Math1010: Progress Report Emina Alibegović

The University of Utah demands of all of its graduates to complete a course that will fulfill a quantitative reasoning requirement. Depending on the students' concentration, this requirement may be fulfilled through courses taken during freshmen year as they prepare for the courses necessary for their major, or it may be a course students postpone until their junior or senior year. Math1010, Intermediate Algebra, is the course that is designed to prepare the students for a successful completion of Math 1050, as they prepare for Calculus, or Math 1030, which is a terminal mathematics course.

It should be obvious that the population of students in this course is very diverse. We have a number of students who are intrinsically motivated to perform well in this class. They are aware of the need to master the material as they are working toward Math1050 and subsequently either toward calculus class for science, engineering or business students. We also have a number of students who have traditionally had poor experiences with mathematics, been unsuccessful in their k-12 mathematics education, and now have to prepare for a course that will be the last mathematics course in their educational career. These students are generally very intimidated by mathematics and have extremely low self esteem and belief in their ability to learn mathematics. These two very different populations are grouped together into large sections and offered the same type of instruction that has traditionally been associated with mathematics: lecture style in which students are to take notes and transfer the knowledge imparted on them by their instructor to the questions and problems they are to work out on their own.

Math1010 has proved to be one of the most challenging courses to teach. The diversity of the students body mentioned above is one of the reasons. Some have claimed that poor performance can be explained by poor attendance during lectures. Other have placed the blame on type of instructions and the way the material has been treated in the course: skill-based material delivered through the lecture style. Research has shown that students who have been unsuccessful in this type of environment achieve better when they can use their common sense and problem solving skills rather than prescribed, memorized algorithms. The educational community agrees that developments in technology and industry require our graduates to be problems solvers and to be able to engage in investigative processes independently. Our courses, however, are not structured to be conducive to this type of engagement. Subsequently, the course coordinator, Emina Alibegovic, began to address the issues facing Math1010 in the Fall of 2011.

There were two approaches to improving Math1010 that were implemented: improved online support and audience response systems. In recent years there has been a significant push towards increasing and improving online course offerings throughout the University. Emina Alibegovic, Marilyn Keir and Kelly MacArthur have obtained Technology Assisted Curriculum Center grants to develop online versions of Math 1010, 1050 and 1060. Throughout the country people have been trying a "flipped" classroom and these materials proved to be very useful in structuring a different classroom environment. In this scenario, each large section¹, has an associated Canvas course page where students have access to short videos, notes associated with those videos, and sets of problems to work on whose solutions are also available to consult after the work has been completed. The students are asked to view the instructional video and work through the problem sets before coming to the classroom. Classroom time is then devoted to resolving the questions students have through new sets of problems which are more challenging than the ones they had encountered previously, and then extending that understanding to application-level problems.

How this model would work is much clearer when we speak of small sections. A reasonable question is "How does the instructor ensure that all students have completed the work necessary and how does she engage the students in the work in the classroom?" Just as it is important for students to be active participants in the creation of their own knowledge, it is important that they receive prompt

¹We will think of large sections as those whose number of students exceeds 50.

feedback on their work. Both of these are equally challenging for the instructor of large classes. To remedy this, we have required the use of audience response systems (clickers) in all of the large sections. In this way the instructor can reinforce the need for engaging with the material prior to class, as well as ensure that the students engage with the material during class and receive feedback on their work. The course coordinator subsequently applied for and received a second University Teaching Grant with which the Department purchased 5 tablet computers so that the instructors can successfully integrate audience response systems and presentations. In addition, each instructor has access to all the materials developed by the group: powerpoint presentations with integrated clicker questions, video lessons, notes and homework problems. Some structures remained the same as there is still a departmental exam which must count for at least 30% of the student's grade.

The new structure has been in place for only four semester, however the limited amount of data has been rather promising. The table below demonstrates the arithmetic mean of the pass rates for all of the sections before and after the changes have been implemented, as well as the average grade achieved by the students in those sections. We would expect that no significant change is noticed in the sections with the number of students smaller than 50 as those were the sections who were not required to implement any of the changes. The large sections were required to use both the online component and the clickers and we expected to see improvement in those sections. Finally, we expected the online course to improve as well. The reason for this expectation is the marked improvement of course materials as well as more rigorous structure and the feedback students were receiving about their work.

	Average pass rate in $\%$				Average GPA		
	before F11	after F11	p	Δ	before F11	after F11	Δ
small sections	73.39 ± 13.68	75.00 ± 13.09	0.69	1.60	2.51	2.52	0.01
large sections	73.49 ± 9.53	80.43 ± 6.59	0.009	6.94	2.47	2.69	0.21
online sections	56.59 ± 10.55	67.10 ± 4.91	0.085	10.51	2.02	2.34	0.32

	D rate			E rate			W rate		
	before F11	after F11	Δ	before F11	after F11	Δ	before F11	after F11	Δ
small	11.00	7.90	-3.10	15.61	17.10	1.49	6.13	15.67	9.54
large	10.94	9.86	-1.08	15.57	9.71	-5.87	5.78	2.97	-2.81
online	14.26	12.48	-1.78	29.15	20.43	-8.73	15.20	8.59	-6.61

Let us take a closer look at the students who did not pass the class:

We see from these tables that our expectations have been confirmed, and we will continue to collect the data in the semesters to come. What is interesting to note is that in the large and online sections the withdrawal rate nearly halved. There are many questions one can ask, and it is not clear whether we will have sufficient data to answer them. Some of these questions are:

- 1. Are the instructors using the instructional methods we have asked them to?
- 2. How much is the attendance and participation influencing the pass rates and the grades?
- 3. Which changes contributed more to the increase in performance?
- 4. In what additional ways can the instructor encourage students to complete the work before class time?

While the answers to these questions would be helpful in confirming our predictions, from the above table we see that we are on the path of improving students' success and experience in Math1010. There are clearly other steps we can take to improve even further. Some of those steps should include:

1. Small sections: they should adapt the teaching methods that are proving to be successful in larger sections.

- 2. Textbook: current textbook does not reflect the order or the manner in which the material is presented.
- 3. Supporting materials: online homeworks intended for increasing skill based performance, engaging problem sets whose purpose is to surface common misconceptions that are to be addressed in class.
- 4. Community: utilize discussion sections of canvas course to improve collaboration between students in and outside the classroom.
- 5. Instructional strategies: the instructors are asked to engage in type of instruction they are not familiar with. Further training could be provided.