Application for the Truly Innovative Teaching Award

Section 1

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Confirmation: Available for the Gala (Wednesday 5/4/22 @ 4:00 pm)

Section 2: The innovation, and application in class

The innovation was a 5 year project to

- Measure student confidence in their own abilities at **synthesis** and **evaluation**
- Measure student learning in objectives of **synthesis** and **evaluation**

Synthesis and evaluation are specifically chosen as the two highest levels of Bloom's taxonomy, where student confidence is usually lowest and where we might expect to stretch student learning. The seed for this project was planted by a series of Teaching Academy events, expanded and funded into my NSF Career award, and then taught by me in a series of Teaching Academy events. The success has been tracked over 5 years in my undergraduate and postgraduate courses and improved on at each stage by student and faculty evaluations. In the last two years, it has been unexpectedly but successfully applied to online learning in both synchronous and asynchronous settings. This innovation has used Team Based Learning, in conjunction with principals from the Affinity Research Group model. Team Based Learning (TBL) is a widely used method of the flipped classroom which, through the process of norming a high expectation level of student preparation, and facilitating the brainstorming process across all education and background levels, uses teams to determine a 'best' answer. The Affinity Research Group (ARG) model is a method to establish research groups using principles of cooperative learning to provide the ideal environment for apprenticing undergraduate students into practices of scholarly and applied research.

The application in class consisted of

- measuring students preconceived levels of confidence, and levels of ability, in synthesis and evaluation, at the start of the semester
- measuring students perceived level of confidence, and level of ability, in synthesis and evaluation, at the end of the semester
- performing these two actions for 100-level Gen Ed classes, 300-level Viewing a Wider World Classes, and 600-level graduate classes, over 5 years.

For the purposes of teaching, the TBL and ARG models both use a cooperative framework to create an environment in which students of varying levels of expertise, capabilities, interests, and backgrounds, develop knowledge, confidence and a love for life-long learning. Preparation expectations on students are high, but in class activities are low risk. This combination encourages everyone to contribute a solution to a problem, then for teams to synthesize and evaluate those solutions, and finally to determine the best solution as a class. My funded NSF career award was based of combining, and then testing the effectiveness, of these complimentary techniques in my teaching and research.

Section 3: Relation between innovation and Teaching Academy

I was first introduced to Team Based Learning in two courses at the Teaching Academy

- "Transform Your Teaching with Team-Based Learning", 2013
- "Team Based Learning: Designing Group Work that Really Works", 2014

As I had also completed

- 'Teaching Scholars', a semester-long Teaching Academy course, 2010
- 'Effective Teaching' a 2-day Teaching Academy course (by Dr Felder), 2013,

the principals of the flipped classroom were immediately clear. However the additional elements of using permanent teams to ensure student preparation for class, and applying the TBL principals of effective application design (in order to then strive for the highest level of student confidence and student learning) were both new and (to be honest) not believable. However, as a scientist the concept of believability doesn't matter as much as testability. When it came to submitting by NSF Career grant that year I decided to blend TBL and ARG into a scholarly activity to test the effectiveness of these two complimentary methods. In the following years, after measured success with the method (See section 4 below) I team-taught 2, week-long, courses at the Teaching Academy

- "Team Based Learning", 1 week course, Summer 2016, taught by Laura Madson and James McAteer
- "Team Based Learning", 1 week course, December 2018, taught by Bill Roberson, Tina Reimers, with Laura Madson and James McAteer.

The 2018 TBL course was followed up in the spring of 2019 with one-on-one support with each of the cohorts as part of a funded Teaching Academy initiative in implementing TBL at NMSU. I was one of the mentors during that semester. Since 2018 I have been an NMSU Teaching Academy Fellow, based of my eagerness to both teach and learn TBL. Of course, following the quote often promoted by NMSU Teaching Academy, "Who dares to teach must never cease to learn" (John Cotton Dana), I have continued to apply principals from more TBL Teaching Academy Courses:

- "Team Based Learning in Calculation-Heavy Courses: Lessons Learned", 2015
- "Designing Successful Group Activities in Your Discipline", 2016
- "Getting Our Students to work in Every Class - Fast-Paced Formative Feedback Techniques to Facilitating Collaborative Problem Solving in a Flipped Course, 2017

In the spring 2020, when COVID restrictions moved us all online, my incorrect initial assumption was that TBL could not work in that setting. However, yet again I was happy to consider myself wrong, through my participation in:

- Short Course, "Scientific Teaching", National Institute of Scientific Teaching, 2020 6 week course on the scientific approach to maximizing online learning, in which I was sponsored by the Teaching Academy
- Book Club / Short Course, "Teaching and Learning STEM", Fall 2021.

Once again, based off my time at the Teaching Academy I tested TBL principals and found they could be successfully implemented online, both synchronously and asynchronously, at all levels.

Section 4: Evidence that innovation positively affected student attitude, motivation and/or learning

I present three sets of evidence, one that demonstrates the positive affect on student attitude, one that demonstrates the positive affect on student learning, and one that focuses on online learning circumstances. To show a positive effect on student attitude, First, I show a survey from my 300-level Viewing a Wider world class.

