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Application Summary

Competition Details

Competition Title:	2020 Scholarship of Teaching and Learning Award
Category:	Institutional Awards - CTL
Award Cycle:	2020
Submission Deadline:	03/02/2020 at 11:59 PM

Application Information

Submitted By:	Raghuram Pucha
Appplication ID:	4343
Application Title:	Raghu Pucha
Date Submitted:	03/01/2020 at 10:18 PM

Personal Details

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Primary School or Department
Woodruff School of Mechanical Engineering

Primary Appointment Title:	Eugene C. Gwaltney, Jr. Professor and Chair

Application Details

Proposal Title
Raghu Pucha

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Georgia Tech | The George W. Woodruff School of Mechanical Engineering

March 2, 2020

Scholarship of Teaching and Learning Award Selection Committee
Center for Teaching and Learning
Georgia Tech

Dear Selection Committee Members:

I am delighted to nominate Dr. Raghu Pucha, Senior Lecturer, School of Mechanical Engineering, Georgia Tech for the CTL *Scholarship of Teaching and Learning Award*. Dr. Pucha constantly thrives to improve his classroom teaching methodologies through curriculum innovations and uses every opportunity to educate himself with pedagogical aspects of teaching and learning. He has initiated multiple collaborative efforts on scholarship of teaching and learning (SoTL) projects to systematically study the impact of learning-centered teaching methodologies on performance and learning of his students. Some of these class-room projects and learning-centered activities are listed here.

Dr. Pucha was one of an exclusive group of faculty members selected to participate in the Inaugural 2008 Class of 1969 Teaching Scholars Program, CTL (Center for Teaching and Learning) based on his dedication to improving student learning initiatives. Through this initiative, he implemented *peer-assisted learning* strategies and *undergraduates teaching other undergraduates'* methodology by inviting his previous students to interact with his current students on selected topics. Many students mentioned in the course surveys – how their learning attitudes changed inspired by Dr. Pucha's teaching methodologies. One of the Fall 2010 students said in their course evaluation, "*Absolutely loved this class I felt like I learned more than the scope of the course through the instructor's refreshing approach. I loved how learning the concept was more than the grade because I was more motivated to learn and retain that*".

Dr. Pucha's proposal has been selected (in Spring 2009) through *LITEE National Dissemination Grant Competition*, sponsored by NSF, for conducting research on the impact of *case study methodology* on student learning. He implemented innovative problem-based and collaborative learning methodologies in his large classes with *formative assessment* to continuously improve and personalize his students' learning experience. A course survey comment from a student of Dr. Pucha is worth mentioning here. *"Dr. Pucha is an excellent instructor. Communicates material in an engaging and exciting way. I learned a huge amount from Dr. Pucha, not only about the use of CAD tools and design process, but also how to think and tackle REAL problems like an engineer. Dr. Pucha makes a huge impact on his students, and they are better prepared for their academic and professional careers after taking his class. This man makes engineers."*

Dr. Pucha was a 2015 CTL Teaching Scholar to collaboratively explore research and best practices in developing creative and critical thinkers in class room. Through this effort he introduced process-oriented creative intervention strategies that are designed to teach metacognitive skills that support creativity in encouraging students to think outside their usual ways of thinking. This resulted in increased student engagement. Some course survey comments from Spring and Fall 2016 are quoted here: *"The best aspect of the course was how the assignments allowed for students' creativity to flourish."* and *"The individual assignment was the best part as I had the opportunity to create anything that I want and something that is realistic that I was quite proud of at the end of the semester"*

In Spring 2016 Dr. Pucha received Instructional Mini-Grant from CTL for projects which promote reflection in learning and instruction. Through this grant a design ideation competition was conducted in two experimental sections (total of about 90 students) and two control sections (total of about 90 students – 9 teams in each section) on using conventional and creative ideation methods in preliminary design. Through student presentations and reflection activity the effectiveness of creative intervention strategies was measured. The students' reflection on creative intervention strategies were very positive and overwhelming, and one of the students, for example, says, *"Creative intervention strategies helped me to think more creatively and challenged me to think outside of the box and to tear down any mental blocks that were keeping me from an idea. They increased my interest and made me appreciate the sketching because it was much easier to plan out my creative process by hand than doing everything on the computer"*

In January 2016, Georgia Tech launched a campus-wide academic initiative ("Center for Serve-Learn-Sustain") aimed at preparing undergraduate students in all majors to use their disciplinary knowledge and skills to contribute to the major societal challenge of creating sustainable communities. Dr. Pucha was selected as inaugural Serve-Learn-Sustain Food, Energy, Water Systems (FEWS) Fellow to implement sustainability aspects in the curriculum. Dr. Pucha developed a socio-technical project-based teaching model with contextualized design problems that incorporate social justice and environmental sustainability through both individual and team projects in a cornerstone design course. Dr. Pucha has seamlessly integrated sustainability aspects in the engineering curriculum to develop sustainability system-thinking skills in students and to understand the social, cultural and environmental impact of professional practice along with discipline-specific knowledge. His curriculum framework, recently published as a book chapter, can be extended to teaching many engineering courses with socio-technical projects with authentic activity and context.

The above mentioned SoTL projects substantiate the fact that Dr. Pucha strongly believes in continuous improvements in course curriculum and delivery methodologies. Dr. Pucha's main concern and priority have always been his students and their learning. Dr. Pucha's teaching excellence is well known among our undergrad students as well as his peers. His innovative learning-centered teaching methodologies, scholarly interest and commitment to excellence in undergrad teaching and learning in core courses, his unique ability to engage, challenge and support students through curriculum innovations, and his influence on students' lives beyond classroom make him uniquely qualified to receive this *Award*.

If you have any questions concerning this recommendation, please do not hesitate to contact me at sgraham@gatech.edu or 404-894-3201. Thank you for considering.

Sincerely,

Samuel Graham, Jr.
Eugene C. Gwaltney, Jr. Professor and School Chair

Teaching Philosophy and Pedagogy

A teacher should facilitate learning with the goal of reaching every student in the class through enthusiasm and expertise to stimulate interest in the subject matter with a global perspective. The essential components of my teaching philosophy to achieve this goal include:

- Understand and respect student learning needs.
- Personalize students' learning experiences
- Transfer learning responsibility to students,
- Create more learning opportunities through formative assessment and feedback
- Challenge students with summative assessment at various Bloom's taxonomy levels.

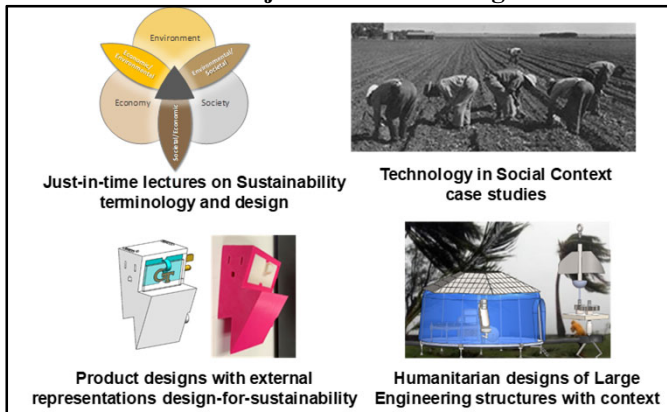"*Teaching is the highest form of understanding.*" Teaching should stimulate active, not passive, learning and encourage students to be critical, creative thinkers, with the capacity to go on learning after their college days are over. Teaching build bridges between the teacher's understanding and the student's learning[1]. Pedagogical procedures must be carefully planned, continuously examined, and relate directly to the subject taught.

