Table of Contents

Graham, Samuel - #4343 - Raghu Pucha ........................................................................................................ 1
Nomination Package ......................................................................................................................................... 2
## Application Summary

### Competition Details

<table>
<thead>
<tr>
<th>Competition Title:</th>
<th>2020 Scholarship of Teaching and Learning Award</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category:</td>
<td>Institutional Awards - CTL</td>
</tr>
<tr>
<td>Award Cycle:</td>
<td>2020</td>
</tr>
<tr>
<td>Submission Deadline:</td>
<td>03/02/2020 at 11:59 PM</td>
</tr>
</tbody>
</table>

### Application Information

<table>
<thead>
<tr>
<th>Submitted By:</th>
<th>Raghuram Pucha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application ID:</td>
<td>4343</td>
</tr>
<tr>
<td>Application Title:</td>
<td>Raghu Pucha</td>
</tr>
<tr>
<td>Date Submitted:</td>
<td>03/01/2020 at 10:18 PM</td>
</tr>
</tbody>
</table>

### Personal Details

<table>
<thead>
<tr>
<th>Applicant First Name:</th>
<th>Samuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicant Last Name:</td>
<td>Graham</td>
</tr>
<tr>
<td>Email Address:</td>
<td><a href="mailto:sgraham@gatech.edu">sgraham@gatech.edu</a></td>
</tr>
<tr>
<td>Phone Number:</td>
<td>(404) 894-3200</td>
</tr>
</tbody>
</table>

**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
Table of Contents

Letter of Nomination
--Samuel Graham, Jr. : Eugene C. Gwaltney, Jr. Chair and Professor
George W. Woodruff School of Mechanical Engineering, Georgia Tech

Nominee’s Statement
  Teaching Philosophy and Pedagogy
  Learning-Centered Instruction
  Creative and Critical-thinking Interventions
  Socio-Technical Project-based Learning with Context
  Process-oriented Approaches to Content-Intensive Courses

Letter of Endorsement
Dr. Sunni Newton and Dr. Meltem Alemdar
Center for Education Integrating Science, Mathematics, and Computing (CEISMC)
Georgia Institute of Technology

Letter of Endorsement
Suresh Sitaraman, Regents’ Professor
George W. Woodruff School of Mechanical Engineering

Nominee’s Condensed CV

Nominee’s Course Evaluations and Teaching Effectiveness Metrics
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 classroom 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 classroom. 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. 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 cornerstone design course. Pedagogical procedure (4) is planned and implemented in ME 3180 (Machine design) course.

1Boyer, E.L. Scholarship Reconsidered. The Carnegie Foundation for the Advancement of Teaching (1990)
1. Learning-Centered Instruction

Teaching / Learning Issues & Challenges

Teacher-centered instruction imposes a moratorium upon students’ vocational development by forcing them to assume a passive role as a student. Learning-centered instruction (i) emphasizes learning (ii) builds meaning for students though inquiry-oriented and socially situated environments (iii) involves problem and case study based open-ended scenarios (iv) uses formative assessment by collecting diagnostic clues on individual needs and feedback and (v) provides opportunities to learn the subject matter beyond surface-level understanding. Teaching Engineering Graphics to freshman engineering students poses challenges to instructors as well as to students. While the instructors are confronted with a lack of text book that covers the broad scope of the subject matter, students struggle to correlate newly developed skills to real-world engineering design problems due to lack of documented design problems and case studies. How to implement learning-centered instruction in teaching Engineering Graphics and design course?

Impact on Student Learning

<table>
<thead>
<tr>
<th>Construct</th>
<th>Pre (average/5)</th>
<th>Post (average/5)</th>
<th>Post-Pre</th>
</tr>
</thead>
<tbody>
<tr>
<td>General attitude toward subject matter</td>
<td>3.17</td>
<td>3.17</td>
<td>0.00</td>
</tr>
<tr>
<td>Relevance of subject matter to life and society</td>
<td>4.30</td>
<td>4.35</td>
<td>.05</td>
</tr>
<tr>
<td>Higher-order cognitive domain of learning</td>
<td>4.10</td>
<td>3.97</td>
<td>-0.13</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>4.13</td>
<td>4.10</td>
<td>-0.03</td>
</tr>
<tr>
<td>Ease of learning subject matter</td>
<td>3.03</td>
<td>3.03</td>
<td>0.00</td>
</tr>
<tr>
<td>Impact on team working</td>
<td>3.80</td>
<td>3.96</td>
<td>0.16</td>
</tr>
<tr>
<td>Communication skills</td>
<td>3.87</td>
<td>3.33</td>
<td>-0.53</td>
</tr>
</tbody>
</table>

How do students feel about learning-centered approaches and real-world case studies?

“I really enjoyed the class and was impressed by the exams and projects which addressed a real need.”
“We went through the planning stages to a real product just like we would in the real world” and “The class was one of the best I’ve taken so far at Tech.”
“The course was fun and challenging and got us thinking outside the box. The instructor pushed us to learn and grow in ways that were constructive and valuable.”
“The instructor gives you plenty of opportunities to show him and yourself that you really understand the material. The class is structured in such a way as to promote learning most effectively.”

Research Questions and Objectives

- How peer assessment in the labs activities helped students in learning the material?
- How to quantify students learning need through formative assessment?
- How real-world case studies as team projects influenced students engagement in the class?
- Assessment of student engagement through interactions between the students, teaching assistants, and instructor, end-of-term Course Instructor Opinion Survey (CIOS) and pre-post surveys.
- Performance comparison with case-study group (used real-world case studies) against control groups (used decontextualized projects).

