Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #48535

Storytelling in System Dynamics: Exploring the impacts of emotional investment on student-chosen projects

Dr. Allison Lee, Campbell University

Allison Lee is an Assistant Professor in the School of Engineering at Campbell University. She earned a PhD in Mechanical Engineering from Brigham Young University. Her roles including teaching junior and senior courses to the multiple engineering concentrations at Campbell and supporting the ongoing K12 outreach activities sponsored by the School.

©American Society for Engineering Education, 2025

Story telling in System Dynamics: Exploring the impacts of emotional investment on student-chosen projects

Abstract

Background: It is often noted that students with intrinsic motivation for a specific topic or project put forth more effort to learn and understand that topic. Story driven learning (SDL) techniques have been used in engineering classrooms to help connect students both to their peers and to the course materials in ways that promote self-efficacy and overall learning. In a senior-level system dynamics course, students were asked to choose their own projects to model and analyze a real-world system. Even with this freedom, the instructor has noticed a general lack of self-efficacy—students' personal belief in their own abilities- to model something useful and limited interest in the project beyond achieving a grade. In this work-in-progress study, students chose their own project groups and then completed a guided brainstorming activity which incorporated elements of story-telling, with the aim of increasing the emotional investment of the group members in successfully completing the project. *Purpose*: Research Question 1: To what extent does allowing students to choose a system dynamics project based on personal/emotional connections to the project help them increase their self-efficacy in system dynamics? Research Question 2: To what extent does choosing their own emotionally invested project improve student competency based on project and over all grades? *Methodology/Approach*: Students completed pre/post surveys to measure increase in self-efficacy. Additionally, anonymized project grades and final grades from previous semesters will be compared to Fall 2024 grades to explore any changes in student competency. *Findings/Conclusions*: Preliminary results indicate that, in general, student self-efficacy increased after completing the project, but additions to the survey and/or other data collection need to be included in future semesters to help quantify the effects of SDL in the project. *Implications*: It is possible that the small addition of story-telling elements into the already established end-of-the-semester project may positively correlate with an increase in student self-efficacy and competency in system dynamics. If so, this may be a useful addition to other courses where instructors are seeking ways to modify existing projects instead of creating brand-new projects.

Introduction

It is well-established that students who are intrinsically motivated by a specific topic or project tend to invest more effort into learning and understanding that subject [1]. Storytelling techniques have been effectively employed in engineering classrooms to cultivate this intrinsic motivation, while also fostering stronger connections between students, their peers, and the course material.

This approach has been shown to promote self-efficacy and enhance overall learning [2]. In this context, self-efficacy is defined as a student's belief in their ability to successfully complete a task [3].

In the summer of 2024, I participated in a storytelling workshop titled "*The Narrative Engineer*", led by Janece Shaffer, Joe LeDoux, Ariana Turner, and Beth Wieder. The workshop offered valuable insights into integrating elements of story-driven learning (SDL) into engineering curricula to boost student engagement and comprehension. A recurring theme throughout the workshop was that when students are given the freedom to explore, they often produce unexpected and innovative outcomes. Additionally, students tend to form stronger connections with the material and develop a deeper understanding when they have an emotional investment in the subject matter. Inspired by this, I sought to incorporate aspects of storytelling into a course and examine whether doing so could enhance the student experience.

Rather than creating entirely new assignments or projects, I integrated one element of SDL into an existing project. The end-of-semester project in a senior-level Mechanical Engineering Systems Dynamics course requires students to select a system (mechanical, fluid/thermal, electrical, or a combination), simplify it using appropriate assumptions, model the system, and analyze its behavior under various scenarios. In previous semesters, students were allowed to choose their own system but did not receive specific instructions on how to generate ideas for potential systems. For the Fall 2024 course, a facilitated brainstorming activity was incorporated into the selection process, with the goal of encouraging students to generate project ideas that held personal significance, rather than simply choosing a project at random. To assess the potential effects of this addition, a pre/post survey instrument was used to collect student data, addressing the following two research questions: (1) To what extent does allowing students to choose a system dynamics project based on personal/emotional connections to the project help them increase their self-efficacy in system dynamics? (2) To what extent does choosing their own emotionally invested project improve student competency based on project and over all grades?

While students were required to complete the class project, participation in the research study was voluntary and student data was anonymized. The study was conducted under Campbell University IRB Protocol #934.

Methods

The pre- and post survey instrument was adapted from the work of Carbbery et al. measuring self-efficacy in engineering students specifically relating to identifying individual's self-concepts for engineering design tasks [3]. This project reduced the number of questions and changed them to focus on concepts specific to the System Dynamics course. With a possible pool of 18 students, this adapted survey instrument cannot be validated, but does provide insight into student self-efficacy [3, 4]. For this study, students were asked to rank their personal belief on being able to complete the stated task between 0 and 100 (in increments of 10) with 100 indicating a student is highly certain successful completion. Table 1 lists the tasks.

