast to Table 5.1, the first two questions show a sizeable but not significant difference in gains between the groups. The difference in gains for question 3 is negligible, while question 5 shows a small delta.

Table 5.2

Parent responses to survey questions on engagement (who received nightly emails)
Scaled 1-5, 1=Strongly Disagree, 5=Strongly Agree

Survey Question	Control			Experiment			
	Unit 1	Unit 2	Gain	Unit 1	Unit 2	Gain	ΔGain
I feel I have a good understanding of what is going on in my student's math class.	3.47 (0.94)	3.94 (0.83)	0.47 (0.87)	3.14 (1.07)	4.00 (0.82)	0.86 (1.07)	0.39
I feel I have a good understanding of how my student is performing in math class.	3.88 (0.99)	4.29 (0.92)	0.41 (0.94)	3.43 (1.13)	4.14 (0.38)	0.71 (0.95)	0.30
I feel I am being provided enough information about my student's performance.	4.00 (1.06)	4.18 (0.81)	0.18 (1.01)	4.00 (0.58)	4.14 (0.69)	0.14 (0.38)	-0.03
I check to make sure my student has completed their homework at night.	3.59 (1.00)	3.24 (1.30)	-0.35 (1.73)	3.29 (1.70)	4.43 (0.79)	1.14 (1.21)	1.50[a]
I closely monitor my student's performance (as in, check grades on assignments and tests)	4.29 (0.92)	4.06 (1.03)	-0.24 (1.35)	4.71 (0.49)	4.71 (0.49)	0.00 (0.00)	0.24

Standard deviations are noted in parentheses.
N = 24; N(Control) = 17, N(Exp) = 7
[a]$p < 0.05$, Effect Size=0.95

Lastly, we wanted to focus on those students who were not necessarily high achievers, as

they had the most to gain from the intervention. We excluded high-performing students based on

another question in the Unit 2 survey, which asked parents if and how they checked whether

their students did their homework each night. One of the options was "My student almost always

does their homework, so I leave them alone." We assumed that students whose parents selected

this option were likely high achievers, and removed them from the results displayed in Table 5.3. We found that with this subgroup of students, question 3—which measures how satisfied parents are with the amount of information provided to them—showed a reliable difference in gains between the conditions, $t(30) = 2.18$, $p < .05$. All of the questions showed sizeable differences in gains, some even more than question 3. These appear to have much higher standard deviations in their scores, however, which may explain why they are not significant. In the latter 3 questions we again see the control group decreasing their average score while the experimental group increases, whereas in the first 2 questions they both increase, with the experimental group increasing slightly more.

Table 5.3

Parent responses to survey questions on engagement (low students)
Scaled 1-5, 1=Strongly Disagree, 5=Strongly Agree

Survey Question	Control			Experiment			ΔGain
	Unit 1	Unit 2	Gain	Unit 1	Unit 2	Gain	
I feel I have a good understanding of what is going on in my student's math class.	3.67 (0.98)	3.92 (1.00)	0.25 (0.87)	3.29 (1.06)	3.81 (0.81)	0.52 (1.08)	0.27
I feel I have a good understanding of how my student is performing in math class.	4.08 (0.79)	4.17 (1.03)	0.08 (0.67)	3.48 (0.93)	3.90 (0.77)	0.43 (0.81)	0.35
I feel I am being provided enough information about my student's performance.	4.25 (0.87)	4.08 (0.90)	-0.17 (0.58)	3.86 (0.91)	4.24 (0.70)	0.38 (0.86)	0.55[a]
I check to make sure my student has completed their homework at night.	3.67 (0.89)	3.17 (1.40)	-0.50 (1.73)	3.67 (1.20)	3.95 (1.17)	0.29 (0.78)	0.79
I closely monitor my student's performance (as in, check grades on assignments and tests)	4.33 (0.78)	4.00 (1.13)	-0.33 (1.30)	4.00 (0.77)	4.29 (0.78)	0.29 (0.72)	0.62

Standard deviations are noted in parentheses.
N = 33
[a]$p < 0.05$, Effect Size=0.86

5.2   Survey Results for Experimental Condition

On the second survey, we asked parents who had been selected for the intervention several additional questions about their experiences with the actual parental notification component and automated messaging feature. These questions are slightly leading and are not statistically verifiable in that they lack a control for comparison. We were primarily interested in the feedback the responses to these questions provide. We were very interested in knowing whether parents liked the component, how they used it, and whether they believed it changed the way they interacted with their students.

We asked two questions on the second survey meant to measure how informed parents perceived themselves as being in regard to their students' homework completion and performance (Figure 5.1). The first asked if parents felt they had a better sense of whether their students were completing their math homework after using parental notification. One of the options was for parents whose students always completed their homework and did not need monitoring; roughly half of the participants (19) selected this option. Of the remaining, 82% felt they had a better sense, with 36% claiming they had a *much* better sense. The second question was identical, but was in regard to how their students were *performing* in math class. This time, only 22% indicated that their student always performed well and did not need monitoring. Of the remaining, 94% said they had an overall better sense, with 16% claiming they had a *much* better sense. This would seem to show that parents felt at least somewhat more informed about their students as a result of parental notification.

We started emailing reports to you every Friday in late October. Do you feel you have a better sense of whether your student is completing their homework in math class compared to before we started sending emails?

at better sense [10]

Yes, I feel I have a

ng has changed [4]

My student almost

My student almost always completes their homework, so I do not generally have to monitor them	19
No, I do not feel like anything has changed	4
Yes, I feel I have a somewhat better sense	10
Yes, I feel I have a much better sense	8

Do you feel you have a better sense of how your student is PERFORMING in math class compared to before we started sending emails?

at better sense [25]