Following pedagogical procedures, the underlying research questions, objectives and impact on students' learning with evidence is presented here.

(1) Learning-Centered Instruction
(2) Creative and Critical thinking interventions for convergent thinking
(3) Socio-technical project-based learning with context (*sustainable communities* framework)
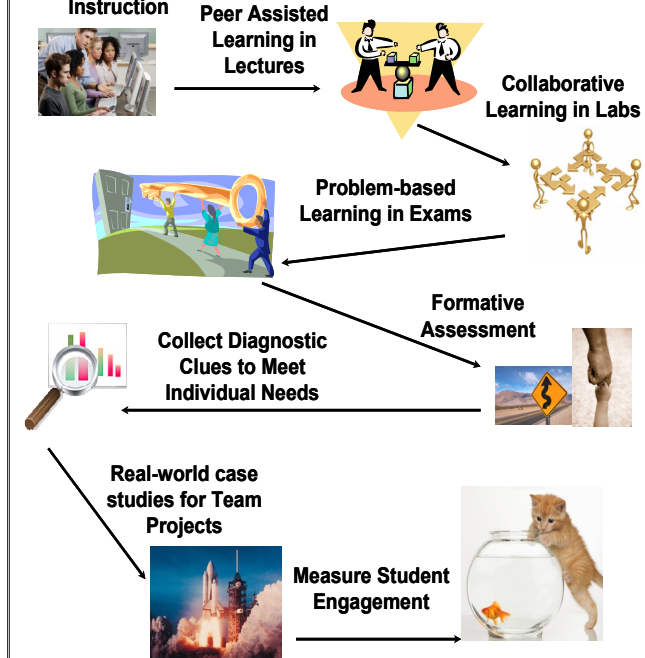(4) Process-oriented approaches to content-intensive courses.

Pedagogical procedures (1), (2) and (3) are planned and implemented in ME 1770, a freshman corner-stone design course. Pedagogical procedure (4) is planned and implemented in ME 3180 (Machine design) course.

1. Learning Centered Instruction

Peer Assisted Learning in Lectures

Collaborative Learning in Labs

Problem-based Learning in Exams

Formative Assessment

Collect Diagnostic Clues to Meet Individual Needs

Real-world case studies for Team Projects

Measure Student Engagement

2. Creative and Critical Thinking Interventions

Creative Thinking
Exploratory, Nonjudgmental, Imaginative, "what if?", Divergent and playful

Interactive Divergent and Convergent Thinking

Critical Thinking
Evaluative, Selective, Analytical, Fact based, Convergent and Logical

3. Socio-technical Project-based Learning with Context

Just-in-time lectures on Sustainability terminology and design

Technology in Social Context case studies

Product designs with external representations design-for-sustainability

Humanitarian designs of Large Engineering structures with context

4. Process-oriented Approaches to Content-Intensive Courses

Process- Oriented Approach
- Home Works (text-book problem-solving)
- Two Take-home exams (process-oriented)
- Team Project (process-oriented)
- Final Exam (text-book problem-solving)
- Use of Prior Knowledge in CAD and Analytical Tools Optional

Content-Centered Approach
- Home Works (text-book problem-solving)
- Two time-bound exams (text-book problem-solving)
- Final Exam (text-book problem-solving)
- Use of CAD and Analytical Tools Optional

Integrated Approach
- Home Work (Process-oriented problems)
- Two time-bound mid-term exams (problem-solving)
- Team Project (Process-oriented)
- Final time-bound Exam (Problem-solving)
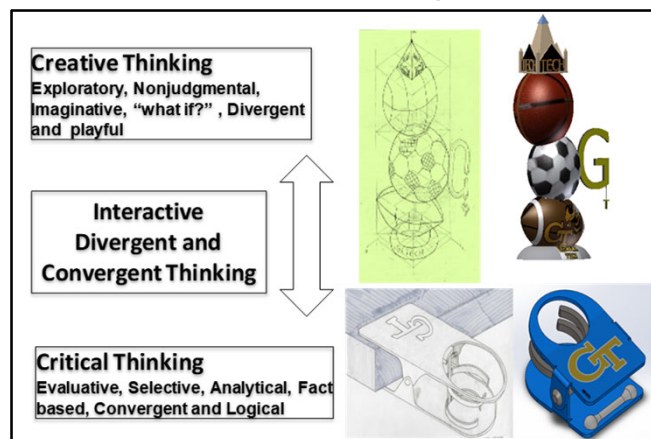- Mandatory to use Prior Knowledge in CAD and Analytical Tools for home works and Projects

[1]Boyer, E.L. Scholarship Reconsidered. *The Carnegie Foundation for the Advancement of Teaching* (1990)

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2. Creative and Critical-thinking Interventions
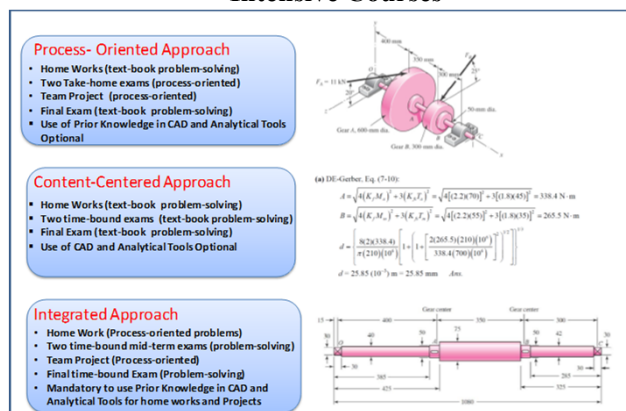
Teaching / Learning Issues & Challenges

Teaching divergent inquiry and creativity during conceptual design ideation is neither fully recognized nor incorporated well in Engineering Curricula. There is lack of knowledge of instructional intervention strategies to help students be more creative. There is lack of knowledge on the open-ended nature of creativity activities, student perception and its impact on student learning. Universities teach creative thinking skills to a much lesser extent, perhaps because of a lack of understanding of how we define creativity[1]. **There are several open research questions** on design pedagogy and how effective inquiry, the systematic interplay between divergent and convergent questions, can be taught and promoted as part of engineering education. There are also unanswered questions about what defines creativity, how it can be measured, and how it relates to other characteristics of design thinking.[2]

Pedagogy / SoTL

Creativity cannot be taught decontextualized – out of context – as a special skill[3]. **Process-oriented intervention** strategies that are designed to teach metacognitive skills to support creativity are used in encouraging students to think outside their usual ways of thinking. **Un**conventional **T**hinking **i**n **E**ngineering **D**esign (**UnTiED**) ideation with design heuristics cards that involve a series of **divergent and convergent thinking** are introduced in design projects.

