Best Practices in Academic Transformation

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Executive Summary

- Academic transformation is an approach that seeks to increase student learning outcomes and contain costs by focusing on the redesign of large introductory university courses.
- The approach makes use of technology to refashion the course activities according to one of five models: a supplemental model; a replacement or hybrid model; an emporium model, a buffet model and a fully online course model.
- The most frequently used model is the replacement or hybrid model.
- The large majority of course redesigns undertaken under the aegis of Carol Twigg and the National Center for Academic Transformation showed improvements in learning outcomes and completion rates.
- The most successful courses maximized student engagement, emphasized active learning and used technology to enable increased amounts of high-quality contact between faculty and students.
- The successful courses achieved these outcomes by increasing the amount of material made available online; using online quizzing and feedback mechanisms; making use of discipline-based computer laboratories; providing flexibility in course options; and maximizing student access to course help, either from an instructor or an undergraduate teaching assistant.
- In order for these approaches to work there the following conditions need to be met: there needs to be a high level of commitment and buy-in from administrators and departments; their needs to be a baseline level of academic technology infrastructure in place and technology and faculty development support needs to be provided; and a model for assessing and evaluating outcomes needs to be developed.

Best Practices in Academic Transformation

Academic transformation is the name given to an approach to using technology to fundamentally reshape how instruction happens in higher education. It is primarily associated with Carol Twigg at the National Center for Academic Transformation (NCAT) and their national project to redesign instruction at 50 colleges and universities around the nation[1]. Although primarily associated with the work of Carol Twigg and NCAT there are many other projects that also use the term and the methods of academic transformation. For example the Student Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) at North Carolina State University and the hybrid course programs at the University of Wisconsin-Milwaukee and elsewhere are but two examples of other initiatives that can be considered examples of academic transformation.[2]

Projects that use academic transformation tend to share a number of features that help define the approach.

1. A focus on large enrollment introductory courses (though the size can vary quite dramatically)
2. A focus on the redesign of a whole course
3. Rethinking the curriculum and the methods of instruction to include more active ways of learning
4. Using technology to facilitate this more active learning, most frequently by replacing passive lecture time with technology enhanced exercises.
5. A focus on improving student learning and increasing retention
6. A focus on using technology to help decrease the costs of instruction

The impetus toward academic transformation comes from a number of consistent concerns. These include:

- Problems with course completion rates in many large enrollment introductory or required courses
- The need to cope with high enrollment
- The need to alleviate problems caused by "chokepoint" and "roadblock" courses that inhibit student progress toward degree
- Inconsistency in course offerings
- Inability of students to apply knowledge learned to other courses
- Rising costs, and the need to contain these

Although, as indicated above the concept of academic transformation has been applied in a number of settings it is closely affiliated with the work of NCAT, whose projects give us a convenient sample with which to work and illustrate how various models were applied, with what levels of success. They also provide us with a way to illustrate which strategies hold the most promise, what challenges may face any institution seeking to implement academic transformation and what sorts of things need to be in place before

[1] See their discussions about academic transformation and descriptions of the projects at http://www.center.rpi.edu/

[2] See http://www.ncsu.edu/PER/scaleup.html and http://www.uwm.edu/Dept/LTC/hybrid/

efforts at academic transformation can be attempted. It is this task that the rest of the report takes on.

The information below is based on the reports produced by NCAT for both stages of their academic transformation, the initial Program in Course Redesign (which involved 30 campuses nationwide) and the follow-up Roadmap to Redesign Project (which involved an additional 20 campuses nationwide). One issue that this report will not cover is the issue of cost-savings. Although a focus on cost savings occupies an important role in the work on NCAT I believe that it is a weakness[3] in their approach (rather than a best practice which is my primary concern) and serves only to detract from the considerable insights that the projects offer in ways to improve student learning.