Yes, I feel I have a

My student almost

No, I do not feel lik

My student almost always performs well, so I do not generally have to monitor them	9
No, I do not feel like anything has changed	2
Yes, I feel I have a somewhat better sense	25
Yes, I feel I have a much better sense	5
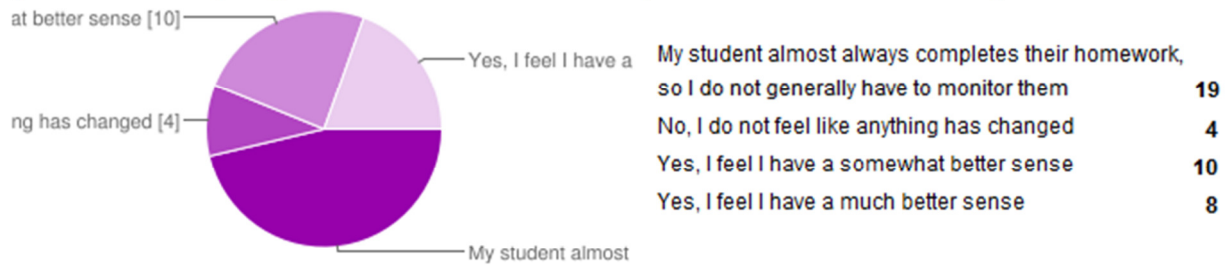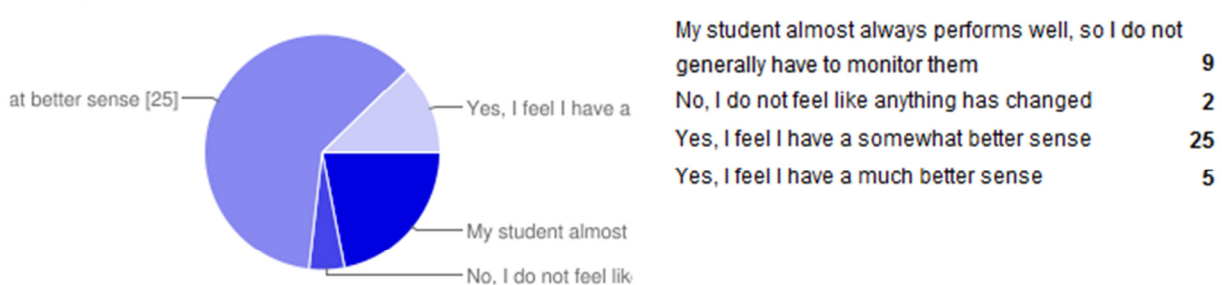
Figure 5.1. Parent responses to survey questions on perception of involvement

The next two questions asked parents whether they found parental notification helpful and if they would recommend it to others; results for these questions are shown in Figure 5.2. Out of the 40 respondents, only 2 found the intervention unhelpful or minimally helpful. The rest of the distribution was skewed very heavily towards somewhat to very helpful. As for recommending it to other parents, none expressed that they were unlikely to do so. Almost all of respondents would likely or very likely recommend it, with 5 undecided. It would seem then that regardless of whether parents perceived the intervention as having a concrete impact on their

involvement with students, they overwhelmingly found the component helpful and would

recommend its implementation for others.

Did you find the parental notification feature helpful?

1 -	Not at all	1
2		1
3		9
4		17
5 -	Very	12

Would you recommend that we make this feature widely avaible to parents?

1 -	Very unlikely	0
2		0
3		5
4		18
5 -	Very likely	16
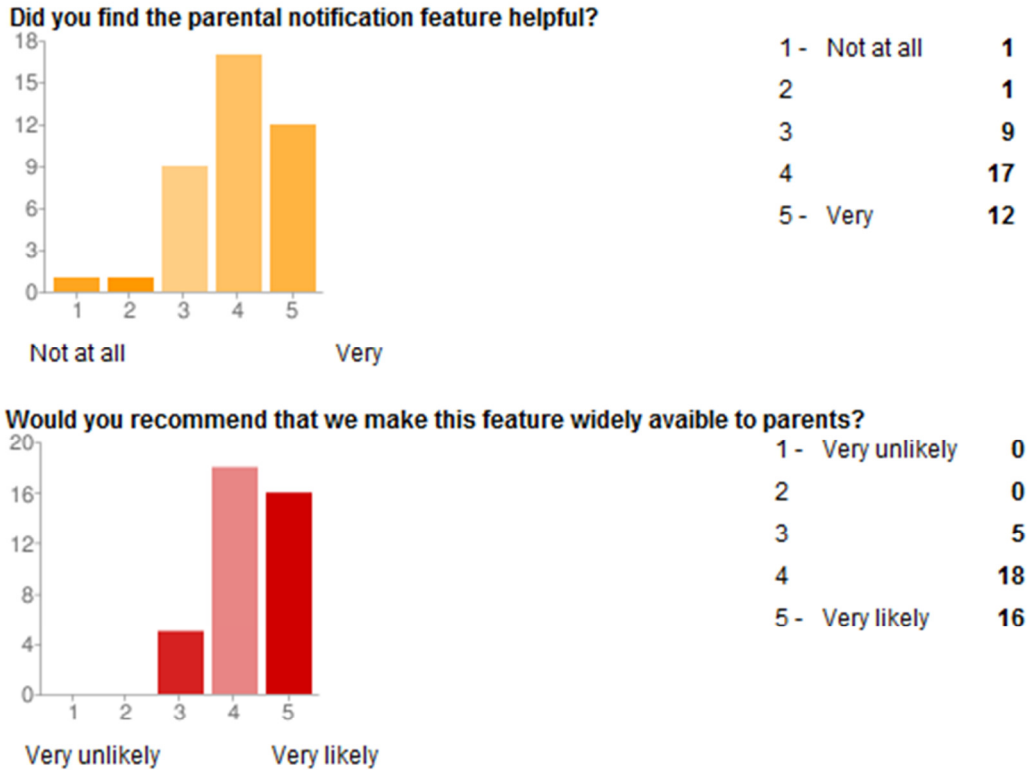
Figure 5.2. Parent responses to survey questions on helpfulness of intervention

The following two questions sought to measure how frequently parents utilized the data

provided to them by ASSISTments and how exactly they used that data. The results are

contained in Figure 5.3. Responses to the first question are expected given the frequency with

which parents were receiving emails. The majority of parents said they used the data a few times

over the course of the unit (roughly one month) or once a week, which is not surprising given

that most parents opted to receive the default one email per week. About one-fifth of the respondents indicated using it more than once a week or every day, which we confirmed were the parents receiving nightly emails. Four parents reported never using the data. Initially, we suspected these were the parents selected to receive the intervention that did not sign up. Upon closer inspection, however, we found that these were parents who indicated their students always completed their homework, and thus they had no need for the data.

The second question in this pair, which was a "Select all that apply"-style question, skewed heavily to the expected use cases. The majority of parents indicated that they used the data to make sure their students were completing and performing well on their assignments. We were hoping to see some alternative additional uses for the data, and indeed a few parents indicated that they used the data to review math content with their student, talk about the importance of completing homework, and discuss the importance of mathematics in future careers. We were surprised to find, however, that not a single parent ended up introducing any sort of incentive system, be it a reward for good performance or punishment for delinquency. We had hypothesized that such consistent and fine-grained data would prompt the implementation of a variety of such systems, but apparently parents were content with simply talking to their students.

How often did you use the data provided to you by ASSISTments and the emails?

Never	4
A few times	12
About every week	16
Several times a week	4
Every day	3

How did you use this data?