Research Questions and Objectives

- What are students' perceptions about the use of specific practices to foster ideation as a part of the conceptual design process?
- How can an instructor in an engineering course using ideation methods for design assess the creativity and quality of student work produced by these methods?
- How do the proposed interventions lead to engaged learning in corner-stone design course?
- Develop rubrics that combines both domain-specific and creativity-relevant skills to evaluate student design projects

Impact on Student Learning

Student Perceptions of Creative Ideations (open-coding)

Item	N	Mean	SD
The ideation methods were useful	40	4.20	1.16
The ideation methods enhanced my ability to think creatively	40	4.18	1.17
The ideation methods enhanced my ability to think critically	40	4.13	1.28
I will use the ideation methods in later classes, even when they are not directly assigned	40	4.05	1.26
The ideation methods improved my overall performance on the design assignments in this course	40	3.98	1.37
The ideation methods were enjoyable	40	3.93	1.35

Response Scale: 1 = Strongly Disagree to 6 = Strongly Agree

End of Course Survey	Spring & Fall 2015 Combined	Spring 2016
Total Respondents	322 (7 sections)	79 (2 sections)
Comments directly mentioning creativity	18 (6%)	30 (38%)
Comments with phrases: allowed/encouraged creativity	9	6
Comments with phrases: choice/freedom/ownership	9	16
Comments with phrases: great way to learn	-	3
Comments with phrases: fun/exciting/generates enthusiasm	5	7
Comments with phrases: multiple stages of design	1	5

"The ideation methods allowed me to think outside the box which in turn helped me make creative designs"
"They motivated me to think of things differently and come up with creative solutions."
"They gave me ways to think about a design that I would not have otherwise thought about."
"It helped me be more creative because it taught me how to think outside the box and how to come up with the idea that I did by thinking of new ways to innovate existing products".
"I want to say yes. I have always been passionate about sketching and designing and these ideation methods just fired up my interest in the subject even more."

[1]Pappas, E. (2002), Creative Problem Solving in Engineering Design, *ASEE Conference*, University of Florida, Gainesville.

[2]Dym, C. L., Agogino, A. M., Eris, O., Frey, D. D., and Leifer, L. J. (2005) Engineering Design Thinking, Teaching, and Learning, *Journal of Engineering Education* 94, 103-120.

[3]Törnkvist, S. (1998). Creativity: can it be taught? The case of Engineering Education. *European Journal of Engineering Education,* 23(1), 5-12.

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3. Socio-Technical Project-based Learning with Context

Teaching / Learning Issues & Challenges

Georgia Tech is well-known for its disciplinary excellence. However there was a disparity in student assessment of preparedness with respect to various skills from Georgia Tech's 2012 Baccalaureate Alumni Survey. More than 75 percent of Georgia Tech graduates rated their disciplinary skill preparation as high. Notably, fewer gave their "interskill" preparation a high rating with regard to effective work in a team or understanding the environmental, social, and cultural impact of their professional practice. This disparity provides one of the motivations for the **Center for Serve-Learn-Sustain (SLS)** as part of a new Quality Enhancement Plan (QEP). The initiative calls for faculty members from all six Georgia Tech colleges to develop courses and co-curricular opportunities that will help students learn about sustainability and community engagement and hone their skills by engaging in real-world projects with nonprofit, community, government, and business partners. Affiliated courses address various aspects of the Center's *sustainable communities* framework, which presents sustainability as an integrated system connecting environment, economy, and society. To prepare engineering students with critical perspectives and deep context for sustainability work without sacrificing disciplinary rigor is a pressing challenge[1]. **How to bring *sustainable Communities* framework into the engineering classroom through socio-technical project-based learning ?**

Source: 2012 Baccalaureate Alumni Survey **Statement:** **To what extent did Georgia Tech prepare you to**	**% saying well or very well prepared**
(Disciplinary skills)	
Identify, formulate, and solve problems in your discipline	87.6%
Use techniques, skills, and tools needed for the practice of your discipline	76.8%
Seek out new information needed for the practice of your discipline	75.5%
(Interskills)	
Function on multi-disciplinary or cross-functional teams	68.6%
Effectively resolve interpersonal conflict within a group or team	51.7%
Understand the social and cultural impact of your professional practice	**44.3%**
Understand the environmental impact of your professional practice	**40.4%**

**The possible responses are
1 (not prepared),
2 (somewhat prepared),
3 (prepared),
4 (well prepared), and
5 (very well prepared).**

Pedagogy / SoTL

A **situated cognition and learning pedagogical theory**[2] is adapted, where concept, activity, and context are involved in student learning to produce useable robust knowledge. A **socio-technical project-based teaching / learning model with contextualized design problems** is used to engage students throughout the course with Computer-Aided-Design (CAD) problems that incorporate *sustainable Communities* framework within both individual and team projects. A multi-faceted assessment is undertaken in an attempt to understand the impact of various Sustainable Communities intervention activities on student learning and perceptions of the course. The larger, GT-level initiative has several stated learning outcomes (SLOs), the primary goal of classroom-level assessment is to determine the level of understanding students possess with respect to SLOs, and in cases where use of a pre/post survey design is possible, to determine the extent of students' growth in understanding on these SLOs over the semester long course.

[1] Engineering justice : Transforming engineering education and practice. Jon A. Leydens and Juan C. Lucena. John Wiley & Sons. 2018.
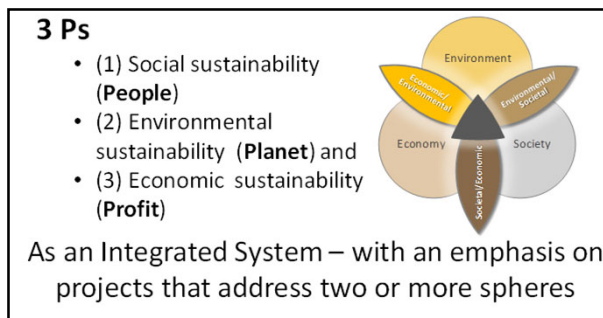
[2] Brown, S.J; Collins, A; and Duguid, P. (1989). "Situated Cognition and the Culture of Learning", *Educational Researcher*, Vol. 18, No. 1, pp. 32-42.

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3. Socio-Technical Project-based Learning with Context (Contd..)

Research Questions and Assessment

Research Question	GT SLS: SLO	Data
What are students' perceptions of the SLS intervention?	n/a	Pre & post student surveys
To what extent can students develop **sustainability system-thinking skills** *during the ideation, implementation, and evaluation stages of engineering design process?*	SLO1: Students will be able to identify relationships among ecological, social, and economic systems SLO3: Students will be able to evaluate how decisions impact the sustainability of communities	Post individual project written reflections Analyzed with: • Thematic analysis (Braun & Clarke, 2006)
To what extent can students develop understanding on the social, cultural and environmental **impact of professional practice?**	SLO4: Students will be able to describe how they can use their discipline to make communities more sustainable	• GT SLS developed rubrics

Approach for *Sustainable Communities*

3 Ps
- (1) Social sustainability (**People**)
- (2) Environmental sustainability (**Planet**) and
- (3) Economic sustainability (**Profit**)

As an Integrated System – with an emphasis on projects that address two or more spheres

Sustainability Systems Thinking Skills

- Systems thinking provides an understanding of a system by examining the linkages and interactions between the elements that comprise the whole of the system

  .
- **Sustainability system-thinking skills** include
  - Identify static / dynamic relationships among ecological, social, and economic factors of sustainability
  - Influence of context and evaluate how design decisions impact the *sustainability of communities*

SLS Interventions in the Course

Just-in-time lectures using GT-SLS center teaching toolkit

Technology-in-social-contexts activities intended to help students understand how social context can influence the success or failure of an engineering design

Individual projects address human wasteful behavior of resources and environmental sustainability through External Representations design-for-sustainability

Team projects address social, environmental and economic sustainability through community and SDG focused humanitarian design projects

Systems thinking, Bloom's Taxonomy

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3. Socio-Technical Project-based Learning with Context (Contd..)