Academic Transformation Models

Academic transformation makes use of five different models:

- Supplement or models
- Replacement or hybrid models
- An emporium model
- A buffet model
- Completely online courses

Supplement model

In this model the lectures and class meetings remain constant but the course is supplemented with online materials and activities. Online quizzes and drill and practice feature strongly among these activities. In many cases the online materials and activities allow for class time to be reassigned to include activities more supportive of student learning.

Replacement or hybrid models

Here online activities and materials replace some portion of class time. Between a quarter and two thirds of lectures and section meetings are replaced by online materials and activities. In most cases the remaining class time is redesigned so as to enable a higher quality of interaction between instructor and students. For much of the analysis in this

[3] I would argue that the way that NCAT analyzes cost is deeply flawed. This is in part because their cost calculations are based on some faulty assumptions, including an assumption about the inherent fungibility of faculty time and the cost of that time (for example, if a faculty member is able to spend less time on a certain task it does not follow that the institution is able to recoup the costs of that time, as their analysis assumes), and about the possibility (and desirability) of replacing faculty with teaching assistants. Finally, the cost analyses are flawed because they exclude the costs of technology. Twigg (1999) argues that this is valid because a. universities are going to invest in technology anyway, b. the cost of technology is marginal compared to personnel costs and c. the costs of technology are falling. While it may be true that the vast bulk of university costs are for payroll the costs of technology are still considerable and following a program of academic transformation will involve investment in technology and faculty development infrastructure.

report I have elected to use the term hybrid rather than replacement as it has become the accepted term to describe this method of course redesign.

Emporium model

Here class time is completely replaced by attendance at a large lab containing computers loaded with discipline specific software. Students work online while instructors circulate and work through problems with students. Most emporium models retain some compulsory meeting time and format, such as a small group or section for students to discuss problems and experiences with the course.

Buffet model

Here students are offered a smorgasbord of options for working through the course materials. For example, in the redesigned statistics course at The Ohio State University students were given the option of online labs, live and online review sessions, small groups study sessions, large group problem solving, group projects and computer or TA graded assessments, among others. Students picked the option that worked best for their learning style, which was diagnosed using preliminary tests.

Fully online course model

Finally, a small number of course redesigns involved online courses. Some of these were always offered at a distance, but others moved all class materials online as part of the transformation.

Summary: Models Used in the NCAT Academic Transformation Projects

Model	**Supplemental**	**Replacement**	**Emporium**	**Buffet**	**Online**
No. Of Projects	6	27	8	1	5

Best Practices and Lessons Learned

The courses undergoing transformation studied and supported by NCAT all showed improvements in learning outcomes and course completion rates. The reported results available for the original 30 courses in the study are shown in the tables below.

Improved Learning Outcomes	**No Significant Difference in Learning Outcomes**	**Inconclusive Results with Learning Outcomes**
22	7	1

Improvements in Completion Rates	No Change in Completion Rates	Worse Completion Rates
23	3	3

However it is worth looking in some detail at the projects to identify best practices and challenges.

Best practices in the redesign model used

Clearly the replacement or hybrid model was the most popular with over half of all projects choosing this particular option. Projects choosing the replacement or hybrid model were more likely to report improved learning outcomes and completion rates than projects choosing other models. They also reported higher promise of sustainability and scalability. At some institutions (for example, the University of Central Florida) this model has been widely adopted beyond the scope of the original project and participation in the NCAT project.

This is not to say that the other models did not enjoy some success. The emporium model met with some success and has been widely copied. However, within the NCAT project (and beyond) it has largely been limited to the discipline of mathematics and there are some reports of it having some limits even in this sphere (see Paneck 2004).

Best practices in pedagogical strategies employed

Looking across all the academic transformation projects undertaken by NCAT a number of clear best practices emerge. A complete summary of methods used by all the NCAT courses and the best practices they identified is available in Appendix 1. In general terms the successful projects

- Maximized student engagement
- Emphasized active learning
- Increased as much as possible the "high-touch" aspects of the course by redesigning course activities

In more specific terms the successful courses shared in common a number of strategies.