I used it to make sure my student was performing well on assignments	21
I used it to make sure my student was doing his or her homework	21
I used it to review math content with my student	7
It prompted me to talk to my student about the importance of completing their homework	6
It prompted me to talk to my student about the importance of math in future careers	3
It prompted me to incentivize my student with some sort of reward/punishment	0
Other	4

People may select more than one checkbox, so percentages may add up to more than 100%.
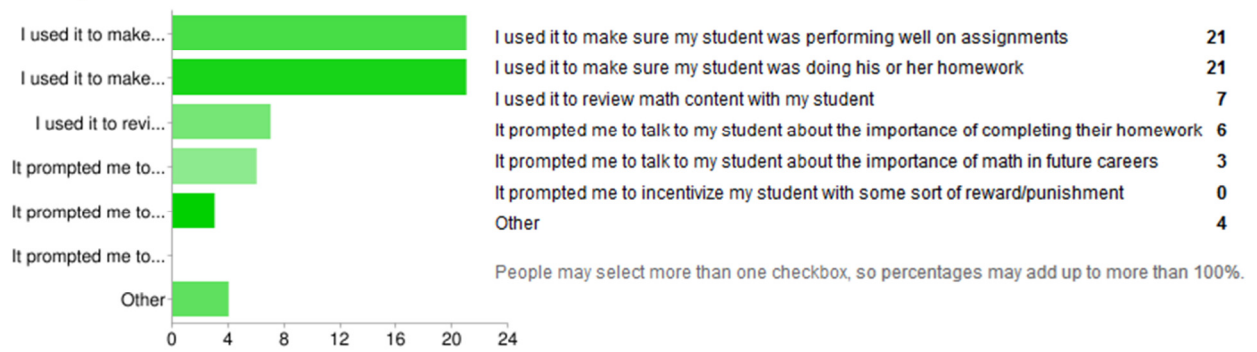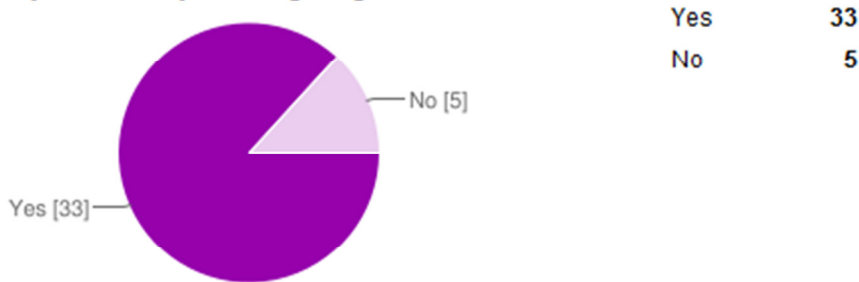
Figure 5.3. Parent responses to survey questions regarding usage of student data

The final pair of questions on the second survey were created mainly out of intellectual curiosity. First, we wanted to know whether parents informed their students that they were receiving the intervention and thus suddenly had access to an almost Orwellian amount of data on their performance. As can be seen from Figure 5.4, the overwhelming majority of parents chose to inform their students. This is perhaps to be expected, as parents are not trying to "catch" their students and punish them, but rather keep them performing at an acceptable level. Informing students of their access to this information instills in them a well-documented sense that an authority figure is watching them and thus motivates them to perform without the parent ever needing to even look at the data. The second question was a rather specific inquiry related to a hypothesis we had regarding how parents would use the data provided to them. We believed

parents would most appreciate the ability to give their students independence by not constantly nagging them about their homework, while still having the comfort of being able to check on their students via ASSISTments. The responses confirmed this to a degree, with the majority of parents agreeing or strongly agreeing with that sentiment. A minority of parents disagreed; looking at their responses to the other survey questions and their students' performance data, it is clear that these parents had high-performing students that did not require monitoring. Thus, they likely felt the addition of the parental notification feature did add anything to their ability to monitor while providing independence.

Did you tell your student you were getting automatic emails and had an account on ASSISTments?

Yes	33
No	5

The parental notification feature allowed me to make sure my student was completing their homework without having to bother them about it.

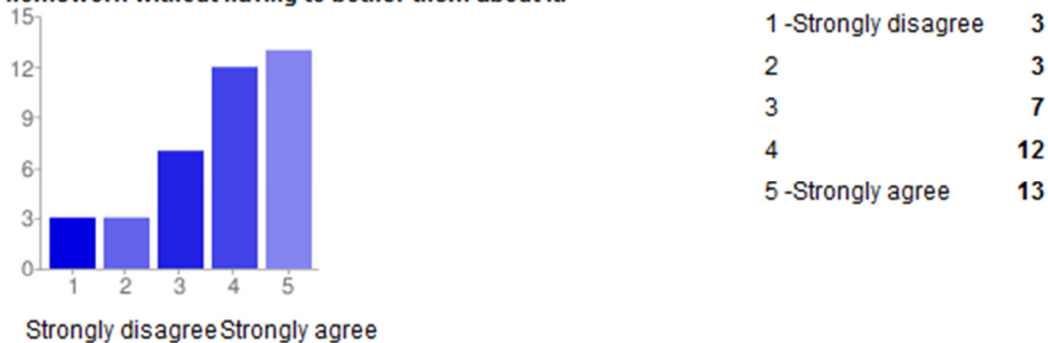|	
1 -Strongly disagree	3
2	3
3	7
4	12
5 -Strongly agree	13

Figure 5.4. Parent responses to survey questions regarding communication with students

65

5.3   Performance Results

The following tables display summaries of student performance data for the metrics and subgroups discussed previously. Based on the survey results, we could reasonably expect the possibility of detecting an effect, though it would likely be harder as it is one step down the causal chain. Table 5.4 displays averages for all of the students combined. Both of the metrics related to assignment completion show a modest increase, though not quite enough to be statistically reliable. Changes in test score averages were negligible. It is again worth noting that all of these averages are fairly high, with the percentages of completed assignments all over 90%, late assignments over 80%, and test scores over 3.

Table 5.4

Student performance data

Performance Metric	Control			Experiment			ΔGain
	Unit 1	Unit 2	Gain	Unit 1	Unit 2	Gain	
Avg percent of assignments completed	93.85 (10.55)	95.37 (11.02)	1.52 (10.09)	93.44 (10.69)	97.87 (5.58)	4.43 (10.01)	2.91
Avg percent of assignments completed on time	84.16 (14.56)	84.57 (16.66)	0.41 (15.89)	84.83 (13.44)	87.18 (14.49)	2.35 (14.83)	1.94
Avg unit test score	3.23 (0.63)	3.20 (0.68)	-0.04 (0.63)	3.32 (0.51)	3.22 (0.62)	-0.10 (0.59)	-0.06

Standard deviations are noted in parentheses.
N = 152

In Table 5.4, students from both teachers are combined to form one sample. This was done on purpose as we used students as the unit of selection in order to give us a larger sample size. All of the results in this paper are reported with this same combined sample, with the exception of Table 5.5. Each of the teachers that participated in this experiment has a different teaching style, and thus when we compiled our results we calculated these measurements for each teacher separately as well. We did not plan on including these results unless we found them particularly insightful, and for the most part they were not, with the exception of the data displayed in Table 5.5. This table contains the same metrics as Table 5.4 but with only one of the teacher's students. The teacher whose students were removed was much more aggressive in making sure his students completed their assignments; thus, his completion percentages are nearly 100%, leaving little room for improvement. This was made possible by the fact that the majority of low-performing students were in the other teacher's class as well. When we focus in on only the other teacher, the trends in Table 5.4 become more pronounced, to the level of statistical reliability, with $t(83) = 2.16$, $p < .05$ and $t(83) = 2.39$, $p < .05$.