Socio-technical project-based learning brings Context and Stakeholders to Design

Specifications

Constraints

Traditional Engineering Design

+

Context

Stakeholders

ACKNOWLEDGMENT: ANDREA MAZZURCO, PURDUE

In addition to technical constraints
- understand structural conditions[1] in designing the products (who suffers and who benefits.; Increasing opportunities and resources; Reducing imposed risks and harms; Enhancing human capabilities).
- Listening to community
- From "Design-for-Industry" to "Design-for-community"

FROM Beverage Mugs **TO** Designs Promoting Sustainable Resource-use

Individual Student Projects (No SLS intervention)
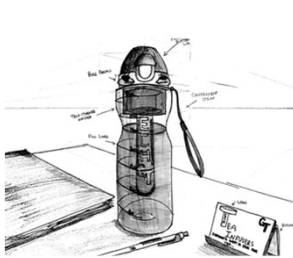
Individual Student Projects (SLS Affiliated Section)

External Representations Design : Promoting Sustainable Resource Use

Ideate / Sketch   **Design-for-Manufacturing & Assembly**
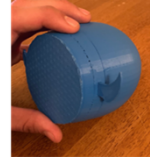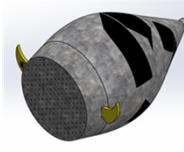
Water-saving Shower Head

FROM Movie / Cartoon Characters **TO** SDG* Focused Community Projects

Team Projects (No SLS intervention)
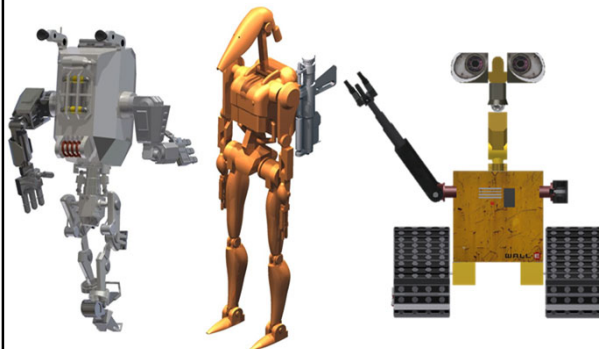
Team Projects (SLS Affiliated Section)

SDG / Challenge

Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable.

Multi-home Dehumidifier   Low-cost Dehumidifier   Dehumidifier with homegarden
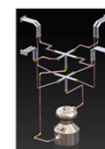
Low-cost dehumidifiers for Proctor Creek Watershed, Atlanta
*SDG: UN Sustainable Development Goals

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[1]Engineering justice : Transforming engineering education and practice. Jon A. Leydens and Juan C. Lucena. John Wiley & Sons. 2018.

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3. Socio-Technical Project-based Learning with Context (Contd..)

Impact on Student Learning

Pre and post-survey response analysis: Rate your understanding of the relationship between ecological, social and economic systems

	Excellent	Good	Average	Poor	Terrible
Pre	0	42.11	52.63	5.26	0
Post	18.75	75	6.25	0	0

- Socio-technical project-based learning with context: implemented in freshman engineering graphics course.
- Intervention with *external representations design-for-sustainability* for responsible use of resources: d in individual projects.
- Intervention with *socio-technical humanitarian design themes* in team projects
- Students see value in the SLS intervention, but note its limiting effects
- Students demonstrate grasp of basis elements of SLS systems - thinking

Individual project post activity reflection results

Student Reflection Results	Frequency
Three ways product design promotes sustainability & Relationship among 3 Ps (planet, people and profit)	
value-attitude	21
help-allowed-understand	16
social-environment-community-context-human	22
What did you learn by creating this product?	
design-innovate-solve	45
skill-experience-creative-learned	33
active-apply-think-improve-focus	24
ideation methods	9
How engineering discipline can make communities more sustainable	
challenged-appreciated-impact	26

"In your own words define sustainability"

Word cloud representation of post activity reflection

Pre-survey response

Post-survey response

"This SLS course has given me a new perspective on engineering and the overarching goals on which I should focus. Rather than being separate from the social, political, and economic issues of modern society, engineering coexists with these paradigms and can deeply impact all of them in unexpected ways"

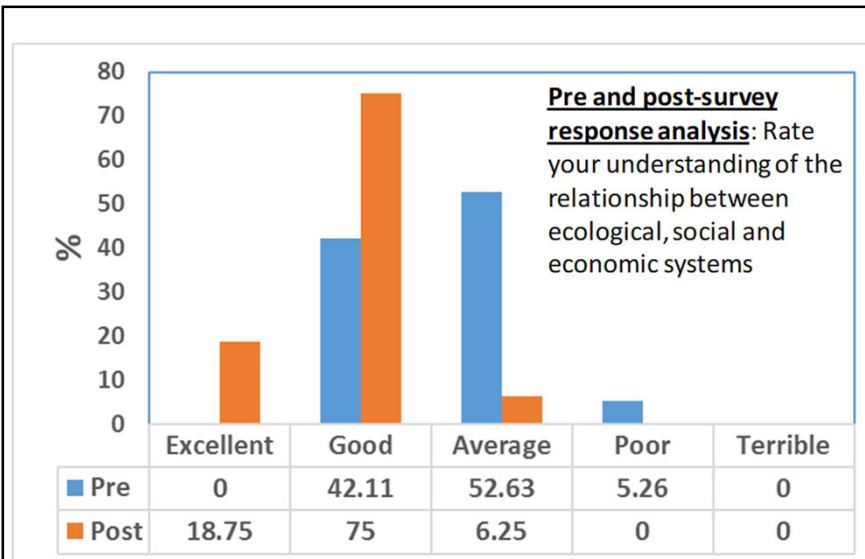*"I think this sustainable project challenged my previous conception of engineering design. Before, I believed engineering design was about finding and creating a new idea; however, what I have learned is the importance of developing current ideas for a greater purpose of improvement."*

"This sustainability theme has helped me see how engineering can help others and the community around me. Since I value my community and love helping, this project helped me rediscover my passion for engineering and using sustainability to help those around me."

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4. Process-oriented Approaches to Content-Intensive Courses

Teaching / Learning Challenges and Pedagogy

Content-intensive core courses in Mechanical Engineering, like *Machine Design,* traditionally are taught with information-based lectures where student's learning is tested with time-bound tests and exams. The content-based lectures leave little time for students to acquire a deep understanding of the subject. Learning is not committing a set of facts to memory, but the ability to use resources to find, evaluate, and apply the information[1]. **How to balance process-oriented activities in content-intensive courses?**

Pedagogy / SoTL

Edelson[1] has argued that teaching / learning methodologies have traditionally seen content and process as competing priorities. **Integrating content and process** together in the teaching/ learning activities offers the opportunity to increase students' experience with authentic activities while also achieving deeper content understanding. It is also well established that **prior knowledge activation[2]** has strong facilitative effects on learning. Prior knowledge provides learners with a relevant context in which new information can be integrated.