1. They improved the amount of feedback a student received and the speed at which they received it. They did this in large part by moving a majority of quizzes and tests online.
2. Related to this, they provided students with a lot of opportunities to explore on their own and practice new material, again by offering a lot of online course materials, simulations and assessment exercises.
3. They provided students with a great deal of flexibility in where and how they could access course materials and help. At the same time however, the courses provided

very clear structure by providing students with detailed course outlines and in-person review sessions to clear up ambiguities and questions.
4. They provided students with a lot of material to engage them (and increase time on task) but also provided them with incentives where necessary to spend that extra time.
5. They maximized student access to help either by having roving instructors available to ask questions in labs, having 24/7 online help or having help and review sessions in person.
6. They utilized the class time freed up by having online assessments, tutorials and labs very wisely. Instead of having lectures they used the class time for class discussions, dealing with difficult material and problem solving.

In order to achieve these gains the projects did the following:

a) They made extensive use of off-the shelf software to add some of the interactive aspects of many courses.
b) They focused on redesigning the whole experience i.e. they did not focus just on "adding technology," but on the class as a whole. Thus much of the actual redesign work had little to do with technology but was made possible by time freed up because of the use of technology
c) They made extensive use of group work. This increased student engagement and peer learning as well as contributing significantly to students' group skills.
d) They increased student interaction by means of the group work above but also by using online tools such as discussion boards and groupware. This increased students' sense of community and intimacy, helped develop collaborative skills and frequently provided students with a source of help and support. The student interactivity also contributed to the focus on active rather than passive learning.
e) They move as many rote activities (such as grammar exercises) and simple communication of content online, freeing up in-person time for more engaging, complex and rich activities.
f) They made extensive use of undergraduate learning assistants who connected better with students, understood the course materials and had a better grasp of common misconceptions. This increased student access to course help in a cost-effective way.
g) The projects made extensive use of student computing laboratories as places where students could interact with online materials yet at the same time receive help from instructors. A good deal of the group work also occurred in these labs.

Conditions for Success

1. The successful programs also illustrate a number of things that need to be present in order to achieve success. For a summary of the issues and problems the projects encountered please see Appendix 2.
2. There has to be strong leadership and a strong commitment on the part of the department or program to do the project. It cannot be the domain or idea of a single faculty member or group of faculty members.
3. There needs to be buy-in to the project from all the major stakeholders.

4. The technical infrastructure needs to be in place to support the provision of online materials (for example the majority of projects reported making heavy use of an LMS and when this was not as robust as it might be they ran into problems).
5. Similarly, technical and faculty development support was a key variable and was a crucial element of success. We cannot assume that faculty have the skills necessary to implement the changes required and need support in order to be able to make these changes.
6. There needs to be an institutionalized mechanism within the program or course to seek and measure student and faculty feedback and there needs to be the flexibility in the plan to be able to make changes to the redesign and course materials where appropriate.
7. There needs to be a good model and good method of assessing outcomes. This was not present in most of the NCAT projects where the methods used were somewhat under-developed and relied too much on "horse-race" like comparisons between a treatment course and a control course. These methods are unreliable. Any institution or system pursuing academic transformation needs to develop a reliable and sophisticated assessment model.
8. The cost models that they developed were unrealistic, as described above. In order to carry out academic transformation in a cost effective way, new methods need to be developed.