Table 5.5

Student performance data (Teacher J only)

Performance Metric	Control			Experiment			
	Unit 1	Unit 2	Gain	Unit 1	Unit 2	Gain	ΔGain
Avg percent of assignments completed	91.14 (13.87)	92.57 (13.82)	1.43 (12.84)	89.53 (12.75)	96.84 (6.88)	7.30 (12.22)	5.87[a]
Avg percent of assignments completed on time	84.24 (13.95)	81.64 (17.16)	-2.60 (15.18)	81.56 (14.65)	87.00 (15.76)	5.44 (15.80)	8.04[b]
Avg unit test score	3.29 (0.78)	3.26 (0.69)	-0.02 (0.63)	3.34 (0.54)	3.22 (0.67)	-0.12 (0.64)	-0.09

Standard deviations are noted in parentheses.
N = 85
[a]$p < 0.05$, Effect Size=0.46
[b]$p < 0.05$, Effect Size=0.53

As with the survey results, we focused in on two subgroups of students when analyzing performance results, the first being those whose parents opted to receive nightly emails. The differences in gains is much more pronounced than in Table 5.4, but still not statistically reliable. Recall that the number of parents who chose this option was relatively small (14), so there were likely not enough data points for a significant result. The gains in average test scores were still negligible.

Table 5.6

Student performance data (nightly emails)

Performance Metric	Control			Experiment			
	Unit 1	Unit 2	Gain	Unit 1	Unit 2	Gain	ΔGain
Avg percent of assignments completed	93.85 (10.55)	95.37 (11.02)	1.52 (10.09)	91.13 (12.94)	98.00 (5.90)	6.87 (13.45)	5.35
Avg percent of assignments completed on time	84.16 (14.56)	84.57 (16.66)	0.41 (15.89)	78.47 (14.79)	84.00 (21.38)	5.53 (16.86)	5.12
Avg unit test score	3.23 (0.63)	3.20 (0.68)	-0.04 (0.63)	3.23 (0.62)	3.13 (0.64)	-0.10 (0.54)	-0.06

Standard deviations are noted in parentheses.
N = 90; N(Control) = 75; N(Exp) = 15;

The second subgroup consisted of students whose percentage of assignments completed on time during Unit 1 were lower than 80. This represents the students who did not always complete their homework and thus could theoretically benefit the most from such an intervention. The results are similar to those in Table 5.5. The differences in gains are much more pronounced than in Table 5.4, though in this subgroup the gains in completed assignments are almost double that of assignments completed on time. Also interesting is that unlike in Tables 5.4 and 5.5, the control group gained considerably in both of these metrics, whereas in the other tables they gained minimally or not at all. The experimental group made up for this difference with sizeable increases in gains as well. Tests scores, unfortunately, still did not increase in this subgroup.

Table 5.7

Student performance data (low performing)

Performance Metric	Control			Experiment			
	Unit 1	Unit 2	Gain	Unit 1	Unit 2	Gain	ΔGain
Avg percent of assignments completed	84.57 (15.24)	89.14 (17.68)	4.57 (15.53)	83.17 (13.24)	95.63 (7.79)	12.46 (13.62)	7.89
Avg percent of assignments completed on time	65.24 (11.68)	72.67 (21.63)	7.43 (20.32)	67.83 (7.56)	78.54 (17.84)	10.71 (18.15)	3.28
Avg unit test score	2.88 (0.79)	2.86 (0.74)	-0.02 (0.90)	3.09 (0.58)	3.00 (0.69)	-0.09 (0.60)	-0.06

Standard deviations are noted in parentheses.
N = 45

Chapter 6

Discussion

Overall, very few of our results were statistically reliable. Those that were would unlikely remain so if a penalty was applied based on the number of t-tests performed (Abdi, H 2007), as we analyzed a variety of different metrics and subgroups. We are confident, however, that the parental notification feature did help parents become more involved and increased student performance as hypothesized. While not reliable, nearly all of our results trended strongly in the direction of our hypothesis. Additionally, the effect sizes for those that were reliable were fairly large, indicating that the intervention was high-impact. We believe the lack of reliability in our results is attributable to several circumstances we will discuss here; we leave it up to the reader to decide whether our conclusions are valid or merely speculative.

First, our experiment took place in an actual middle school during the course of a normal school year. We were very limited in our ability to control the behavior of students, teachers, and parents in this setting. Thus, the data is inherently "noisy"—there are an abundance of unknown variables influencing the data aside from our intervention. We did our best to isolate these variables, as described in the section on preprocessing. We removed students who had inconsistent internet access, special education considerations, or long periods of absence. We discounted assignments during the transitional week between the two units. We even tracked

down particular outliers and anomalies to make sure their inclusion or exclusion was warranted. While all of these strategies helped, the data is still very noisy, as evidenced by the large standard deviations in the results. This makes statistical reliability difficult to come by. This is exacerbated by the fact that, once we removed outliers and focused in on particular subgroups, our sample sizes became increasingly small. Experiments in real-world settings such as this are logistically difficult to manage, and that difficulty only increases with more participants.

Secondly, we believe we experienced an almost universal ceiling effect in our results. This was not surprising, as we ran into a similar issue in the exploratory study. The middle school where this experiment was conducted is a very high-performing school located in a community with a reputation for academic excellence. This is reflected in our survey results, where parents indicated a high level of involvement with their students even before the intervention, as well as the performance results, with test scores and homework completion rates well above average in almost every category. Unfortunately, this leaves little to no room for improvement, or at least the magnitude of improvement that is easily detected. This is evidenced by the fact that our results were much stronger whenever we focused in on low-performing students, or when we removed the teacher with better performing students from our overall performance data in Table 5.5, resulting in some of our few statistically reliable values. We chose to conduct the experiment at this school despite knowing of this problem beforehand because of our close relationship with the teachers and administrators there that allows us to conduct these studies in the first place.

Lastly, we encountered a couple of confounding variables in our results. We believe our experimental design was strong enough that these variables did not invalidate our findings;

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however, they made detecting effects more difficult. For example, in many of our metrics, the control group experienced an increase between Unit 1 and Unit 2, both on the survey and on measures of student performance. The fact that the experimental group increased considerably *more* allowed us to still perform analysis. We managed to identify several potential causes of this phenomenon. First, we mentioned earlier that Unit 2 contained new material and thus was more difficult than Unit 1. This could very easily explain some of the negative gains control groups experienced in certain performance metrics. Second, Unit 1 was the first unit of the school year. According to our teachers, there is a significant transition in behavior as students, teachers, and parents become accustomed to the new environment. How this transition manifested itself is unclear, but it could certainly have had a sizeable effect on our results.

As we discussed previously, the survey results trended strongly in the direction of our hypothesis, with the experimental group responding that they became more involved in monitoring their student's performance after the intervention than the control group. When we focused specifically on parents who opted to receive nightly emails these differences in gains increased, especially in responses to the question regarding monitoring of nightly homework. This makes sense as involvement in nightly homework is the area we would expect nightly emails to improve the most. When focusing on low-performing students, a similar trend occurs, though in this instance the question regarding whether parents are being provided with enough information shows the strongest difference in gains. While this could easily just be noise as described previously, it is also possible that parents of low-performing students were already checking their students' homework frequently; what they really needed was access to information, which is what the intervention provided. Overall, the survey results seem to suggest

that with a more frequent intervention (nightly emails) and the removal of the ceiling effect (low-performing students), we may be able to detect a reliable effect in the future.

