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ASSESSING CORE CURRICULUM IN THE FOUNDATIONAL COMPONENT AREA OF MATHEMATICS FOR UNDERGRADUATE RESEARCH

Rohitha Goonatilake†, Miguel San Miguel†, Runchang Lin†, Sofia C. Maldonadoν, and Aida C. Garza±
Department of Mathematics and Physics†, School of Engineeringν, and University Learning Center±
E-mails: harag@tamiu.edu, msanmiguel@tamiu.edu, rlin@tamiu.edu, sofiac.maldonado@tamiu.edu, and aidagarza@tamiu.edu
Texas A&M International University
5201 University Boulevard
Laredo, Texas 78041-1900

Abstract:
The Texas Higher Education Coordinating Board (THECB) revised the Texas Core Curriculum (TCC) rules in October 2011. Implementation of the rules and revisions was effective Fall 2014. The Coordinating Board based the revisions on the recommendations of the Undergraduate Education Advisory Committee (UEAC), which is comprised of faculty members from Texas public community colleges and universities. In particular, College Algebra, Plane Trigonometry, Business Mathematics-I, Pre-calculus, and Calculus-I courses will be evaluated on a rotation basis to see if the content of the courses meet competencies in Critical Thinking, Communication Skills, Written Communication, and Empirical & Quantitative Skills necessary for expanding discipline-specific undergraduate research and scholarship.

This presentation will discuss the way these courses were selected, the nature and extent of the assessment being conducted, and, most importantly, the technology and textbook materials being used in the courses at Texas A&M International University (TAMIU).

Preliminaries
An important aspect of our mathematics programs is the core curriculum. The reason why the core curriculum is so fundamental to student's undergraduate education is because it is the point in which he or she begins developing his or her critical thinking skills such as the ability to innovate, analyze, evaluate, and synthesize information. Students also develop communication skills through the core curriculum since these courses require that one writes extensively and gives presentations in front of peers. Lastly, the core curriculum allows students to develop empirical and quantitative skills which consist of ability to manipulate and analyze data.

Furthermore, mathematics is a subject that has proven to be of great importance in the modern world. The applications and everyday uses of this field are growing significantly, and applied mathematicians continue to find new practical uses for this subject every day. Despite its practicality, mathematics is often seen as a rather parched subject which can only be grasped by those who are naturally proficient at manipulating numbers. However, nothing can be further from the truth. It is a subject that often requires students to find creative methods for solving difficult problems, and it is the ultimate goal of the core mathematics curriculum to acquaint them with the concepts of the subject as well as to make them skilled problem solvers. Something important to keep in mind is that this subject is one that is accessible to anyone who is willing to put the effort to understand and practice it. Mathematics as a discipline, on the other hand, provides a language and tools necessary for understanding the abstract world within us and for advancement of all living things.

Core-Curriculum

The core curriculum is a set of basic courses an academic institution requires its student population to take regardless of the program of study. The mathematics level courses range from College Algebra to Calculus-I in order to capture all students taking entry level courses in mathematics. It could also be used in classes teaching mathematics for the liberal arts. It provides a very rudimentary and, at the same time, minimal fundamental understanding of many different fields that can be pursued to be beneficial in the study. Educators and administrators in each institute decide what would be appropriate to achieve these goals. This is done by requiring their students to take a certain number of courses that will help them in the long run. In some cases, the Texas state will give a set of parameters and guidelines when choosing courses which means that institutions within the state will not deviate that much. It would probably compose of a different balance of subjects than those in the traditional liberal arts education. The collection of subjects that were seen as universally and fundamentally important in advancement can be modified to reflect a more comprehensive perspective in modernity.

It is widely agreed that any innovative instructional practice should include the following for the successful course delivery (Moeller & Reitzes, 2011).

- Course design and development.
- Classroom instructional practices.
- Institute infrastructure and support.
- Assessments.
- Knowledge specific to a given course.