Research Questions and Objectives

- Why students performed bad in traditional final exam in Process- Oriented Approach?
- Does learning of fundamentals (content understanding) got diluted in Process-Oriented Approach ?
- What are the positives in Process- Oriented Approach ?
- Did students learned better in Integrated Approach compared to Process- Oriented Approach and Content-Centered Approach ?
- Did Integrated Approach students gain more without compromising on fundamental content understanding?
- In **Integrated Approach**: How the prior knowledge in CAD from ME 1770) and programming in MATLAB (ME 2016) has helped students understand design of mechanical elements for functionality and parametric analysis?
- Are the students relatively more engaged in Process- Oriented and Integrated Approaches compared to Content-Centered Approach ?

Impact on Student Learning

Which approach provides the best results?

Comparison of Student Performance									
	HW1	HW2	Exam1	HW3	HW4	Exam2	HW5	Project	Final
Process-Oriented Approach - Fall 2011 (N=90)									
Avg. (%)	82.60	60.40	87.81	80.96	73.10	95.87	73.06	85.40	60.64
Sdev	4.63	10.54	16.73	8.24	12.22	5.18	9.78	23.95	10.98
Integrated Approach - Fall 2012 (N=78)									
Avg. (%)	93.60	80.08	83.28	71.70	80.13	81.98	78.66	85.28	71.82
Sdev	3.42	10.06	8.71	10.00	9.52	5.68	11.83	31.94	15.72

- Process oriented approaches were well received by students.
- However, the teaching methodology with a primary focus on process oriented activities resulted in worse student performance in traditional time-bound end-of-term exams.
- A more integrated approach combining content-centered and process-oriented elements indicates improved performance.

How do students feel about the integrated approach?

"This class has done a great job with relating everything to the big picture."
"This is the first class I felt would be applicable in real life situations. I learned more than I do in most classes due to teaching style."
"I know that if tomorrow in any industry I need to design one of the mechanical elements covered in the book, I will be able to apply my knowledge and achieve objective."
"This class focused less on memorization and difficult exams so I was able to focus more on conceptual ideas."
"Having to code for HW and the project, I felt that I needed a great knowledge and understanding of the material."

[1]Edelson, D.C., Learning-for-Use: A Framework for the Design of Technology-Supported Inquiry Activities, *Journal of research in science teaching vol*. 38, no. 3, pp. 355 - 385 (2001)

[2]Wetzels, A.J.S., Kester, L. and van Merriënboer, J.J.G., Adapting prior knowledge activation: Mobilization, perspective taking, and learners' prior knowledge, *Computers in Human Behavior*, 27 (2011) 16–21.

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Georgia Tech | Center for Education Integrating Science, Mathematics & Computing
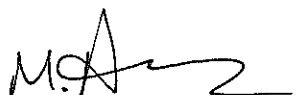
To the selection committee,

We, Drs. Sunni Newton and Meltem Alemdar of CEISMC, would like to offer our enthusiastic support of Dr. Raghu Pucha's nomination for the CTL Scholarship of Teaching and Learning Award. We have been working with Dr. Pucha the past five years on various educational research projects to improve undergraduate engineering curriculum. It has been pleasure to witness Dr. Pucha's commitment to honing his craft as a teacher through his engagement in the rigorous study of a variety of teaching practices and curricular offerings. Dr. Pucha has demonstrated sustained commitment to approaching his teaching and improvements therein through the lens of scholarly research. We have had the unique perspective of partnering with him on this research over the past five years, and have had direct experience with his combined passion for both working with students and conducting research on teaching and learning in his classroom.

We have partnered with Dr. Pucha to investigate the impact on students of classroom interventions in two areas: 1) sketching for an engineering design application, and 2) sustainability in engineering design. In both of these projects, our role has been to learn about Dr. Pucha's approach to these interventions and what he expects students to gain from them, and then to design student surveys to measure student perceptions of these interventions. Dr. Pucha cares deeply about this work, and is consistently open to receiving feedback from his students, be it positive (as it is in most cases) or negative. Our work together on these projects has led to several journal publications and conference presentations, as well as a book chapter on teaching sustainability content in engineering. We have also had the opportunity to observe him teaching and interacting with students, and his respect for them and interest in helping them learn is evident. He also expresses genuine enthusiasm and delight when discussing students' engineering projects and the ideas that they come up with.

Dr. Pucha incorporates a variety of evidence-based, learner-focused approaches into his teaching philosophy, including: active learning, project-based learning, creative and critical thinking strategies, and a socio-technical focus. The adoption of these strategies, particularly within a field in which instruction has largely been teacher-focused, is evidence of his commitment to make all efforts within his power to optimize his teaching to engender both positive student experiences and robust student learning. Dr. Pucha's previous scholarly work as well as the numerous accolades and awards that he has earned support his qualification for this award, and we wholeheartedly offer our support as well. He is an excellent candidate for the award.

Sincerely,

Meltem Alemdar, Ph.D.
Associate Director for Educational Research
& Evaluation
Senior Research Scientist

Sunni Newton, Ph.D.
Senior Research Scientist

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Georgia Institute of Technology

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    February 28, 2020

CTL Scholarship of Teaching and Learning Award Committee

Dear Award Committee Members:

It is with great pleasure that I endorse the nomination of Dr. Raghu Pucha for the CTL Scholarship of Teaching and Learning Award. I am a Regents' Professor in the School of Mechanical Engineering and have known Dr. Pucha over the past 15 years as a mentor, research collaborator, and colleague. As a Senior Lecturer in the Woodruff School, Dr. Pucha primarily teaches two of computer-based courses: *ME 1770: Introduction to Engineering Graphics and Visualization* (Fall 2005 - Present) and *ME4041: Computer Graphics and Computer Aided Design* (Fall 2004 - Present), and has done exceptionally well in both of these courses, as evidenced by student evaluations and comments over the years.

When Georgia Tech converted from quarter to semester curricula in 1999, the college of engineering created a three-credit hour introductory engineering graphics course, ME 1770, for undergraduates. ME1770 was traditionally taught with lecture-based teaching methods with time-bound exams. This course is a critical course in our undergraduate curriculum to stimulate engineering interest among our students who otherwise think that engineering is not interesting to pursue. In the last 15 years, using SoTL approaches, Dr. Pucha introduced real-world project-based and learning-centered instruction in the classroom to improve student's engagement and learning. In 2016, one of the sections of this course was affiliated to SLS (Serve-Learn-Sustain) Center to integrate sustainable communities framework into the course curriculum. Preparing engineering students with creative and critical thinking skills with a deep contextual understanding is essential. Creative and critical thinking cannot be taught decontextualized – out of context – as a special skill. The current version of this freshman-level course introduces incoming freshmen to design ideation, computer-based engineering design, modeling, assembly, and additive manufacturing with real-world design problems with context. The creative and critical thinking skills in the course focuses on contextualized design projects with sustainability systems-thinking, which include (i) identifying dynamic relationships among ecological, social, and economic factors of sustainability (ii) understanding the influence of context and (iii) evaluating how design decisions influences the sustainability of communities.

Dr. Pucha's hands-on and personal approach to teaching ensure that our freshman students, who have just graduated from high school, are not intimidated by the impersonal atmosphere often present in the university. Moreover, Dr. Pucha's teaching approach with research-based best teaching practices, grounded in proven pedagogical theories, is providing a perfect platform for our undergrad students to become lifelong learners in understanding the real-world design challenges and the impact of their professional practice.