When asked how they felt after receiving the intervention parents were largely supportive, with several themes emerging. First, parents overwhelmingly felt they had a much better sense of their student's performance after being given access to ASSISTments data, and overall the majority of them found it useful and would recommend it to others. They particularly liked the feeling of "safety" it gave them, in being able to trust their student and teach them independence while still being able to verify in the event something went wrong. There was also a sizable portion of parents for whom the feature really did not add any value, as their students always completed their homework and did not need to be monitored. These parents, however, still recognized the intervention as a useful tool for others and were supportive of its implementation.

Performance results showed a similar trend, with stronger gains in the experimental group between the two units, gains which increased when focused in on the relevant subgroups. The results were most pronounced when one of the teachers, who "fell victim" to the ceiling effect, was removed from analysis, giving us some of our few reliable values. Worth mentioning are some interesting results that occurred when focusing on only low-performing students. For example, in this subgroup in particular, the control group experienced dramatic gains (though the experimental group experienced even *more* dramatic gains). Our best interpretation is that this is the result of the beginning of school transition period, which may have resulted in low-performing students becoming much better at completing their homework on ASSISTments as they became more familiar with the system. It could also be the result of the artificial due dates

we inserted into one of the teacher's assignments. Additionally, the difference in gains for assignments completed was almost twice that of assignments completed on time. It is possible that, due to the fact that most parents only received a weekly email, students became more diligent about completing their assignments *eventually*, but the data was not granular enough for parents to make sure they completed them *on time*. Nightly emails would theoretically address this problem, but we did not force parents to enable them as we thought it might be perceived as unwanted spam.

One result that was surprisingly universal for such noisy data was the fact that differences in test score gains were always nearly 0. The intervention appeared to have no effect on student performance in this regard. While disappointing, this is not entirely unexpected. If we analyze this again from a causal perspective, access to data is meant to increase parental involvement. Parental involvement is theoretically supposed to increase student performance, particularly in areas such as homework completion. As we mentioned in the introduction, homework itself is supposed to be beneficial in increasing student learning, which we would expect to show up in assessments such as tests. We are now about 4 jumps down the causal chain, however, and intuitively each jump introduces more noise and dilutes the effect. Thus, detecting an increase in test scores was possible but not likely.

6.1 Parent Feedback

Both of our surveys contained open-ended essay questions that allowed parents to give us qualitative feedback on their experiences with parental notification. As was the case in the exploratory study, the response from parents was very positive. Parents overwhelmingly see the need for such a component, are excited when given the opportunity to use it, and for the most part utilize it effectively. It is for these reasons we are confident that parental notification in an ITS is a concept worth pursuing, even if the quantitative results do not always reflect this.

The first survey was given after students had been using ASSISTments for almost two months, but before the intervention was introduced. Based on their responses to the essay question, it was obvious that many of the parents had already been looking at ASSISTments data using their students' accounts and were very pleased. Many expressed that they felt a sense of "safety" in the ability to verify that their students were completing assignments and performing acceptably on them. The general sentiment was that parents are not provided with enough information about their students and struggle to stay involved, as expressed by the first response in Figure 6.1.

> (1) I have no interaction with my child's teacher and there are no longer any parent/teacher conferences. We are left to assume our child is doing well if we have not heard from her teacher. I would like some feedback as to how my child is doing throughout the year PRIOR to report cards.
>
> (2) [XXXX] is an excellent student and has always been very responsible when it comes to homework. She has been doing homework independently since 3rd grade. While she will sometimes ask for help, I do not typically check her homework because I don't feel I need to. I do monitor her grades and I like that assistments gives me the opportunity to monitor her math homework activity. I have two boys who are not nearly as accurate and responsible so I do see the value in this system!
>
> *Figure 6.1*. Sample parent comment regarding lack of information about student performance.

Several parents indicated that their students always completed assignments independently and expressed indifference about parental notification, citing they had little need for it. However, they recognized the potential benefit to other parents, and some even liked the idea of being able to verify such information in the event their students began to slip. Overall, it was clear parents had long desired such a feature and were excited by the preview given to them by the standard ASSISTments functionality.

The second survey contained several questions that allowed parents to provide us with personalized feedback regarding their experience with the intervention. It asked parents to describe what they liked about the system, as well as what they didn't like, was missing, or would change. Most of the responses were positive, echoing sentiments previously addressed in other questions such as feelings of safety. The essay in Figure 6.2 is representative of such responses.

(1) I liked the system as it was easier for me to go to one place to see all assignments. I think this is a wonderful program. The only negative thing I experienced was that there were times when I would get the same assistment message several times during the course of the late afternoon through evening. I loved being able to look at his work online and know that he either mastered it or did not. You could see right away where the problems were and where he needed no help at all. All in all I hope that this program will continue to be used at Oak. My son loves it as well.

(2) I liked that the email shows me incomplete assignments. I liked getting the weekly emails— [they] helped me to know what was going on.

Figure 6.2. Sample positive parent responses to intervention

Others, as we discussed, again noted that their students were independent high-performers and thus they did not need the intervention, though they appreciated its potential for others. Several parents used the opportunity to express dissatisfaction with ASSISTments in general, which was

not the focus of our experiment. Others confirmed a suspicion we had midway through the experiment—that many parents would rather receive an email only when something is wrong or out of the ordinary, with a lack of emails indicating that everything is fine.

> (1) I honestly don't feel it was a value added tool in our particular case. [XXXXX] is pretty independent and I trust her to get her work done.
>
> (2) We would have preferred to get an email only when there was a problem, but our student normally does his homework and performs pretty well in class. I can certainly anticipate this feature being very useful if the circumstances were different.

Figure 6.3. Sample neutral parent responses to intervention

This brings up the important question of what is the best way to send automated messages. In general, survey results revealed that parents checked on their students' performance about as frequently as they received automated emails (weekly or nightly). This is consistent with our exploratory study, where parents did not really check on their students at all until they were indirectly reminded to by their teachers. It seems clear then that a "push" method is preferable for such parental notification systems, as (presumably busy) parents do not seem to seek out the information themselves. Yet as we saw, some parents expressed a desire to be notified only when something was wrong, and could thus assume everything was fine if they were not hearing anything from the system. As teachers and academics, we would like to think that parents are constantly analyzing their students' data, but perhaps this is not practical or even beneficial to students. This is something that could be addressed in future work on the subject.