The instructional practices guide will be a research and evidence based exercise for active learning. We face a dire shortage of engineers and scientists in the workforce and we can improve the first-year mathematics experience with the objective that students must be part of the solution in mind. They offer creative options for what, when, and how they are delivered and taught as determined by the institutions.

Undergraduate Research

One of the primary goals of academics is to gain a greater understanding of how the world works and to increase the level of knowledge that is currently available. The way in which this is done is through research. However, research is something which, for the most part, one does not encounter until entering graduate school. This is unfortunate since, according to study conducted by Nadelson, Warner, and Brown (2015), undergraduate research has been found to increase the knowledge of students participating as well as further their professional development. Also, according to Gilmore, Vieyra, Timmerman, Feldon, and Maher (2015), undergraduate research helps make one more prepared for conducting research at the graduate level.

It is believed that providing undergraduate research and presentation opportunities across disciplines can lead to an improvement of student retention. Students are more likely to succeed if they have clear academic goals, are active learners, and are active participants in campus activities. To contribute to student success, faculty members must be proactive in their approaches while focusing on conditions and methods that promote student learning (Bachnak et al., 2013). A pie chart that appears in Student Engagement Techniques illustrates the average retention rates from different teaching methods. According to the chart, active learning is the most effective method of them all with a retention rate of 76% (2010). Correspondingly, some key approaches that can lead to student success consist of advising that encourages undergraduate research with faculty mentors, research experiences that stimulate active learning, student engagement in research conferences, and paid research assistantships that provide financial and academic support.

For these reasons, it is of great importance that attempts are made by institutions of higher learning to provide opportunities for undergraduates to actively engage in research. Recently, a number of retention and success efforts have been developed across the country. A few of the ways that some universities have successfully managed to do this is by offering courses in undergraduate research and holding conferences in which students are able to present their findings. Some funded programs at Texas A&M International University (TAMIU) such as the Building of Scholars and SYSTEM (Serving Youth in Science, Technology, Engineering and Mathematics) provide ample assistance for faculty in carrying out discipline-specific undergraduate research. The students working on these projects will have the opportunity to present at the Lamar Bruni Vergara & Guillermo Benavides Z. Academic Conference usually held in Spring semesters, other University-wide forums, and conferences outside the University.

The student learning outcomes expected from delivering core mathematics courses underpinning the students' mathematical experience in the categories of critical thinking, communication skills, and empirical and quantitative skills are spelled out below.

Core-Curriculum Learning Outcomes:

1. Critical Thinking: includes creative thinking, innovation, inquiry and analysis, evaluation, and synthesis of information.
2. Communication Skills: includes demonstration of the ability to communicate effectively by using *written* communication.
3. Empirical and Quantitative Skills: includes the manipulation and analysis of numerical data or observable facts resulting in informed conclusions.

The effective delivery of core curriculum in mathematics is vital needed for students to be successful in undertaking undergraduate programs in any discipline as seen in the core-curriculum learning outcomes. There are nine Foundational Component Areas (FCA), including one Component Area Option (CAO). The CAO may provide options for students to choose additional courses from the other FCA. At TAMIU, 6 Semester Credit Hours (SCH) of CAO has been broken down to three Areas, I, II, and III. Area I consists of 2 SCH of UNIV courses, Area II is 1 SCH of science lab courses, and Area III is essentially devoted to 3 SCH covering courses such as communication or foreign languages for students to choose from making a total of 42 SCH in FCA. Each FCA has a component description as definition, a set number of SCH required for completion of a component, and specified core objectives requirements. The nine FCA are:

I. Communication (6 SCH)
II. Mathematics (3 SCH)
III. Life and Physical Sciences (6 SCH)
IV. Language, Philosophy and Culture (3 SCH)
V. Creative Arts (3 SCH)
VI. American History (6 SCH)
VII. Government/Political Science (6 SCH)
VIII. Social and Behavioral Sciences (3 SCH)
IX. The Component Area Option (6 SCH)

After lengthy deliberations with faculty in all disciplines, TAMIU decided that the selection courses, as listed in Table 1 in the respective FCA, provide the core curriculum as required and sought the approval by THECB, thereafter.