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Dr. Pucha's teaching evaluations over the years are uniformly exceptional and commendable. Dr. Pucha puts his heart and mind into teaching and does an enviable job in motivating our freshmen students and guiding our senior students into becoming successful engineers. Clearly, over the years, Dr. Pucha developed systematic evidence-based teaching methods to teach the discipline knowledge using real-world projects with context that further motivate his students towards engineering design and manufacturing. I believe that he is the most deserving person for the CTL Scholarship of Teaching and Learning Award. I hope that CTL will concur with my assessment and select Dr. Pucha for the CTL Scholarship of Teaching and Learning Award.

If you need any additional information, please contact me at (404)-894-3405 or through email at suresh.sitaraman@me.gatech.edu.

Sincerely,

Suresh K. Sitaraman, Ph.D.
Regents' Professor and Morris M. Bryan, Jr. Professor

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Raghu Pucha
Senior Lecturer
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I. Earned Degrees

Ph.D. in Aerospace Engineering, 1995 – Indian Institute of Science, India

M.S. in Aerospace Engineering, 1990 – Madras Institute of Technology, India

B.S in Civil Engineering¸1988 – Nagarjuna University, India

II. Employment History

Senior Lecturer, Georgia Institute of Technology, 2015-Present

Academic Professional, Georgia Institute of Technology, 2013-2015

Senior Research Engineer, Georgia Institute of Technology, 2005-2013

Post-Doctoral Researcher, Georgia Institute of Technology, 2000-2005

Post-Doctoral Researcher, Purdue University, 1997-2000

Research Associate, Nanyang Technological University, Singapore, 1996-1997

III. Honors and Awards

- CTL Geoffrey G. Eichholz Faculty Teaching Award 2015, Georgia Tech.
- CTL Undergraduate Educator Award 2012, Georgia Tech.
- Featured in GT News: A Tale of Two Teachers : The Whistle 2015 : Putting 'TECH' in 'Teaching'
- Acknowledged by Dr. G.P. "Bud" Peterson – Past President, Georgia Institute of Technology, Dean Griffin Day Talk, Friday, April 23, 2010: People like Raghu are leaders
- CTL Teaching Scholar 2020: Faculty Learning Community (FLC) : Transparency in Learning and Teaching (TiLT).
- CTL Teaching Scholar, 2018 – 2019, Georgia Tech. – Teaching as Research program.
- Inaugural Serve-Learn-Sustain: Food, Energy, and Water Systems (FEWS) Fellow in 2016 to implement sustainability aspects in the curriculum
- Book Chapter Reviewer, Engineering Justice: Transforming engineering education and practice. Jon A. Leydens and Juan C. Lucena. John Wiley & Sons. 2018.
- CTL Teaching Scholar 2015-2016, Georgia Tech. – to explore research and best practices related to the notion of developing critical thinkers in classroom.
- GWW Woodruff School of Mechanical Engineering Teaching Fellow Spring 2014
- CTL Inaugural 1969 Teaching Scholar, 2008 – 2009, Georgia Tech. – to develop peer-assisted learning initiative in classroom.
- Selected for conducting classroom research on the impact of case study methodology on student learning (Spring 2009) – LITEE National Dissemination Grant Competition, sponsored by NSF DUE # 0442531.

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- Honored with many "*Excellence in Teaching*" recognition certificates from the Center for Teaching and Learning (CTL) at Georgia Institute of Technology in Spring 2007 to Fall 2019.
- Invited to the "Dean Griffin Day" program in honor of outstanding contributions to the Georgia Tech Community through teaching. 2008 - 2019: Hosted by Center for Enhancement of Teaching and Learning, and Georgia Tech Alumni Student Ambassadors, Georgia Tech.
- Invited Talk: Sustainability Showcase, Kendeda Building for Innovative Sustainable Design.

IV. Publications: Scholarship of Teaching and Learning

1) [Book Chapter] Pucha, R., Dosa, K., Newton, S., Alemdar, M., Yow, R., and Hirsch, J. (2020) "Integrating Sustainability into a Freshman Engineering Course Through an Institute–level Initiative: A Teaching–Learning Model with Authentic Activity and Context". In ***Integrating sustainable development into the curriculum***: Vol.18. Innovations in Higher Education Teaching and Learning Series. Patrick Blessinger (Ed). Emerald Publishing Limited. ISBN: 9781787699427.

2) Pucha, R., Newton, S., and Alemdar, M. (2019). "Freshman Engineering Students See Value in Sustainability-themed Project-based Learning". Presented at ***AASHE Conference & Expo*** Oct.27 – Oct.30, Spokane, WA, USA.

3) Pucha, R., Newton, S., and Alemdar, M. (2019) "Sustainability-Themed Socio-technical project-based learning in the Engineering classroom". Presented at ***Sustainability Showcase: Kendeda Building for Innovative Sustainable Design.*** Oct.28 – 30, Georgia Tech., Atlanta, GA, USA.

4) Pucha, R., Dosa, K., Newton, S., and Alemdar, M. (2019). "External Representation Design-for-Sustainability Intervention in an Engineering Graphics Course". ***Proc. ASEE Annual Conference & Exposition.*** June 16 – June 19, Tampa, FL, USA.

5) Pucha, RV., Thurman, CJ; Yow,R; Meeds, CR; and Hirsch, J (2018). "Engagement in Practice: Socio-technical Project-based Learning Model in a Freshman Engineering Design Course". ***Proc. ASEE Annual Conference & Exposition.*** June 24 – June 27, Salt Lake City, UT, USA.

6) Pucha, R; Levy,B; Linsey,J; Newton, SH; Alemdar, M; and Utsching, T. (2017). "Assessing Concept Generation Intervention Strategies for Creativity Using Design Problems in a Freshman Engineering Graphics Course". ***Proc. ASEE Annual Conference & Exposition.*** June 25 – June 28, Columbus, OH, USA.

7) Hirsch,J; Yow,R; O'Brien,S; Pucha, R; Wisdom,N; Realff, M; Zegura, E (2017) "Socio-technical Approaches to Sustainable Community Development in Atlanta". ***Atlanta Studies Symposium,*** Apr.26. (Engineering problem solving has technical and social parts.)

8) Hilton E, Li W, Newton SH, Alemdar M, Pucha R, Linsey J. (2016). "The Development and Effects of Teaching Perspective Free-Hand Sketching in Engineering Design". ***Proc. ASME. International Design Engineering Technical Conferences.*** August 21 – 24. Charlotte, NC, USA.

9) Pucha, R, Newton, SH., Alemdar, M., and Utschig, TT (2016). "Process-Oriented Intervention and Reflection Strategies for Creativity in Student Design Projects". ***Proc. 4th international conference on design creativity,*** Nov.2 – Nov.4, Atlanta, GA.

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10) Pucha R; Utschig TT; Newton SH; Alemdar M; Moore R; Noyes CR (2016). "Critical and creative thinking activities for engaged learning in graphics and visualization course". *Proc. ASEE Annual Conference & Exposition.* June 26 – June 29, New Orleans, LA.

11) Pucha R; Utschig TT; Liang SY (2013). "Use of process-oriented approaches in content-intensive courses: Some insight in teaching / learning of machine design". *Proc. ASEE Annual Conference and Exposition*, June 23 – June 26, Atlanta, GA.

12) Pucha R; Utschig TT (2012). "Learning-Centered Instruction of Engineering Graphics for Freshman Engineering Students". *The Journal of STEM Education: Innovations and Research* 13(4), (pp. 24 – 33)

13) Pucha R; Utschig TT (2009). "Computer-Aided-Nano-Design Education in the Engineering Curriculum: Scope and Challenges". *Proc. ASEE Southeast Section Conference.* April 5-7, Southern Polytechnic State University, Atlanta, GA.