The post survey also included a way for students to indicate whether their system would be categorized as a Mechanical, Fluid/Thermal, Electrical or any combination of the three types of

Table 1: List of the eight tasks that students rated themselves on before and after the project.

Survey tasks
1. Model Mechanical systems
2. Model Fluid/Thermal systems
3. Model Electrical systems
4. Model combined Mechanical-Fluid-Thermal and/or Electrical Systems
5. Perform computer simulations (Simulink) of various dynamic system responses.
6. Solve problems with insufficient information
7. Identify/evaluate information sources
8. Provide a meaningful analysis of a system model

systems. Students took this survey prior to performing the group brain storm activity, and then again on the last day of class. The project was officially complete two days after the post survey when students turned in their reports and gave a presentation on their projects during the university scheduled final exam time.

Project grades and final class grades were anonymized and averaged to be compared to the average grades from the Fall 2023 class to provide insight into research question 2 on student competency.

Implementation

The class project was introduced one class period before the group brainstorming activity so students could choose their groups ahead of the activity. They were informed that they would be allowed to choose their own project with their group, but they would be doing a brainstorming activity to help them decide on a project. On the day of the brainstorming activity, students sat with their groups and each individual received a four page document designed to help them start with a broad individual brainstorming session that would then narrow down into possible project ideas to be discussed as a group. The goal of the activity was to have students reflect on memories with strong emotions and then think of the physical systems (mechanical, fluid/thermal, and electrical) that were a part of those memories. Students received a four page document (to allow for writing space) with the following prompts at the top of each page:

- **Broad**: Fill the page with sentences/brief descriptions of moments or stories in your life that are emotional (Joy, sorrow, excitement, anger, peace, etc). This will be 10 minutes of continuous, individual writing. Don't stop to think, just write while you're thinking. Don't focus on the details, just focus on coming up with as many memories as possible.
- **Narrowing it down**: Review your lists from above and star the moments where you interacted with many "things" or systems. Put yourself back in the moment (5 senses) to help remind yourself of what was there. For each of the 3 items write down as many of the "systems" that you can remember from that moment. (Systems can be Mechanical, Electrical, Fluid/Thermal, Combinations)
- **System Selection**: Pick 2-3 of the systems from your previous list. For each system list the following information: What type of system is it? (Mechanical, Electrical, Fluid/Thermal,

Combinations?) If you were to model the system, what would the dynamic variable(s) be? What kind of physical quantities would you need to look up/solve for to model this system?

- **Talk as a group about everyone's ideas**. Share the story (as much or as little as you are comfortable with) surrounding the system you are interested in modeling. Start FBD's of the systems you are leaning towards as a group to make sure you can model it.

After completing the brainstorming activity, groups were instructed to use the generated ideas to choose a project and then write a project proposal, which was due five days after the brainstorming activity. The rest of the project followed the same requirements as the previous semester (Fall 2023) where students completed the project proposal, a MATLAB/SIMULINK check in with the instructor, a report outline, and then submitted final MATLAB files, a project report, and a group presentation of their project.

Results

Survey results are taken from the 14 students (out of 18 in the class) who completed both the pre- and post surveys. As seen in Table 2, ten participants indicated that their project was solely a mechanical system project, while four students said their projects were either only fluids/thermal systems or a combination of mechanical and fluid/thermal systems. For each of the eight task questions, the pre- and post survey responses for all students were averaged. Figure 1 shows the pre-survey averages in dark gray and post survey averages in light gray. It is promising to note that the total group showed an increase in self-efficacy in all eight tasks, though sometimes the increases were small, such as for task 2 for Model Fluid/Thermal systems.

It is interesting to note the changes in reported self-efficacy for students who worked on projects related to each of the tasks. The average rating for the 12 students who reported having projects that had at least some mechanical systems increased by 10.4% for the "Model Mechanical Systems" task. Similarly, the four groups who indicated they had fluid systems in their projects increased their average rating for the "Model Fluids/Thermal Systems" by 17.2% While these are positive increases, it is important to note that while none of the projects had electrical systems included in the model, the average student rating for "Model Electrical systems" increased by 7.8%. Based on these values it may be the students felt an overall increase in their abilities to model different systems, but that their project choice generally affected their personal belief in being able to model the different system types. Of the two students who completed a combined system project, one rated themselves lower from the pre- to the post survey, while the other increased their rating by almost the same amount, with an average between the two students as 1%.

Table 2: Breakdown of project types by student.