6.2 Conclusion and Future Work

Statistical reliability or not, we believe our experiment demonstrated the potential of Intelligent Tutoring Systems to increase parental involvement in student learning by providing parents with the fine-grained data ITS can make available. Survey results indicated that parents became more involved in their students' education when they were given access to this data through a parental notification component of ASSISTments combined with an automated messaging feature. Furthermore, student performance data indicated that this increased involvement led to increased homework completion rates. These increases in involvement and homework completion, however, were not reflected in test scores measuring actual student learning. Qualitatively, feedback from parents regarding the intervention was very positive, with parents responding that access to students' data gave them a better sense of how their students were performing and allowed them to feel a sense of security about their students' education.

Based on our results, we are confident that this is a topic worthy of further study. We believe we have been successful in demonstrating the potential of Intelligent Tutoring Systems to increase parental involvement in student learning and thereby increase student performance. We recognize, however, that our results are far from definitive and lack the backing of statistical reliability. Therefore, another baseline experiment similar to ours is warranted in order to establish a strong foundation on which further research can be built. We believe that with the precedents and guidelines our study has produced, this can be accomplished in the near future. Most importantly, these guidelines include avoiding some of the pitfalls we believe prevented us from achieving stronger results.

For one, an even stronger intervention may be desirable in order to "cut through the noise" and produce a reliably detectable effect. This is a difficult proposition as it involves towing the line between providing parents with useful information and spamming them to the point where it could potentially have the reverse effect. Most of the parents in our experiment did not opt for the nightly emails, indicating that such a high frequency is undesired. Several even objected to receiving weekly emails, instead preferring to be notified only when there is a problem. One possible way to increase the intervention is through text messaging. Instead of nightly emails, nightly texts could be sent. We hypothesize that at this point in time, text messaging is far more pervasive than email, and there seems to be far less stigma attached to unwanted texts than emails, perhaps rendering a nightly text more acceptable. The emergence of applications for cell phones presents another opportunity for increased intervention via this medium as well.

Future researchers should also attempt to avoid some of the confounding variables we encountered in our experiment. For one, any studies conducted at an actual school should be held in the spring if possible to avoid the period at the beginning of the year when participants are familiarizing themselves with their new environment. There is no guarantee this will not occur in the spring either, as students could potentially become apathetic the closer they get to completing the school year. Theoretically, the best time would be any period during the school year when the behavior of parents, students and teachers is unlikely to change dramatically. Also, an experiment designed similar to ours should seek to avoid using math units that vary significantly in difficulty, as this could also introduce unwanted variations in the data. This problem was especially pronounced with the units we used, as the students were already familiar with the

material from one but not the other. This is also possibly a side-effect of conducting our study at the beginning of the year.

Lastly, opportunities for ceiling effects should be avoided if at all possible. Our analysis suffered from above average results in almost every metric before the intervention was even given. Even minimal attempts at removing some of the high-achieving students and teachers resulted in considerably stronger findings. In our case, we conducted our study at a school regarded for its academic excellence, with highly experienced teachers and located in a community with a reputation for commitment to student education. Running the experiment at a lower performing school or with less experienced teachers are both options, though with the difficulty of establishing the necessary relationships with schools this is not always feasible. Additionally, lower-performing schools are often located in areas where internet access among students and parents is lower than required for such an experiment. The previously discussed strategy of using cell phones may be able to overcome this issue.

We conclude this analysis with one final suggestion. As we discussed, some parents felt they would be better served by being notified only if something was wrong with their students' performance. While this seems almost counterproductive on the surface by giving parents a false sense of security and possibly an excuse to become even less involved in their students' education, it may in fact be no less effective and could even be more practical. It would not be difficult to simply give parents this option in a future experiment and measure any differences in efficacy. We believe this would be a particularly interesting research angle; with the amount of data that ITS provide, the delivery becomes extremely important in determining whether or not and how it is utilized.

Appendix A

Surveys

A.1   Exploratory Study Parent Pre-survey

Oak Middle School Parent Involvement Pre-survey

8th grade is a transitional time when it comes to a parent's involvement in their students education. During elementary school, parents tend to closely monitor every aspect of their student's education. By high school, however, many parents begin a more hands-off approach in order to teach their student responsibility and independence. We are curious as to what stage 8th grade parents are at in terms of level of involvement, and this survey is meant to measure that.

* Required

What is your name? *

Who is your student's math teacher? *
If you student is not in one of these classes, you were mistakenly given the link for this survey. Please only fill out this survey if you received a letter from WPI asking you to complete this survey.

Ms. O'Connor
Ms. Mulcahy
I don't know

Is your student in the Honors class? *

Yes
No
I don't know

Is your student male or female? *

Male
Female

Almost all homework assigned by Ms. O'Connor and Ms. Mulcahy requires a parent sign-off, including ASSISTment homework (in which case, it is a parent "check-off"). Were you aware of this?
We ask this because, while a student may forge a parent signature on paper and pencil assignments, it is even easier for the student to just check the box on ASSISTment homework. Note: mastery learning assignments don't have parent check-offs.

Yes
No

I feel I have a good understanding of what is going on in my student's math class (i.e. topics being covered, upcoming exams, etc).
We all know that when you ask your student what he or she did in school each day, the answer is often likely to be "Nothin." It can be hard for parents to feel they know what is going on in their student's class, and we understand that. That is why we are interested in this issue.

1 - Strongly disagree
2
3
4
5 - Strongly agree

I feel I have a good understanding of HOW my student is doing in math class.
For example, how well he or she is performing, whether he or she is doing his or her assignments, and if he or she understands the material.

1 - Strongly disagree
2
3
4
5 - Strongly agree

My child thinks I know how well he or she is performing in math class.
To clarify: we want to know what you believe about your child's perceptions, namely whether he or she thinks you are aware of how he or she is doing in math.

1 - Strongly disagree
2
3
4
5 - Strongly agree

I think my child likes math class this year.

1 - Strongly disagree
2
3
4
5 - Strongly agree

I think my child likes math in general.

1 - Strongly disagree
2
3
4
5 - Strongly agree

I think my student will need to use math in his or her future career(s).

1 - Strongly disagree
2
3
4
5 - Strongly agree

I believe my student thinks math is important.

1 - Strongly disagree
2
3
4
5 - Strongly agree

I feel my school is *not* giving me enough information to adequatly monitor my student's progress.

1 - Strongly disagree
2
3
4
5 - Strongly agree

In the past week, how frequently did you check up on your student's homework?
Do you ask them what their homework is, make sure they do it, and/or help them with it/check it afterwards? Or are you more of the opinion that they should be handling it themselves at this point?

Never, it is their responsibility
Once or twice, just to make sure
3-4 times, to keep them on track
Almost every day

The report card is the primary means by which I get feedback about my student's performance in math class.
As opposed to asking to see their graded assignments, etc.

1 - Strongly disagree
2
3
4
5 - Strongly agree

How often do you give consequences (rewards/punishments) for grades and homework completion?

1 - Never
2
3
4
5 - Often

How often have you interacted with ASSISTment in the last 30 days?
This includes visiting the site either through your account or your student's, helping your student with his ASSISTment work, viewing his or her performance reports, etc.