14) [Accepted] Pucha, R., Newton, S., Alemdar, M., Hull, R.A., and Bhagat.A (2020). "Contextualized design projects in graphics and visualization course: Student perceptions and sustainability systems-thinking knowledge". *ASEE Annual Conference & Exposition.* June 21 – June 24, Montreal, QB, Canada.

15) [Accepted] Pucha, R (2020). "Creative and Critical Thinking Interventions with Context in a Freshman Design Course". USG Teaching and Learning Conference, Apr.7 – Apr.11, Athens, GA, USA

(For all publications including research in Design and Manufacturing of Advanced Materials, please see Google Scholar)

V. Courses Taught

Total number of students taught: **5445 (**Fall 2005 - Fall 2019)

Course Number	Course Title
ME / AE / CEE 1770	Introduction to Engr Graphics & Product visualization
COE 2001	Statics
COE 3001 and COE 3001 QUP	Deformable Bodies
MLDR 8803 QML	Special Topics
ME 4041	Computer Graphics & CAD
ME 6124	Finite Element Method
ME 3180	Machine Design
ME 4698	Research Assistantship
ME 2699 & 4699	Undergraduate Research

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VI. Pedagogical Innovations and Contributions to Curriculum Development

1) Students construct knowledge through gathering and synthesizing information, and integrating it with the general skills of inquiry, communication, critical thinking, and problem solving. This process enables students to take ownership of their learning. Freshman engineering core course ME 1770: *Introduction to Engineering Graphics and Visualization* was revamped from lecture-centered time-bound exam based teaching approach to [learning-centered project-based teaching/learning](#) course.

2) Teaching / Learning methodologies have traditionally seen content and process as competing priorities. [Integrating content and process together](#) in the teaching/ learning activities offers the opportunity to increase students' experience with authentic activities while also achieving deeper content understanding. Prior knowledge activation also has strong facilitative effects on learning. Prior knowledge provides learners with a relevant context in which new information can be integrated. Core course ME 3180: Machine Design, was taught with process-oriented CAD activities students learned from ME 1770.

3) In cornerstone design courses, design thinking skills that support an iterative loop of divergent (creative) and convergent (critical) thinking through project-based learning environments are needed in addition to instruction of graphics and visualization tools. Critical thinking skills have a more established history in academia and in engineering programs, most specifically for teaching problem solving. Universities teach creative thinking skills to a much lesser extent, perhaps because of a lack of understanding of how we define creativity. There are several open research questions on design pedagogy and how effective inquiry, the systematic interplay between divergent and convergent questions that are taught and promoted as part of engineering education. [Creative and critical thinking activities](#) in individual projects with [authentic activities and process oriented interventions](#) for improved learning are introduced in freshman engineering core course ME 1770: Introduction to Engineering Graphics and Visualization. [Concept generation intervention strategies for creativity using design problems](#) with [perspective ideation sketching](#) are also introduced.

4) In January 2016, Georgia Tech launched a campus-wide academic initiative, "Center for Serve-Learn-Sustain", aimed at preparing undergraduate students in all majors to use their disciplinary knowledge and skills to contribute to the major societal challenge of creating sustainable communities. The initiative collaborates with faculty in all six Georgia Tech colleges to develop courses and co-curricular opportunities that will help students learn about sustainability and community engagement and hone their critical thinking skills by engaging in real-world projects with nonprofit, community, government, and business partners. A teaching–learning model with authentic activity and context is introduced by [integrating sustainability into a freshman engineering course through this institute–level initiative.](#) Students see value in the [socio-technical project-based learning model](#) through humanitarian design projects and [external representation design-for-sustainability interventions](#) in the classroom in learning the discipline-specific knowledge with context.

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Course Evaluations and Teaching Effectiveness Metrics

Metric: Instructor Overall Effectiveness
14 Years Average Interpolated Median : 4.67 / 5.0

Each semester taught 3 or 4 sections of ME 1770

4.67

Fall 2019, Fall 2018, Fall 2017, Fall 2016, Fall 2015, Fall 2014, Fall 2013, Fall 2012, Fall 2011, Fall 2010, Fall 2009, Fall 2008, Fall 2007, Fall 2006, Fall 2005
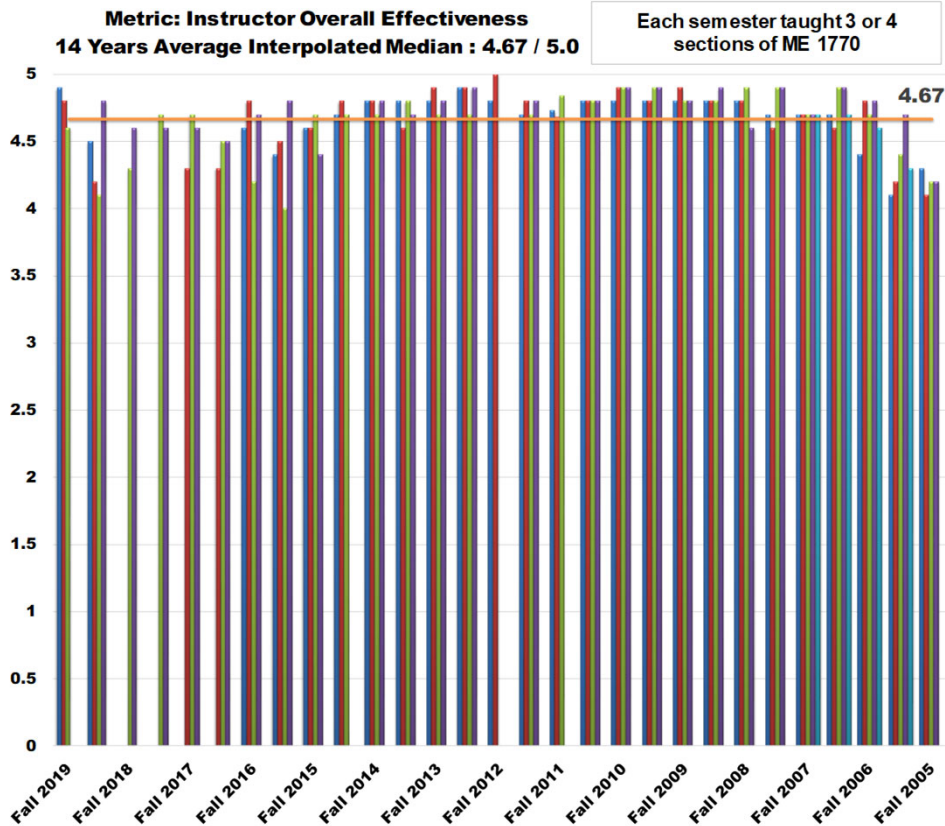
Dr. Pucha was an amazing professor. His teaching philosophy effectively maximizes the amount of learning his students can obtain through him, by getting rid of the pressures of the typical engineering course, and instead developing enjoyable (and cool!) abilities. He felt very human and supportive, too -- at the end of the course, he was happy to have encouraged me to go into engineering. It's like he enjoys seeing his students succeed, as opposed to seeing them fail or suffer. Dr. Pucha gave me the time space I needed to succeed in his course regardless. I only have good things to say about him, and will recommend all of my friends to take him for this class.