Table 1. TAMIU Core Curriculum Courses

Prefix	Number

Communication (010) - 6 SCH		
ENGL	1301	English Composition I
ENGL	1302	English Composition II
Mathematics (020) - 3 SCH		
MATH	1314	College Algebra
MATH	1316	Plane Trigonometry
MATH	1324	Business Math I
MATH	2412	Pre-calculus
MATH	2413	Calculus I
Life and Physical Sciences (030) - 6 SCH		
ASTR	1310	Principles of Astronomy
BIOL	1306	Principles of Biology I
BIOL	1311	Principles of Biology II
BIOL	1370	Survey of Life Science
BIOL	1371	Human Biology
BIOL	2301	Anatomy & Physiology I
BIOL	2302	Anatomy & Physiology II
CHEM	1311	General Chemistry I
CHEM	1370	Survey of Chemistry
EPSC	1370	Survey of Earth Science
EPSC	2301	Atmospheric Science
GEOL	1303	Introduction to Physical Geology
GEOL	1305	Environmental Geology
PHYS	1370	Survey of Physical Science
PHYS	2325	University Physics I
PHYS	2326	University Physics II
Language, Philosophy and Culture (040) - 3 SCH		
ENGL	2322	British Literature through Neoclassicism
ENGL	2323	British Literature from Romantics-Present
ENGL	2327	American Literature to the Civil War
ENGL	2328	American Literature from Civil War-Present
ENGL	2332	Survey of World Literature to 1650
ENGL	2333	Survey of World Literature Since 1650
ENGL	2365	Literature and Film
PHIL	1301	Introduction to Philosophy
PHIL	2306	Introduction to Ethics
SPAN	2350	Introduction to the Hispanic World
Creative Arts (050) - 3 SCH		
ARTS	1303	Art History Survey: Prehistoric to Renaissance
ARTS	1304	Art History Survey: Renaissance to Modern
ARTS	2356	Photography I
DANC	1349	Ballet Folklorico
DANC	1351	Dance Performance
DANC	2303	Dance Appreciation
ENGL	2307	Introduction to Creative Writing
MUSI	1301	Music Fundamentals
MUSI	1306	Music Appreciation
MUSI	1310	American Popular Music

SPAN	2307	Introduction to Creative Writing - removed from Core 8/2/15
THAR	1310	Theatre Appreciation
		American History (060) - 6 SCH
HIST	1301	The U. S. to 1877
HIST	1302	The U.S. since 1877
		Government/Political Science (070)- 6 SCH
PSCI	2305	American National Government
PSCI	2306	American State Government
		Social/Behavioral Sciences (080) - 3 SCH
ECO	1301	Survey of Economics
ECO	2301	Principles of Macroeconomics
ECO	2302	Principles of Microeconomics
GEOG	1303	General World Geography
LEDR	2301	Principles of Leadership
PSCI	2301	Introduction to Political Leadership
PSYC	2301	Introduction to Psychology
PSYC	2314	Lifespan Growth & Development
SOCI	1306	Contemporary Social Problems & Social Policy
		Component Area Option (090) - 6 SCH
		Area I - 2 SCH
UNIV	1101	Learning in a Global Context I
UNIV	1102	Learning in a Global Context II
		Area II - 1 SCH
ASTR	1110	Principles of Astronomy Lab
BIOL	1106	Principles of Biology I Lab
BIOL	1111	Principles of Biology II Lab
BIOL	1170	Survey of Life Science Lab
BIOL	1171	Human Biology Lab
BIOL	2101	Anatomy & Physiology I Lab
BIOL	2102	Anatomy & Physiology II Lab
CHEM	1111	General Chemistry I Lab
CHEM	1170	Survey of Chemistry Lab
EPSC	1170	Survey of Earth Science Lab
EPSC	2101	Atmospheric Science Lab
GEOL	1103	Introduction to Physical Geology Lab
GEOL	1105	Environmental Geology Lab
PHYS	1170	Survey of Physical Science Lab
PHYS	2125	University Physics I Lab
PHYS	2126	University Physics II Lab
		Area III - 3 SCH
COMM	1315	Public Speaking
ENGL	2311	Technical Communication
FREN	1311	Elementary French
MAND	1311	Introduction to Mandarin Chinese - Non-Native Speakers
PORT	1311	Beginning Portuguese I
SPAN	1311	Introductory Spanish for Non-Native Speakers
SPAN	2313	Spanish for Heritage Language Speakers I