Pedagogy / SoTL

A learning-centered instructional model\(^1\) with (1) Abstract conceptualization (2) Active experimentation / application (3) Concrete experience and (4) Reflective observation is combined with problem-based learning\(^2\) and case-study based approaches\(^3\) are used to achieve the connection between the academic abstraction and hands-on concrete application.

3LITEE / NSF DUE # 0442531: Conducting classroom research on the impact of case study methodology on student learning
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.\(^2\)

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 cornerstone design course?
- Develop rubrics that combines both domain-specific and creativity-relevant skills to evaluate student design projects

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. Unconventional Thinking in Engineering Design (UnTiED) ideation with design heuristics cards that involve a series of divergent and convergent thinking are introduced in design projects.

Impact on Student Learning

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

End of Course Survey Spring & Fall 2015 Combined Spring 2016

- Total Respondents: 422 (7 sections) 19 (2 sections)
- Comments directly mentioning creativity: 18 (6%) 30 (18%)
- Comments with phrases: allowed/encouraged creativity: 9 8
- Comments with phrases: choice/freedom/ownership: 9 16
- Comments with phrases: great ways to learn: - 3
- Comments with phrases: fun/inspiring/generates enthusiasm: 5 7
- Comments with phrases: multiple stages of design: 1 5

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

“...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.”

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.

How to bring sustainable Communities framework into the engineering classroom through socio-technical project-based learning?

Pedagogy / SoTL

A situated cognition and learning pedagogical theory is adapted, where concept, activity, and context are involved in student learning to produce usable 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.

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


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

Research Questions and Assessment

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

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

System thinking, Bloom’s Taxonomy
3. Socio-Technical Project-based Learning with Context (Contd..)

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”

---

1. Socio-Technical Project-based learning brings Context and Stakeholders to Design

**Specifications**

**Context**

**Stakeholders**

Traditional Engineering Design

---

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

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

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

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

---

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

Impact on Student Learning

- 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: 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

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

**“In your own words define sustainability”**

**Word cloud representation of post activity reflection**

- “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.”
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?

<table>
<thead>
<tr>
<th></th>
<th>HW1</th>
<th>HW2</th>
<th>Exam1</th>
<th>HW3</th>
<th>HW4</th>
<th>Exam2</th>
<th>HW5</th>
<th>Project</th>
<th>Final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process-Oriented Approach - Fall 2011 (N=90)</td>
<td>82.60</td>
<td>60.40</td>
<td>87.81</td>
<td>80.56</td>
<td>73.10</td>
<td>95.87</td>
<td>73.06</td>
<td>85.40</td>
<td>60.64</td>
</tr>
<tr>
<td>Avg. (%)</td>
<td>4.63</td>
<td>10.54</td>
<td>16.73</td>
<td>8.24</td>
<td>12.22</td>
<td>5.18</td>
<td>9.78</td>
<td>23.95</td>
<td>10.98</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>4.02</td>
<td>10.06</td>
<td>8.71</td>
<td>10.00</td>
<td>9.52</td>
<td>5.68</td>
<td>11.83</td>
<td>31.94</td>
<td>15.73</td>
</tr>
</tbody>
</table>

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."


To the selection committee,

We, Drs. Sunni Newton and Meltem Alemdar of CEISMC, would like to offer our enthusiastic support of Dr. Raghunath 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 a 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

Sunny Newton, Ph.D.
Senior Research Scientist

Center for Education Integrating Science, Mathematics & Computing (CEISMC)
Georgia Institute of Technology
817 West Peachtree Street, NW, Suite 300
Atlanta, Georgia 30308-1198 U.S.A.
PHONE 404.894.0777 FAX 404.894.9675
www.ceismc.gatech.edu

A Unit of the University System of Georgia | An Equal Education and Employment Opportunity Institution
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: ME1770: 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.
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
Raghu Pucha  
Senior Lecturer  
The George W. Woodruff School of Mechanical Engineering  
Georgia Institute of Technology, Atlanta, GA  
Email: raghuram.pucha@me.gatech.edu  
URL: http://intact.gatech.edu

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.
- 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.
- 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
- 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.
- 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


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.)


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)

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME / AE / CEE 1770</td>
<td>Introduction to Engr Graphics &amp; Product visualization</td>
</tr>
<tr>
<td>COE 2001</td>
<td>Statics</td>
</tr>
<tr>
<td>COE 3001 and COE 3001 QUP</td>
<td>Deformable Bodies</td>
</tr>
<tr>
<td>MLDR 8803 QML</td>
<td>Special Topics</td>
</tr>
<tr>
<td>ME 4041</td>
<td>Computer Graphics &amp; CAD</td>
</tr>
<tr>
<td>ME 6124</td>
<td>Finite Element Method</td>
</tr>
<tr>
<td>ME 3180</td>
<td>Machine Design</td>
</tr>
<tr>
<td>ME 4698</td>
<td>Research Assistantship</td>
</tr>
<tr>
<td>ME 2699 &amp; 4699</td>
<td>Undergraduate Research</td>
</tr>
</tbody>
</table>
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.
Course Evaluations and Teaching Effectiveness Metrics

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 and 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.

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.

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.

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!

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"

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.

Course Evaluations and Teaching Effectiveness Metrics

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 and 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.

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.
“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”

“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”

“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”

“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.