References and Resources

National Center for Academic Transformation
http://www.center.rpi.edu/

- NCAT, Program in Course Redesign: Outcomes Analysis. http://www.center.rpi.edu/PCR/Outcomes.htm
- See especially
- Program in Course Redesign: Project Descriptions Sorted by Model http://www.center.rpi.edu/PCR/Proj_Model.htm
- The Roadmap to Redesign: Project Descriptions Sorted by Model http://www.center.rpi.edu/R2R/R2R_ProjModel.htm
- Round I Redesigns: Lessons Learned http://www.center.rpi.edu/PCR/R1Lessons.html
- Round II Redesigns: Lessons Learned http://www.center.rpi.edu/PCR/R2Lessons.html
- Round III Redesigns: Lessons Learned http://www.center.rpi.edu/PCR/R3Lessons.html

Paneck, Richard (2004) 101 Redefined. The New York Times 16 January 2005, http://www.nytimes.com/2005/01/16/education/edlife/EDTECH.html

Twigg, Carol A. (1999) Improving learning and reducing costs: redesigning large enrollment courses Report from the National Center for Academic Transformation, Saratoga, NY. http://www.thencat.org/Monographs/ImpLearn.html

Twigg, Carol A. (2005) Increasing Success for Underserved Students: Redesigning Introductory Courses. Report from the National Center for Academic Transformation, Saratoga, NY. http://www.thencat.org/Monographs/IncSuccess.htm

Appendix 1

Methods and Best Practices in Academic Transformation

Institution	Discipline and Course	Model	Lecture Replacement Method	Best Practices
University of Alabama	Spanish	Hybrid	1. Some class time replaced by guided online content. 2. Self-tests allow students to check their comprehension of the grammar, vocabulary and cultural sections. 3. Creation of e-portfolio	1. Online grammar exercises freed up class time. 2. Online videos freed class time for more productive discussion. 3. Integration of online components with specific assignments.
Portland State University	1st Year Spanish	Hybrid	1. Moved drill and practice online leaving class for oral communication 2. Online quizzing, writing and grammar 3. Small f-2-f groups in class time 4. Online chat as preparation for weekly f-2-f discussion.	1. Online materials allowed more effective use of class time 2. Increased student communication (online, in Spanish) increased skills. 3. Student self-monitoring via technology. 4. K-16 standards alignment.
Montclair State University	Spanish	Hybrid	1. During class sessions students cover communicative "real-life" tasks and cultural awareness 2. Supplemented with an online session covering grammar and vocabulary 3. Homework assignments, online workbook exercises, and other web-based materials. 4. Students can work in a staffed language lab	No final report available
University of Tennessee, Knoxville	Introductory Spanish	Hybrid	1. Online diagnostic homework assignments 2. Online quizzes 3. More active speaking exercises in freed-up class time	1. Moved vocabulary and grammar practice online to better use in-class time 2. Rich array of online resources 3. Improved feedback for students with online quizzes 4. The flexibility of the course structure allowed for continuous improvement of the course
Texas Tech University	Spanish	Hybrid	1. Section meet three times a week with class time devoted to communicative exercises	1. Careful division of learning activities between online and in-class

			emphasizing oral skill development. 2. Workbook, grammar, and writing components are online. 3. Online practice in grammar with automated diagnostic feedback 4. Students also participate in one hour of language lab weekly. 5. Studio sessions taught by TAs will be held for at risk students	2. Training for all teaching personnel. 3. Automated grading improved consistency and speed of feedback. 4. Improved assessment methods helped students better understand what they did and didn't know.
Drexel University	Computer Prog-ramming	Hybrid	1. Replaced lecture with online interactive materials to allow for self-paced learning. 2. Online modules accommodated different learning styles. 3. Moved a lot of course management online 4. Increased group work in a dedicated computer lab.	1. Increased student interaction 2. Online options encouraged greater communication between students and faculty 3. Students appreciated the flexibility of the partially online format
SUNY-Buffalo	Computer Literacy	Hybrid	1. Web-based tutorials 2. Diagnostic quizzes 3. Online mini-lectures 4. Online group activities	1. Use of undergrad TAs who proved better able to assist students 2. Increased lab hours which allowed students more one-on-one assistance 3. Self-paced learning materials allowed for individualization of learning experience
Brigham Young University	English Composition	Hybrid	1. Class supplemented with online learning materials. 2. In class time spent on group activities and peer learning 3. Increased individual contact between students and instructor 4. Increased use of peer learning groups.	Results inconclusive
University of Southern Mississippi	World Literature	Hybrid	1. Online lectures to supplement f-2-f lectures	1. Low stakes quizzes provided immediate feedback 2. Individualized on-demand help with writing skills from TAs 3. Accommodation of different learning styles.
Tallahassee Community College	College Composition	Hybrid	1. Use of online diagnostic tools to develop individualized learning plans 2. Interactive online tutorials 3. Online discussions 4. Use of online tutorial	1. Greater course consistency because of a menu of common assignments 2. Increased interaction among students