The delivery of the 2014 core curriculum courses, its implementation, and assessment need to occur simultaneously. Table 2 is an essential scheme to deliver and, also, to assess the course sequence periodically over a set period and duplicated thereafter. Students are allowed to transfer core curriculum credit to another institution or university within the state. The core courses are guaranteed to transfer to any Texas public colleges and universities as the students have already shown competency in the respective areas. For the 2014-2015, the following scheme has been implemented and the first cycle to be completed in Spring 2016 and repeated thereafter.

Table 2. Delivery of Core Curriculum Courses in Mathematics and Physics

Prefix	Number	Course Title	When Assessed	Core Objectives	Artifacts	Scheduled
Mathematics - 3 SCH						
MATH	1314	College Algebra	Fall 2014	CT	5 quizzes	During the semester
MATH	1316	Plane Trigonometry	Spring 2015			
MATH	1324	Business Math I	Spring 2015	COM: Written	Final paper (5 pages collected periodically)	End of the semester
MATH	2412	Pre-calculus	Fall 2015			
MATH	2413	Calculus I	Spring 2016	EQS	5 quizzes	During the semester
Life and Physical Sciences - 6 SCH						
ASTR	1310	Principles of Astronomy	Fall 2014	CT	Group project final report	End of semester
PHYS	1370	Survey of Physical Science	Spring 2015	COM: Written	Group project final report	End of semester
PHYS	2325	University Physics I	Fall 2015	EQS	Final exam	End of semester
PHYS	2326	University Physics II	Spring 2016	TW	Group project final report	End of semester
Component Area Option Area II - 1 SCH						
ASTR	1110	Principles of Astronomy Lab	Fall 2014	CT	Group laboratory experiment: individual lab report needed	During the semester
PHYS	1170	Survey of Physical Science Lab	Spring 2015	COM: Visual & Oral	PowerPoint group presentation with visual aids	End of the semester
PHYS	2125	University Physics I Lab	Fall 2015	EQS	Group laboratory experiment: individual lab report needed	During the semester
PHYS	2126	University Physics II Lab	Spring 2016			

Legends: CT: Critical Thinking Skills, COM: Communication Skills (Written, Visual, or Oral), EQS: Empirical and Quantitative Skills, and TW: Teamwork Skills

Assessment Rubrics

Assessment rubrics have been developed to measure whether these curriculum items will in fact be contained in the courses. Inclusion of the courses in the core curriculum is contingent upon the courses being offered and taught at least once every other academic year. The courses will be reviewed for renewal every five years. Each academic unit should understand that instructors teaching the courses will be expected to provide student work and to participate in the University-wide assessments of student effort. This includes, but may not be limited to, designing instruments such as rubrics, and scoring the work submitted by students in the courses. In addition, instructors of core curriculum courses may be asked to include brief assessment activities in their courses to let the students know that the course is part of the university core curriculum and will be subjected for the assessment. Assessment rubrics are available for each of the following:

1. Communication (COM)
2. Critical Thinking (CT)
3. Empirical and Quantitative Skills (EQS)
4. Personal Responsibility (PR)
5. Social Responsibility (SR)
6. Teamwork (TW)