Table 1

	Pre-Course		Post-Course	
	Yes	No	Yes	No
My experience in team work are				
I have taken part in in-class group work in classes at NMSU.	23	1	27	1
I have taken part in small group learning (e.g., think-pair-share).	22	2	27	1
I have had assessed group work count as part of some of my grades.	22	2	28	0
I think that a lecturer should just stand up and lecture and I can learn by listening	12	12	2	26
In team work I end up doing most of the work in order to make sure I get my grade	16	8	2	26
I dislike team work as I am shy to interact	10	14	5	23
I worry some people might see I know very little about the material	10	14	3	25
I dislike team work as I worry some people might see I am not trying	5	19	3	25
I enjoy teamwork as it gives me a chance to express myself	8	16	21	7
I learn best in an interactive setting.	19	5	25	3
I enjoy teamwork as it help me learn more about how I learn	10	14	22	6
I am confident that I can contribute to team work	21	3	27	1
I know how to stop someone from excessively dominating a team	11	13	19	9
I am a leader in teamwork.	11	13	16	12

Below are a selection of student feedback from the same course.

"*Teams were extremely influential in the learning process, it was great getting help from peers and understanding point of views","Liked the group work, it helped me to understand things that confused me","The professor provided a challenging environment that helps the students to excel instead of punishing them", "I was scared to take a team-based learning class, but once we got going, and I saw how fairly everything was graded, I really liked it. It was definitely a new experience, and I recommend this class for those who absolutely despise group work. They might change their mind about it", "What I loved the most in this class is the fact that Prof McAteer has found a way to teach a whole lot without stressing out the students*"

From these data and student feedback, I conclude that TBL shows a success in growth a positive attitude towards learning in a TBL setting in an undergraduate course and that the ARG principal of obtaining low-risk, shared solutions, to hard questions, in a inhomogeneous set of student backgrounds and expectations, is a benefit to learning.

Second, can the same growth be found in a math-heavy graduate course (where student expectations on difficulty and content are much higher)? Below are a selection of student feedback from my 2019 TBL 600-level course, "Heliophysics":

"I felt welcomed in the class, I wasn't afraid to try to answer questions and get them wrong", "Pre-class readings were rewarded with quick 3-question (or less) quizzes that that was enough incentive to study and restudy the Reading and Class Notes material beforehand","The group collective often would hone in on the proper answer after

some discussion of each member's rationale. That allowed me to see my own errors as well as my classmates' errors - which is enlightening in itself (illustrating how something could be mis-interpreted)", "The quizzes at the beginning of class felt fun (as fun as a quiz can get at least). I love the scratch off multiple choice cards, and I loved the format of doing the questions individually then doing them as a team","it was extremely effective in learning what is normally a very challenging topic (E&M in plasmas)"

From these comments, I conclude that TBL builds student confidence in learning, through demanding student preparedness, allowing (and norming) all incorrect answers to low-risk in-class activities, and then **synthesizing** and **evaluating** those answers (the two highest level Blooms taxonomy activities)

Third, to measure any positive effect on student learning, I show the % of students who pass / fail exam questions in these two levels of Blooms learning taxonomy, in my 100-level Gen Ed learning objectives, pre and post class from 2016 to 2018.

Learning Objective Blooms level	**Fall 2016**		**Spring 2017**		**Fall 2018**	
	Pre - Class test (% pass)	**Final Exam (% Pass)**	**Pre - Class test (% pass)**	**Final Exam (% Pass)**	**Pre - Class test (% pass)**	**Final Exam (% Pass)**
5 - Synthesis	60	84	55	82	53	85
6 - Evaluation	45	76	51	82	47	72

The key here is although the high-level (synthesis and evaluation) objectives make up a minority of my module objectives in a 100-level course, they should, nonetheless, be present. It is TBL that enables these to be successfully included.

Finally, could these positive effects on student attitudes and learning be used effectively online? Below are a selection of online student comments from asynchronous spring 2021 and fall 2021

"In this class, … I was cracking under the pressure but then all the other students got together to help each other out, and I began to slowly ease the pressure of myself.","I was able to learn even more when I was tasked with finding answers. It was not a simple pathway to find the answer and in the process of finding the answer I had a full view of what we were talking about", "I felt as if communication amongst the students is just as important as communicating with instructors", "I really did like a lot of the group discussions as well as the google presentations and talk to other students"

And from the sudden Spring 2020 sudden switch to synchronous online classes

"He even made his instructional elements functional during the COVID on-line portion of the class with effective use of breakout rooms and assigning a facilitator to assist with interruptions", "The instructor was also very understanding and helpful during the transition to online, maintained active learning through breakout rooms and in class problems, and made sure we were able to get as much out of the course as we could given the situation"

The NMSU Teaching Academy planted the seed of TBL into my teaching and I intend to continue to both teach and learn this technique for decades to come.