			service 5. Refocus of classroom time on more intense writing activities and individual attention	
Cal Poly Pomona	General Psychology	Hybrid	1. Class supplemented with online and CD-Rom lectures and course materials 2. Online proctored testing	None reported
Calhoun Community College	Statistics	Hybrid	1. Substitute a computer lab session for one of the three weekly class meetings. 2. Modular format 3. Use of software packages to provide automated tutorials, online exams, low stakes quizzes, and automated course management.	No full report available
University of North Carolina-Greensboro	Statistics	Hybrid	1. Classroom time spent on discussion of online assignments, resources,, learning issues and strategies. 2. Online, interactive, guided homework problems, practice tests, tutorials and assessment tools that promote active learning required. 3. Student progress monitored and both online and face-to-face assistance is provided . 4. Math Help Center will provides both online and face-to-face individualized assistance.	1. Online homework and tutorials. 2. Online quizzes 3. Tutoring
University of Illinois at Urbana Champaign	Economic Statistics	Hybrid	1, Shifted lectures to consultation period 2. Used a team and project oriented approach 3. Increased student feedback using interactive software 4. 24/7 online help	1. Online quizzing helped students attain mastery 2. Recitation sessions with TAs in the lab 3. Team based projects
University of Arkansas-Fort Smith	Psychology	Hybrid	1. One-hour weekly large-group overview lecture. 2. A one-hour weekly small-group facilitated recitation activity 3. A one-hour weekly online computer-based learning module using interactive software, short video segments, and mastery quizzes and exercises. 4. Use of a classroom response system 5. Undergraduate teaching assistants will assist with	No final report available

			record keeping, organizing materials and answering routine questions from students using the computer-based learning materials.	
Chattanooga State Technical Community College	Psychology	Hybrid	1. Online content including video segments, interactive activities with portfolio evaluation, mastery quizzing, discussions and simulations.	No full report available
East Carolina University	Psychology	Hybrid	1. Large master lectures one day a week. 2. Small discussion groups, online. 3. Online mastery quizzes.	No final report available
Georgia State University	Pre-Calculus Mathematics	Hybrid	1. Half of class time replaced by staffed computer math lab 2. Remaining class time used for problem-based-learning materials and group activities, 3. A course coordinator and a lab coordinator will be appointed to ensure greater consistency among the sections.	No final report available
Seton Hall	Pre-Calculus Mathematics	Hybrid	1. Math software, provides interactive, guided, homework problems and practice tests; online tutorials and assessment tools as well as student progress tracking. 2. Student sections attend two one-hour lab sessions and meet one hour per week in small groups for lecture/check-in with their instructors. 3. Additional small group tutoring is offered for at-risk students.	No final report available
Riverside Community College	Elementary Algebra	Hybrid	1. Participation in a computer math lab 2. More emphasis on and course progress linked to mastery	1. Use of instructional software for diagnosis and remediation. 2. Participation in math labs 3. Participation is special focus sessions on specific problems. Supplementary tutorial activities.
University of North Carolina-Greensboro	Pre-Calculus Mathematics	Hybrid	1. Use of math software for interactive, guided, homework problems and practice tests; online tutorials, assessment tools, student progress tracking and to generate personalized study plans for	1. Online homework, quizzes and tutorials. 2. Availability of help.