Project Types	Student Responses
Mechanical System	10
Fluid and/or Thermal System	2
Both Mechanical and Fluid/Thermal Systems	2

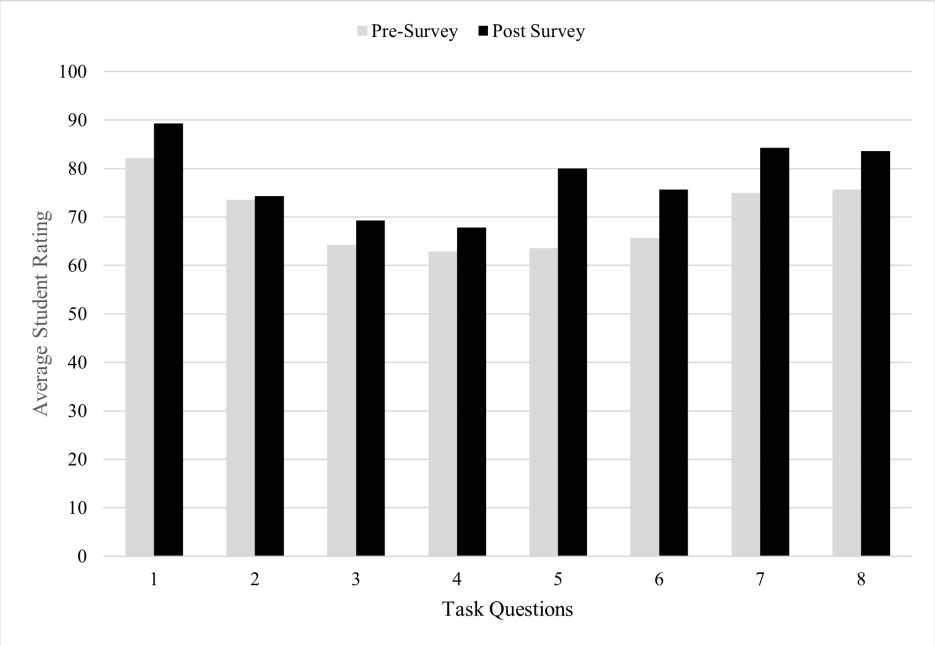

Figure 1: Average student rating for the pre- and post survey tasks.

The survey data for the final four questions can be presented for all of the students since all of the questions are applicable to each project. The change in student responses is indicated in Table 3. At least half of the students indicated an increase in their personal belief of success for all of the listed categories. This trend, combined with the trends in the previous graphs, does indicate that student self-efficacy increases throughout this project, but these questions do not have a way to relate changes in student self-efficacy to the brainstorming/story-driven activity at the beginning of the project. With this current set of data, only the overall effects of the project can be investigated. Survey items are being evaluated and will be updated for the next time this class is taught.

The second research question focused on student competency and if including the brainstorming activity would have a measurable affect on student grades between the Fall 2023 (control) and Fall 2024 classes. Unfortunately there was small decrease in the average class grade, from 92% to 89%, while the class average on the project was a constant 89% for both semesters. It is good to see that the additional assignment did not negatively affect project grades, but there is not much room for improvement in general based on these grades.

Table 3: Variation in student ratings on for the final four tasks from Table 1.

Survey task	Increased Rating	Decreased Rating	No Change in Rating
5. Perform computer simulations	71%	7%	22%
6. Insufficient information	71%	22%	7%
7. Information sources	50%	29%	21%
8. Meaningful analysis	50%	14%	36%

Ongoing work

This study will continue for the Fall 2025 System Dynamics course, with updates to the data collected from participants to improve the ability to understand if the brainstorming activity made a difference in student self-efficacy. A number of ideas are currently being discussed such as

- Have students complete two projects, one where the system is assigned and the other where it chosen by the groups.
- Include a space for comments soliciting student responses on why they chose their project
- Let students work individually on a smaller project and then work with a group project expanding on one group member's small project.
- Identify a portion of the project grade that would best indicate student competency for the different survey items.
- Include story-driven learning activities throughout the course instead of just the one brainstorming activity.

References

[1] C. S. Hulleman and J. M. Harackiewicz, "Promoting interest and performance in high school science classes," *Science*, vol. 326, no. 5958, pp. 1410–1412, 2009. [Online]. Available: https://www.science.org/doi/abs/10.1126/science.1177067

[2] A. Turner, H. Y. Lee, and J. M. LeDoux, "Story-driven learning in higher education: A systematic literature review," in *2023 ASEE Annual Conference & Exposition*, no. 10.18260/1-2–44260. Baltimore , Maryland: ASEE Conferences, June 2023, https://peer.asee.org/44260.

[3] A. R. Carberry, H.-S. Lee, and M. W. Ohland, "Measuring engineering design self-efficacy," *Journal of Engineering Education*, vol. 99, no. 1, pp. 71–79, 2010. [Online]. Available: https://onlinelibrary.wiley.com/doi/abs/10.1002/j.2168-9830.2010.tb01043.x

[4] L. A. DiBerardino III, L. Funke, and D. R. Mikesell, "Incorporating the entrepreneurial mindset into a system dynamics course," in *2018 ASEE Annual Conference & Exposition*, no. 10.18260/1-2–30648. Salt Lake City, Utah: ASEE Conferences, June 2018, https://peer.asee.org/30648.