Never
Less than once per month
About once or twice per month
About once per week
Several times a week

How often have you intiated contact with your student's teacher in the last 30 days?
This includes via e-mail, phone, note, or scheduling a meeting.

Never
Once
Twice
3-5 times
6 or more times

ASSISTment has a feature where your student can view detailed reports on how he or she did on any given assignment (the Item Report). Has your student showed you this feature?

Yes
No

Do you have any comments regarding the questions asked in this survey? Do you want to share with us your opinion about the appropriate level of parent-teacher communication? Any other thoughts you would like to share are welcome.

A.2   Exploratory Study Student Pre-survey

Parent Involvement Pre-survey (student version)
Please answer as honestly as you can. Your parents are not going to see your answers to these questions, and your answers will not affect your grades or get you in trouble.

* Required

What is your name? *

Whose math class are you in? *

Ms. O'Connor - Honors
Ms. O'Connor
Ms. Mulcahy - Honors
Ms. Mulcahy

Are you male or female? *

Male
Female

I like math class this year

1 - Strongly disagree
2
3
4
5 - Strongly agree

I like math in general

1 - Strongly disagree
2
3
4
5 - Strongly agree

Do you think you will use math in your future career(s)?

Yes
No

I think math is important

Strongly disagree
Strongly agree

I think my parents know what I'm doing in math class.
As in, what you are studying, when your exams are, etc.

1 - Strongly disagree
2
3
4
5 - Strongly agree

I think my parents know HOW I'm doing in math class.
As in, what you're getting for grades, whether you understand the material, and if you are doing your homework.

1 - Strongly disagree
2
3
4
5 - Strongly agree

I think how well I do in math class is primarily caused by how hard I work.

1 - Strongly disagree
2
3
4
5 - Strongly agree

I have shown my parents ASSISTment this year.

Yes
No

I have shown my parents my Item Report this year.
Yes
No

My parents have sat down and helped me with my ASSISTment work this year.
Yes
No

A.3   Experiment Pre-survey

PN.Parent.Survey.Pre.Fall.2010
7th grade is a transitional time when it comes to a parent's involvement in their students education. During elementary school, parents tend to closely monitor every aspect of their student's education. By high school, however, many parents begin a more hands-off approach in order to teach their student responsibility and independence. We are curious as to what stage 7th grade parents are at in terms of level of involvement, and this survey is meant to measure that.

We are also interested in how well you feel you are being provided with the information on your student's performance necessary to engage in your preferred level of involvement.

* Required

What is your student's name? *
First and last please.

What is your e-mail addres? *
Please put the one you used to sign up for your ASSISTments account. This is solely so that we can match your survey up with your parent account, not to send out spam.

I feel I have a good understanding of what is going on in my student's math class (i.e. topics being covered, upcoming exams, etc). *

We all know that when you ask your student what he or she did in school each day, the answer is often likely to be "Nothin." It can be hard for parents to feel they know what is going on in their student's class, and we understand that. That is why we are interested in this issue.

1 - Strongly Disagree
2
3
4
5 - Strongly Agree

I feel I have a good understanding of how my student is performing in math class. *

For example, how well he or she is scoring on assignments, whether he or she is doing his or her assignments, and if he or she understands the material.

1 - Strongly Disagree
2
3
4
5 - Strongly Agree

I check to make sure my student has completed their homework at night. *

Do you closely monitor your student to keep them on track or do you take a hands-off approach that emphasizes personal responsibility?

1 - Never
2
3
4
5 - Always

I closely monitor my student's performance (as in, check grades on assignments and tests) *

Again, we are interested in your approach towards your student's education, and whether you keep on them to make sure they're doing well or prefer that they be independent.

1 - Never
2
3
4
5 - Always

I feel I am being provided enough information about my student's performance. *
This includes from the school, teachers, and from the ASSISTments system.

1 - Strongly Disagree
2
3
4
5 - Strongly Agree

Please add any comments or clarifications here.

A.4   Exploratory Study Parent Post-survey

Oak Middle School Parent Involvement Post-Survey
For the past two months, your student's math teacher has been sending you messages through the ASSISTment system informing you about what is going on in class and perhaps how your student is doing individually. You may remember taking a similar survey at the beginning of this period--we apologize for the repetition, but in order for us to measure any positive or negative effects of introducing this new feature to ASSISTment, we need you to take a second survey so that we can detect any changes in your answers during this time period. We are also very interested in your thoughts on the parent messaging feature, and the last question on the survey will allow you to share them with us. Thank you for taking the time to participate; this research helps us improve ASSISTment and ultimately we hope it will help improve student learning.

* Required

What is your name? *

I feel I have a good understanding of what is going on in my student's math class (i.e. topics being covered, upcoming exams, etc).
We all know that when you ask your student what he or she did in school each day, the answer is often likely to be "Nothin." It can be hard for parents to feel they know what is going on in their student's class, and we understand that. That is why we are interested in this issue.

1 - Strongly disagree
2
3
4
5 - Strongly agree

I feel I have a good understanding of HOW my student is doing in math class.
For example, how well he or she is performing, whether he or she is doing his or her assignments, and if he or she understands the material.

1 - Strongly disagree
2
3
4
5 - Strongly agree

My child thinks I know how well he or she is performing in math class.
To clarify: we want to know what you believe about your child's perceptions, namely whether he or she thinks you are aware of how he or she is doing in math.

1 - Strongly disagree
2
3
4
5 - Strongly agree

I feel my school is *not* giving me enough information to adequatly monitor my student's progress.

1 - Strongly disagree
2
3
4
5 - Strongly agree

In the past week, how frequently did you check up on your student's homework?
Do you ask them what their homework is, make sure they do it, and/or help them with it/check it afterwards? Or are you more of the opinion that they should be handling it themselves at this point?

Never, it is their responsibility
Once or twice, just to make sure
3-4 times, to keep them on track
Almost every day

How often do you give consequences (rewards/punishments) for grades and homework completion?

1 - Never
2
3
4
5 - Often

How often have you interacted with ASSISTment in the last 30 days?
This includes visiting the site either through your account or your student's, helping your student with his ASSISTment work, viewing his or her performance reports, etc.

Never
Less than once per month
About once or twice per month
About once per week
Several times a week

How often have you intiated contact with your student's teacher in the last 30 days?
This includes via e-mail, phone, note, or scheduling a meeting.

Never
Once
Twice
3-5 times
6 or more times

Have you used the Item Report feature of ASSISTment? This is the feature that allows you to view in detail how your student did on a particular assignment. The Parent account feature of ASSISTment allows you to view your student's Item Report.

Yes
No

We are extremely interested in how you feel about the parent notification feature of ASSISTment. Please take this opportunity to tell us what you liked about it as well as what you didn't like about it. We are also interested in what features and changes you would like to see (regarding parent involvement in ASSISTment). Did this feature cause you to log onto ASSISTment more often? Did you visit other parts of the site besides the message inbox? Do you feel it has increased your involvement in your student's education? Really any thoughts would be appreciated.