			students to enable them to master the skills in which they are deficient. 2. Classroom time to be spent on facilitating problem solving and mathematics skills. 3. Math Help Center will also provide both online and face-to-face individual assistance.	
Penn State University	Elementary Statistics	Hybrid	1. Changing of traditional recitation sections to computer-mediated workshops, 2. Online learning materials and testing 3. More emphasis on learning facilitation rather than information presentation.	1. Computer labs and group activities encouraged more active learning. 2. Readiness assessment tests increase time on task and give students feedback on progress and identify potential problems.
University of Central Florida	American Government	Hybrid	1. Online modules replaced some lectures. 2. Online group collaboration	1. Rich resources. 2. Increased interaction among students.
University of Colorado Boulder	Introductory Astronomy	Hybrid	1. Replaced large lecture with small learning teams led by undergraduate assistants in a wired group classroom 2. Course content delivered on-line	1. Undergraduate assistants proved very effective 2. Team collaboration worked well and contributed to student learning
University of Iowa	General Chemistry	Hybrid	1. Replaced lectures with online modular content, computer-based assignments, tutorial help, Web-based homework, and discovery-based labs.	1. More use of activity-based techniques in class and out. 2. Online learning resources increased time on task and mastery 3. The course now offered multiple options for learning
University of Wisconsin-Madison	General Chemistry	Hybrid	1. Eliminated one lecture and one discussion period per week and replacing them with a modularized, online system of diagnostic examples, tutorials, and quizzes	1. Online diagnostic homework made class time more effective 2. Online tutorials 3. Pre-lab tutorials and quizzes
University of Southern Maine	Introductory Psychology	Supp-lemental	1. Interactive online learning activities 2. Improved feedback using online quizzing 3. Use of modules calibrated student progress through the course	1. Online quizzes forced students to prepare for class 2. The quizzes helped students to grasp the material before moving on. 3. This was also encouraged by links from the quizzes to the relevant course materials
University of New Mexico	General Psychology	Supp-lemental	1. Weekly studio session led by undergrad TAs 2. Online course materials and interactive activities	1. Online quizzes that helped structure student learning and kept them on task 2. Studio session for at-risk students 3. More consistency among

				sections
University of Mass-Amherst	General biology	Supp-lemental	Lectures supplemented with: 1. Online class preparation pages 2. Online pre-class quizzes 3. Increased use of classroom response technology (clickers) to foster interactivity	1. Pre-class preparation using online activities vastly improved in-class discussions 2. use of clickers increased problem-solving skills
Fairfield University	General Biology	Suppl-lemental	Lectures were increased in size but supplemented with small recitation sessions and the use of online activity-based modules. Also incorporated collaborative use of laptops into in-class activities	1. Use of modules increased the breadth of information to which students were exposed. 2. Facilitated more team-centered learning due to the questions and discussions raised by the Web sites. 3. Online activities extended the learning process beyond the lab.
Indiana University-Purdue university Indianapolis	Introductory Sociology	Supp-lemental	1. A new common format for all sections. 2. Online learning modules and threaded discussions, an interactive research module and interactive computer-based testing	1. Collaborative work on an online research module 2. Online testing freed up class time 3. LMS allowed faculty to monitor student progress
Carnegie Mellon University	Statistics	Supp-lemental	Lectures were not replaced but were supplemented with an intelligent tutoring system	1. Intelligent tutor meant increased feedback to students and more active learning
Ohio State University	Introductory Statistics	Buffet	1. Discovery labs 2. Live and online review sessions 3. Small group study sessions 4. Oral and written presentations 5. Active large group problem solving 6. TA or auto-graded homework assignments 7. Individual or group projects	1. Students self-tested their learning styles and chose options that worked best for them 2. Help lab staffed by faculty and TA's throughout the day 3. Taxonomy of learning objectives linked all components and provided a class framework
Northern Arizona University	College Algebra	Emp-orium	1. created a lab where students were able to use math software to work through problems and receive individual assistance and tutoring	1. The software encouraged more time on task 2. The lab environment fostered more interaction 3. Students could work at their own pace
Virginia Tech	Linear Algebra	Emp-orium	Sections were replaced with the Math Emporium, a 500-work station computer lab, staffed by faculty, teaching assistants and undergraduate peer tutors who provide one-to-one onsite help. A Web-	1. Online tutorials 2. The emporium model 3. Online video lectures and notes 4. Online weekly practice quizzes