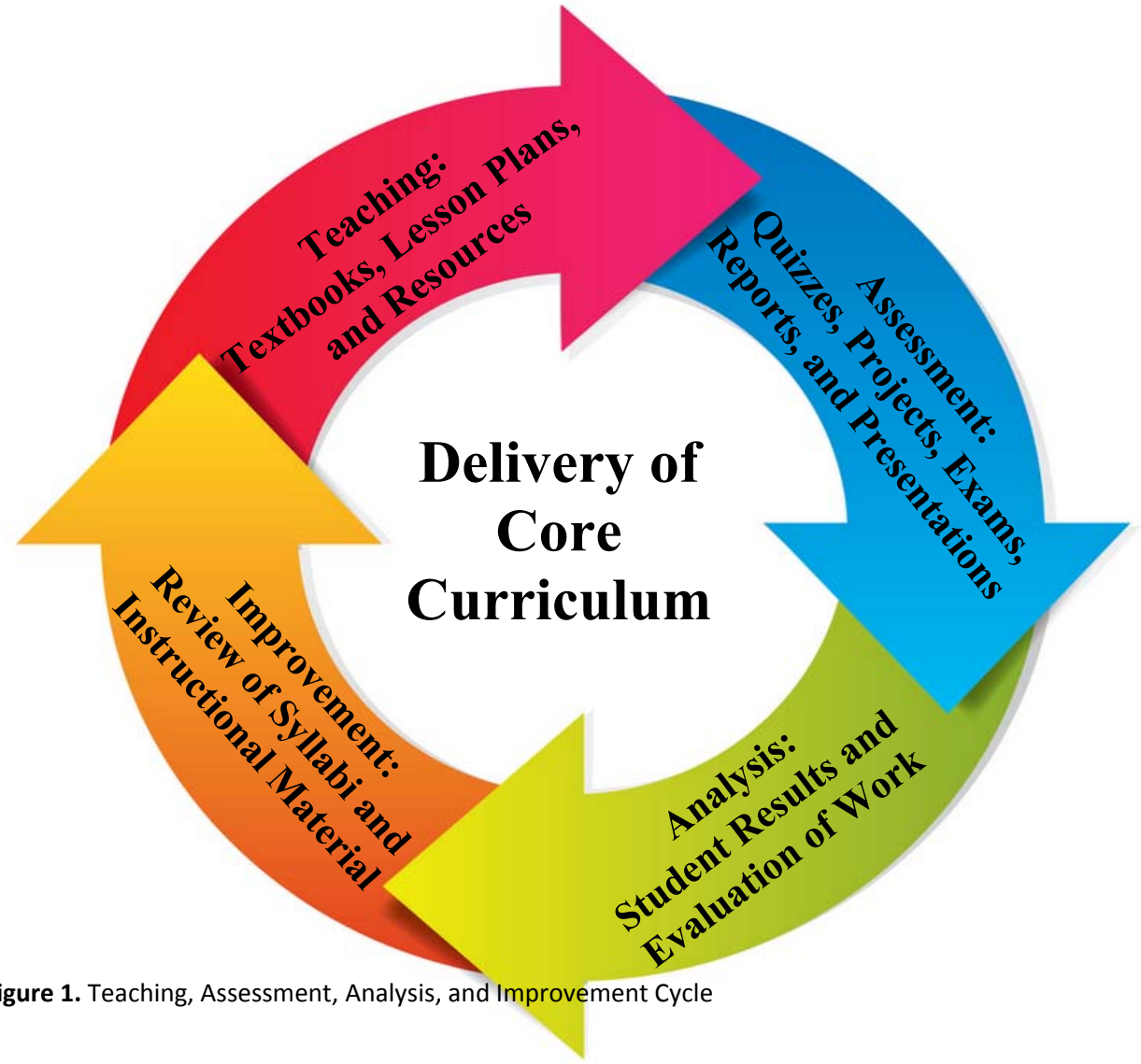

Figure 1. Teaching, Assessment, Analysis, and Improvement Cycle

All instructors, after teaching the core courses, will enter their respective data to these sites for each student. Moreover, teaching, assessment, analysis, and improvement cycle naturally occur in this implementation for continuous improvement of the course delivery. Figure 1 provides the cycle that needs to occur for a successful delivery of core curriculum courses that requires teaching, assessment, analysis, and improvement, if necessary.