A.5   Exploratory Study Student Post-survey

Parent Involvement Post-survey (student version)
Please answer as honestly as you can. Your parents are not going to see your answers to these questions, and your answers will not affect your grades or get you in trouble.

* Required

What is your name? *

I think my parents know what I'm doing in math class
As in, what you are studying, when your exams are, etc

1 - Strongly disagree
2
3
4
5 - Strongly agree

I think my parents know HOW I'm doing in math class
As in, what you're getting for grades, whether you understand the material, and if you are doing your homework.

1 - Strongly disagree
2
3
4
5 - Strongly agree

My parents have sat down and helped me with my ASSISTment work this year (say, since January)

Yes
No

A.6   Experiment Post-survey

A.6.1   General Questions

PN.Parent.Survey.Post.Fall.2010
Dear parents and guardians,

Thank you for taking this survey. You may notice it is very similar to the one you took several months ago. We are attempting to measure changes over that period of time, so it is very important that you complete this one as well. We appreciate your participation.

ASSISTments Team

7th grade is a transitional time when it comes to a parent's involvement in their students education. During elementary school, parents tend to closely monitor every aspect of their student's education. By high school, however, many parents begin a more hands-off approach in order to teach their student responsibility and independence. We are curious as to what stage 7th grade parents are at in terms of level of involvement, and this survey is meant to measure that.

We are also interested in how well you feel you are being provided with the information on your student's performance necessary to engage in your preferred level of involvement.

* Required

What is your student's name? *
First and last please.

I feel I have a good understanding of what is going on in my student's math class (i.e. topics being covered, upcoming exams, etc). *
We all know that when you ask your student what he or she did in school each day, the answer is often likely to be "Nothin." It can be hard for parents to feel they know what is going on in their student's class, and we understand that. That is why we are interested in this issue.

1 - Strongly Disagree
2
3
4
5 - Strongly Agree

I feel I have a good understanding of how my student is performing in math class. *

For example, how well he or she is scoring on assignments, whether he or she is doing his or her assignments, and if he or she understands the material.

1 - Strongly Disagree
2
3
4
5 - Strongly Agree

I check to make sure my student has completed their homework at night. *

Do you closely monitor your student to keep them on track or do you take a hands-off approach that emphasizes personal responsibility?

1 - Never
2
3
4
5 - Always

I closely monitor my student's performance (as in, check grades on assignments and tests) *

Again, we are interested in your approach towards your student's education, and whether you keep on them to make sure they're doing well or prefer that they be independent.

1 - Never
2
3
4
5 - Always

I feel I am being provided enough information about my student's performance. *

This includes from the school, teachers, and from the ASSISTments system.

1 - Strongly Disagree
2
3
4
5 - Strongly Agree

Did you participate in the parent notification pilot this past month? *
If you are unsure, did you get an invitation from us to sign up for an account on ASSISTments in late October? Have you been receiving automated emails from ASSISTments every Friday? If so, you were (randomly) selected for the pilot, and should select yes. If you were not selected, don't worry, we plan on making this feature available to everyone in the spring!

Yes
No

A.6.2   Questions for Control Group

Additional Questions
If you have time and would like to share, we would love it if you could answer a few additional questions. Thanks! EVEN IF YOU DO NOT ANSWER THESE QUESTIONS, MAKE SURE YOU CLICK CONTINUE AT THE BOTTOM OF THE PAGE SO THAT YOUR OTHER RESPONSES ARE RECORDED!!

As you are probably aware, your student is doing their nightly homework on ASSISTments, getting immediate feedback. Compared to last year when your students was not using ASSISTments, we want to know, whether and how this has changed they way your monitor homework. [C]

It did not change
It did change (Please explain below how it did change)

Use this space below to tell us how this has changed the way you monitor your students homework. [C]

Which best describes your current relationship with your student in regard to homework? [C]
Please select the answer that applies most to your relationship

My student almost always does their homework, so I leave them alone
I ask my student whether they have completed their homework
I check to make sure my student has completed their homework
I check to make sure my student's homework is correct
I look into my student's homework only when his or her teacher indicates there is a problem

Please add any comments or clarifications here.

A.6.3   Questions for Experimental Group

Additional Questions for Pilot Participants
If you have time and would like to share, we would love it if you could answer a few additional questions. Thanks! EVEN IF YOU DO NOT ANSWER THESE QUESTIONS, MAKE SURE YOU CLICK CONTINUE AT THE BOTTOM OF THE PAGE SO THAT YOUR OTHER RESPONSES ARE RECORDED!!

May we contact you about your experiences with the parental notification feature?
If so, please include how and when you would like us to contact you in the general comments essay from the previous section.

Yes
No thank you

If so, how and when may we contact you?

As you are probably aware, your student is doing their nightly homework on ASSISTments, getting immediate feedback. Compared to last year when your students was not using ASSISTments, we want to know, whether and how this has changed they way your monitor homework.

It did not change
It did change (Please explain below how it did change)

Use this space below to tell us how this has changed the way you monitor your students homework.

Which best describes your current relationship with your student in regard to homework? Please select the answer that applies most to your relationship

My student almost always does their homework, so I leave them alone
I ask my student whether they have completed their homework
I check to make sure my student has completed their homework
I check to make sure my student's homework is correct
I look into my student's homework only when his or her teacher indicates there is a problem

We started emailing reports to you every Friday in late October. Do you feel you have a better sense of whether your student is completing their homework in math class compared to before we started sending emails?

My student almost always completes their homework, so I do not generally have to monitor them
No, I do not feel like anything has changed
Yes, I feel I have a somewhat better sense
Yes, I feel I have a much better sense

Do you feel you have a better sense of how your student is PERFORMING in math class compared to before we started sending emails?

My student almost always performs well, so I do not generally have to monitor them
No, I do not feel like anything has changed
Yes, I feel I have a somewhat better sense
Yes, I feel I have a much better sense

Did you find the parental notification feature helpful?

1 - Not at all
2
3
4
5 - Very

What did you like about the system? What didn't you like, felt was missing, or would change about it?
Other things to consider: Did you find the emails annoying or a waste of time, especially after the first week or so? Would you have preferred to get an email only when there was a problem rather than all the time?

Would you recommend that we make this feature widely avaible to parents?

1 - Very unlikely
2
3
4
5 - Very likely

How often did you use the data provided to you by ASSISTments and the emails?

Never
A few times
About every week
Several times a week
Every day

How did you use this data?

I used it to make sure my student was performing well on assignments
I used it to make sure my student was doing his or her homework
I used it to review math content with my student
It prompted me to talk to my student about the importance of completing their homework
It prompted me to talk to my student about the importance of math in future careers
It prompted me to incentivize my student with some sort of reward/punishment
Other:

We are very interested to hear from parents how they actually used this data. If you can, please give us a concrete example of how you used this information. This will help us improve the system.

Did you tell your student you were getting automatic emails and had an account on ASSISTments?

Yes
No

The parental notification feature allowed me to make sure my student was completing their homework without having to bother them about it.

1 - Strongly disagree
2
3
4
5 - Strongly agree

Please add any additional comments or clarifications here.

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