			based resource system (interactive tutorials, computation examples, an electronic textbook, and online quizzes) increased student feedback and allowed 24 x 7 access to course materials.	
University of Idaho	Intermediate Algebra, Algebra and Pre-Calc	Emp-orium	1. Math lab using commercial math software 2. Students also worked in groups with faculty and TAs in the lab 3. Online streaming mini-lectures 4. Online course materials 5, Students met weekly in "focus groups" to coordinate activities and discuss experiences	1. The math lab changed students from passive to active learners 2. Abundant online resources 3. Weekly task lists that provided a breakdown of assignments and course structure 4. Weekly mandatory one-hour tutor training sessions
University of Alabama	Intermediate Algebra	Emp-orium	1. Time in a math focused lab working with math software and faculty and TA assistance	1. The math software supported multiple learning styles, quick feedback for students and easy monitoring of student progress 2. Students could do their math lab work at times convenient to them 3. Weekly compulsory 30 minute class session focused on problems
Louisiana State University	Precalculus Mathematics	Emp-orium	Replaced lectures with work using math software in a lab. Included weekly class meetings to review schedule.	1. The math software fostered active learning 2. Lab tutors 3. Comfortable computer labs at flexible hours 4. Weekly class meetings. 5. Weekly instructor meetings.
University of Missouri - St Louis	Precalculus Mathematics	Emp-orium	1. Students attend one weekly 50-minute class meeting and two 120-minute lab sessions in a math technology lab 2. Software-based online homework assignments. 3.Video lectures 4. Class meetings will introduce new material, provide examples, review past and future assignments, troubleshoot student problems and keep students on track.	1. Online assessment – more and better feedback. 2. Better student preparation for class time. 3. Structural support to facilitate student progress. 4. Accommodating diverse learning styles.
University of North Carolina at Chapel Hill	Precalculus Mathematics	Emp-orium	1. Students learn from textbook and an online software including problems, weekly low-stakes quizzes and other examinations.	1. One-on-one assistance afforded by lab. 2. Quicker feedback 3. Consistency across sections.

			2. Math lab with extended hours and staffing gives students flexibility 3. Opportunities to "test out" of modules helps students accelerate their progress.	4. Better accommodation of learning styles. 5. Rich assortment of learning styles
Wayne State University	Precalculus Mathematics	Emp-orium	1. Students use math software in a lab staffed by instructors. The software is also available remotely. 5 hours lab time per week is required. 2. Online textbook, video lectures, online exercises and practice tests.	1. The software addressed all learning styles and facilitated good feedback. 2. Awarding credit for lab attendance 3. Availability of help in the lab.
Florida Gulf Coast University	Visual and Performing Arts	Online	All content moved online	1. Low stakes quizzes – auto feedback 2. Online discussions of model essays
Rio Salado College	Precalc Math	Online	Was always offered at a distance	1. Consistent content coverage. 2. Individualized study and assessment
Iowa State University	Discrete Mathematics	Online	1. The course was modularized and self-paced and included online content and testing. 2. Online help sessions 3. Voluntary f-2-f recitation sessions	1. Continuous assessment and feedback 2. Improved communication 3. Improved interaction among students
University of Dayton	Introductory Psychology	Online	Nearly all lectures were replaced by online content. Interactive simulations and group activities were emphasized.	1. Online content allowed self-pacing 2. Online collaborative learning activities. 3. Improved communication

Appendix 2

Summary of Issues and Problems Reported by the First Round of NCAT Transformation Projects