

## What Constitutes a Good Design Education Research Paper That Would be Suitable for JMD?

Have you heard? Did you know? The *Journal of Mechanical Design* (JMD) has been accepting and publishing quality design education research papers for the last 2 years. As the associate editor handling this area, I am all too often surprised. First, I am surprised that the word has not spread widely and that there are not more design education submissions to JMD. Clearly, there is a tremendous surge in the interest of engineering educators nationwide to increase student learning and skills through design projects, often with genuine experiences and with the participation from industry, the community, or individual “customers” working with student design teams. Design education seems to be the new focus of how engineering educators are going to fix what is perceived to have been broken for many years: a content focused curriculum, lacking in the context of real problems that would motivate and engage students and deepen their learning and increase their confidence in how to think, reason, problem-solve, and apply mathematics, science, and engineering methods and tools.

Where did this new interest in context come from? Perhaps it comes from the urgent cry from industry for change. Can we answer the question where are the students who are prepared to take on the significant engineering challenges of the 21st century? How students were educated in years gone by is not addressing many of the new challenges. The market place, indeed, the business enterprise, is dispersed globally, design teams are charged to innovate and collaborate with stakeholders who are invested in the quality, costs, and value of products throughout the life cycle of products. All the while, technologies are changing rapidly, the complexity of products has risen, and designers are under great pressure to reduce their cycle time since products need to get to market faster in order to capture greatest market share.

In response, engineering educators are increasingly looking to broaden and deepen student preparation with topics that are technical and nontechnical such as teaming and collaboration, project management, design process methods and tools, complex problem solving, analysis, decision making, visualization, simulation, and much more. Fundamental work on topics, such as learning styles, pedagogy, class size, use of technology in education, and issues surrounding under-represented groups, have also increased.

It is wonderful to see the wave of interest in transforming engineering education, most especially with a focus on engineering design and in the context of real problems. At the same time, it is also frightening. Frightening that engineering faculty across disciplines who often know little about design processes, methods, and tools are taking on these challenges. Yes, these efforts are with good intentions but with naïve and potentially harmful practices of bottom-up trial-and-error approaches that simply bring students together in a team and cast them off on a mission.

Here is where you come in, those of you who have contributed to the research and practice of engineering design; you have a significant role in improving design education! You may be (and are likely) doing this already. How can you share your expertise in

design and aid others in success and long lasting changes in design education excellence? Submit your research and findings in design education in JMD!

And you ask *what constitutes a good design education research paper that would be suitable for JMD?* The answer to this is very much the same as it would be for any other research in JMD. Indeed, a good research paper reflects good research practice. Design education, or engineering education, in general, should be no different. It is simply a new application area for some of you perhaps, but the needs and challenges of this problem area should be approached with similar rigor and good problem solving, design process, and research methods.

The following outlines the basic sections that should be included in a design education research paper.

1. Introduction (what is the problem, why is it important, who does it affect, and what is the impact and significance if solved).
2. What have others done to date that have attempted to solve this problem (or something similar to it)? Reflect on prior work in your review of literature. What are the merits and still the needs remaining?
3. What is the objective of your work?
4. What and how did you develop the requirements? (i.e., How will you know that you have succeeded in your objective?)
5. What approach and methods did you apply to solve this problem? Provide an overview and details. What methods did you use to test and validate what you did?
6. Did you iterate? If so, why and how?
7. What were the results? How did you assess and evaluate these? Did they meet the requirements and the stated objective? How do you know? How well?
8. Did you iterate more?
9. Ultimately, what conclusions can be drawn from your work that others can learn from and/or use?

Do these steps sound familiar? They likely do, as they reflect basic steps in good design process and are the sections that would be found in a good research design and a good research paper that reports on the work and findings.

What is different in design education research than in other application domains? The terminology and methods used in each step are different perhaps. However, the basic constructs are the same. Do you now need to be expert in assessment and evaluation, working with human subjects and statistical analysis? Perhaps or, you could also consider broadening your collaboration to include experts in education or in engineering education, in particular.

Please do *not* submit papers that are “tell about” papers to design education in JMD. There are far too many conferences where such practices are acceptable already. JMD is interested in research and scholarship. How do you know that whatever your innovation in design education worked? Why would someone at another institution adopt your methods or believe them to be true?

Did you follow the usual steps that you would have in any other field of research? As outlined above, did you state the problem, look at what others have done, describe what you did, test and validate it, and then do an assessment and evaluation? From this, what conclusions can be drawn? What did you contribute to the body of knowledge?

I have a slew of stories from my own research into design education where for years I was sure that the many creative and innovative things I was doing in and out of the classroom with students was effective. Surely, they were learning more and deeper, they were more motivated and engaged. It “looked” that way, and so it must be true. Right? It was not until data were collected and analyzed that I really knew. In the case of a product dissection activity, envisioned to engage, motivate, and improve learning about relationships between form and function, we found, after collecting and analyzing data, that active learning hands-on activities were overspecified. Students’ internal motivation to learn (for their own knowledge) actually lessened due to our intervention. Not an outcome I am proud of. Have you collected data and unexpectedly found “bad” results? These are shareable and valuable lessons learned, ones that lead us to addressing new research questions to better understand the needs and develop truly transformative change in design education. Research in design education is important!

To summarize, JMD is interested in publishing high quality papers grounded in good research methods that address innovative design education teaching, learning, and/or assessment methods. Example topics might include a myriad of aspects of preparing the next generation of students (graduate and undergraduate) including the following:

- capstone design
- collaborative distributed design
- computer-based methods and tools
- concept selection and evaluation
- courses and curriculum in design
- creativity and concept generation
- design competitions and learning
- design for X (where X=life cycle issues such as manufacture and service)
- design process and methods

- design requirements
- design teams
- design throughout the curriculum
- designing sustainable products
- diversity in student engagement and learning
- economics of engineering design
- ethics and design
- graduate curriculum and degree programs in design
- human-centered design
- industry-based projects
- integrating design research and design education
- interdisciplinary design
- international collaborations
- inventions, patenting, and intellectual property
- learning evaluation and assessment methods
- lifelong learning
- mentors and mentoring design
- pedagogy
- project planning and management in design
- service-learning and design
- test and validation of design
- undergraduate curriculum reform and degree programs in design

Thank you for your valuable contributions and work in transforming the research and practice of engineering design education. We look forward to your submissions to JMD.

**J. P. Terpenny**  
**Guest Editor**  
**Program Director**  
**National Science Foundation (NSF)**  
**Division of Undergraduate Education**  
**Professor,**  
**Mechanical Engineering and Engineering**  
**Education**  
**Virginia Tech**