University Support Service

The University Learning Center (ULC) uses its resources for walk-in-tutoring, SI (Supplemental Instruction sessions), and, in some cases, online tutoring for students taking core mathematics courses in order to meet the learning objectives since the new core in the State of Texas became effective Fall 2014. All mathematics core courses were provided sufficient assistance so that students will have the opportunity to complete 3 SCH of core curriculum in mathematics satisfactorily. Table 3 depicts that those who seek assistance through these ULC services were successful, as failures rate in these courses largely remained low. Technology can certainly play a role in this while it is student and faculty friendly. Teaching and tutoring go hand in hand for learning strategies to work. Therefore, the ULC plays a pivotal role in making sure the core curriculum is delivered effectively and, more importantly, successfully.

Table 3. University Support for Fall 2014, Spring 2015, Fall 2015, & Spring 2016

Semester	Title	Enrolled	SI Group	SI or Tutoring Group	SI and Tutoring Group	DFW Rate SI or Tutoring	DFW Rate SI & Tutoring
FALL 2014							
MATH 1314	College Algebra	525	118	304	88	21.05	12.50
MATH 1316	No SI						
MATH 1324	Business Math I	168	28	64	24	9.38	4.17
MATH 2412	Pre-Calculus	100	12	46	11	23.91	18.18
MATH 2413	Calculus I	143	65	86	44	27.91	22.73
Spring 2015							
MATH 1314	College Algebra	133	55	76	29	22.37	17.24
MATH 1316	Plane Trigonometry	38	0	8	0	25.00	0.00
MATH 1324	Business Math I	61	30	35	11	5.71	0.00
MATH 2412	NO SI						
MATH 2413	Calculus I	65	12	20	8	30.00	50.00
Fall 2015							
MATH 1314	College Algebra	568	98	273	63	16.85	9.52
MATH 1316	No SI						
MATH 1324	Business Math I	161	57	84	14	8.33	0.00
MATH 2412	NO SI						
MATH 2413	Calculus I	95	45	53	21	7.55	4.76

A similar support is available for Spring 2016 and beyond. However, most of the time, students take MATH 1314—College Algebra to fulfill the core mathematics requirement for their respective programs. This

course is offered in all Fall and Spring semesters including Summer semesters. Table 4 shows the extent of course delivery in terms of number of students and aggregates of DFWI (D's, F's, W's, and Incompletes).

Table 4. DFWI Rates for all Math 1314, College Algebra sections taught since Spring 2012

Year	2012			2013			2014			2015		
Semester	SP	SS+	FL	SP	SS+	FL	SP	SS+	FL	SP	SS+	FL
Total #	480	128	612	408	118	598	475	104	523	438	121	534
DFWI #	152	17	207	123	13	222	86	14	119	69	20	148
% of DFWI	31.67	13.28	33.82	30.15	11.02	37.12	18.11	13.46	22.75	15.75	16.53	27.72

+ Summer = both Summer I and II combined

Figure 2 shows the daily normal activities at the ULC. The students gather around a tutor or an SI instructor to go over the materials of the day or to learn how a particular problem is solved and the steps necessary for a solution.

Figure 2. ULC at Work in a Typical Day

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Conclusions

It is important that an academic institution be able to separate the course description from the course objectives. At the same time, these should be tied to a course description illustrating what the course is all about. The core curriculum learning outcomes and objectives provide the overall design structures that to be linked to the course description, and, broadly speaking, the educational statements suitable for the mission and course description. However, the precise measurable objectives will also tell the student how well they have accomplished the goals upon successful completion of the course. The student learning outcomes result from meaningful discussions around the question of what is expected from the same course taught state-wide. Finally, it is the time to be taken seriously about the effective delivery of core

curriculum in mathematics into fruition of undergraduate research capabilities and scientific interests among the students.

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