(Some student comments might have been edited for length and grammar)

"One of the most passionate and dedicated educators at Georgia Tech. Dr. Pucha teaches because he loves to, not because he has to do research. His willingness to work with and for his students is head and shoulders above the rest..".

Dr. Pucha was extremely enthusiastic about this course and truly cared about his students' success and understanding of the material. He emphasized the material we learned over the grades we got, which I thought was very helpful because this course is the basis for the courses we will be taking in the next few years.

Dr. Pucha clearly cares about students and puts in effort to ensure that we succeed. He is also very personable and easy to chat with during office hours. This combined with fairly effective teaching strategies makes him my favorite professor of the semester as well as my favorite course I've taken at GT.

The fun, relaxed nature of Dr. Pucha's teaching style. His focus on learning instead of grades really helped me to reduce my anxiety and focus on the material. The course covered a broad range of topics and skills and gave students the opportunity to improve in each area before moving on to deeper concepts. Also, there was always a clear connection to industrial and real-world applications of these skills.

"His overall teaching style and plan is perfect! I learned so much in this course and feel confident in my ability to succeed as an engineer"

"This instructor felt like he actually wanted to be there teaching. His enthusiasm for the course was infectious and his kindness made it easy to go to him for feedback. Pucha's greatest strength is relating the individual processes we learn in class to the overall design process."

"He let us loose on our projects and exams to give it our creative touch in learning it, and it was very interesting. He is extremely enthusiastic about teaching effectively, rather than just trying to get a point across and I sincerely respect that and hope that continues in the future!"

Dr. Pucha's greatest strength was his constant availability and willingness to help. Dr. Pucha was always available and eager to answer any question I had. He gave me the courage to try new things and explore further in my designs knowing I could go to him for help with any challenges that may arise"

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Metric: Amount Learned
**(This rubric was introduced in course survey in Fall 2011)**   4.7
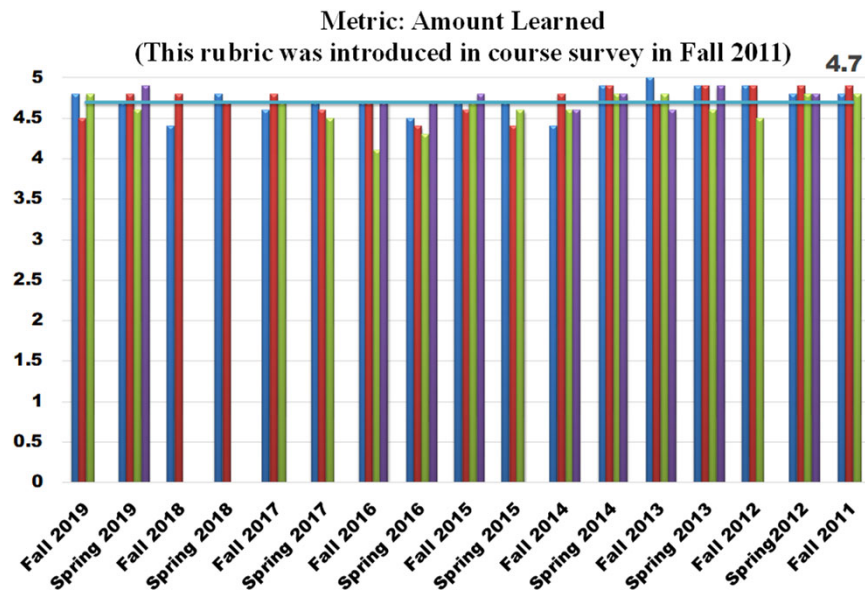
"Dr. Pucha's greatest strength was his teaching style. Out of all of my professors at GT he has been one of the most inspirational professors I have had. The way he facilitates learning is unique. He takes time even with a large number of students and examines their work for fundamentals and certain techniques. He is helping students prepare for real world challenges for future engineers. He is a vital asset to the GT faculty"

"I have taken both ME 1770 and ME 4041 with Dr. Pucha and I am confident with my CAD abilities because of them. He makes you feel like an actual engineer and not just another grade on his paper. Both classes were enjoyable and after taking them I feel comfortable going into the industry with my current CAD experience. I just wanted to thank him for making my first and last undergraduate semesters at Georgia tech fun ones". – **Thank a Teacher note**

Dr. Pucha Is a great professor due to the fact that he knows the subject, and knows how to transmit the information, and also has lots of patience.

"Dr. Pucha is an excellent instructor. Communicates material in an engaging and exciting way. His sense of humor keeps students entertained even at 8am. I learned a huge amount from Dr. Pucha, not only about the use of CAD tools and design process, but also how to think and tackle REAL problems like an engineer. Dr. Pucha makes a huge impact on his students, and they are better prepared for their academic and professional careers after taking his class. If more professors looked to Dr. Pucha as an example, the quality of instruction at GT would improve tremendously. This man makes engineers."

"Dr. Pucha is absolutely one of the best professors that Georgia Tech has. You should give him a raise, 107 TAs, and let him teach every class in the ME department"
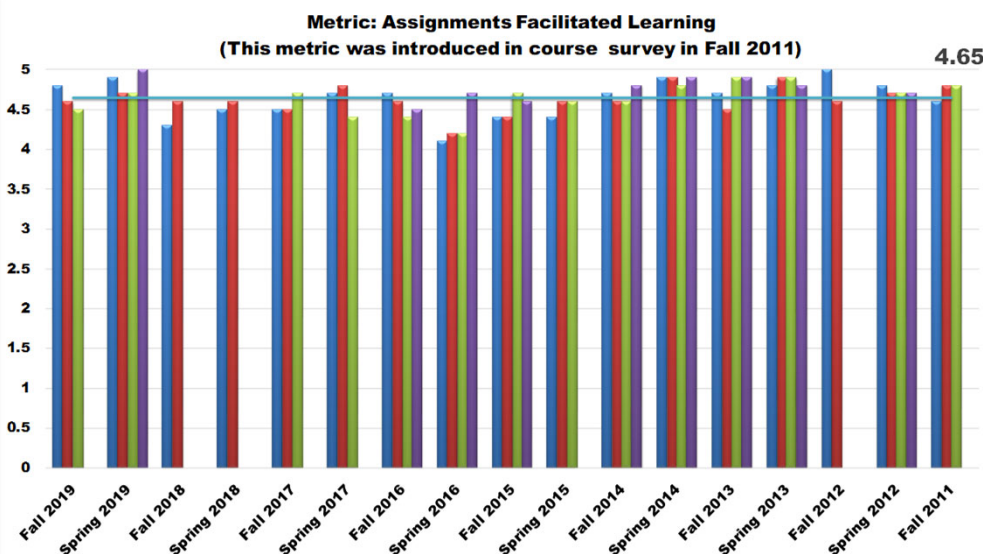
"Professor Pucha is an incredible instructor. Extremely accessible and understanding of his students. He motivates learning throughout his classes and lab work"

"His overall teaching style and plan is perfect! I learned so much in this course and feel confident in my ability to succeed as an engineer"

Metric: Assignments Facilitated Learning
(This metric was introduced in course survey in Fall 2011)   4.65

Dr. Pucha is the rare instructor who manages to mix planned course content with useful tangents and explanations that go beyond the scope of the course in order to further our understanding. I think that the College of Engineering has produced a great course, and Dr. Pucha has done an amazing job of implementing it"

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