Making experiences matter - attempts to increase recall and transfer in experiential learning

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Capstone design programs devote significant resources to creating project-based learning opportunities for students. These experiential learning opportunities often contain memorable moments that are much more likely to be recalled by students at a later time than many other college experiences, but it is unclear how much transferable learning students take away from these experiences, and what specific activities and interventions could increase experiential learning transfer for the wide range of students and capstone design experiences that exist. This exploratory work in the use of personal narrative in engineering education is a starting point for 'making experiences matter' more in terms of learning that transfers. This work also seeks to help students develop useful interviewing skills for starting and advancing their career.

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Introduction

The Professional Formation of Engineers is one of the research areas of interest for the authors of this paper. As instructors or co-instructors of the Capstone Design Experience and other project related courses since 2000, we have organized many opportunities for experiential learning. In retrospect, we do not have a lot of evidence that demonstrates that students who have an engineering project experience actually learn from it in a way that transfers or influences their behavior in another situation. Our current research objective is to assess and improve the impact of experiential learning on the ongoing professional formation of engineers, with a focus on recall and transfer of learning from one project experience to another relevant but unrelated scenario.

After some deliberation, we selected interviews as a means of direct and authentic assessment of recall and transfer of project-related learning. Since job interviews and performance reviews are high-stakes events in which an individual's ability to recall and relate a relevant story or experience can make the difference between being selected for a job or promotion opportunity or not, interventions that help experiential learners increase their learning and their ability to perform in an interview could positively impact both their career advancement and their ability to perform effectively in a wider range of engineering projects.

The exploratory research project discussed in this paper uses an endorsement request as the type of treatment meant to spur students to make deeper connections with their project-based capstone design learning experience. This treatment is authentic in that the process of requesting endorsements or letters of recommendation that highlight specific skills is an important step in a student's professional formation, as well as a reflective practice that could impact transferability of learning. Two levels of instructor-student interaction related to endorsement requests were tested to help inform how limited faculty/instructor time should be used to maximize the benefit of experiential learning. In the low interaction level, students made a written endorsement request, and all interactions were through written correspondence. The high interaction involved a face-to-face meeting where the instructor asked structured questions related to the endorsement the learner sought, specifically asking for stories or examples as evidence to support the request. Future work will test other treatments, other levels, and other durations between experiences, treatments, and assessment of recall and transfer of that learning.

The context of this study is a class of 94 mechanical engineering seniors in a capstone design course. To set a common baseline for the study, all students were encouraged to embrace their capstone experience as an opportunity for professional skill development and were required to use the PDSA (plan-do-study-act, or alternately PDCA when study is replaced with check) cycle as a means of skill improvement. The PDSA cycle is based on the scientific method and was popularized by W. Edwards Deming and others in the mid to late 1900s as a cycle of continuous improvement. About a month before the end of the first semester of the year-long experience, we randomly selected about 1/3 of the teams to be in the treatment group (to complete the endorsement request), with the rest of the

teams in the control group. We used a random assignment method within the treatment group to assign students to the low or high interaction level, resulting in 10 students in the high group and 24 in the low group. A few weeks after the endorsement activity, all 94 students participated in the 10-minute interview session where they were asked to respond to questions that had not been shared with them before the interview. This interview was used to test their recall and transfer (ability to apply past experiences in a new setting) through structured, pre-planned questions. Two faculty who had previously completed three calibration interviews conducted the interviews and evaluated student performance using a common rubric. The rubric included ratings from 0 (unable to demonstrate) to 5 (exceeds expectations) of recall, transfer, and communication (or storytelling). For illustration, the performance dimension for the transfer rating was "The ability to apply past experiences to describe what they would do in a scenario different than their past experience," and factors that influenced the rating were: a) quality of response to future scenario, b) relevance of supporting example, and c) example context / detail. Frequent faculty communication during the time of the interviews was used to increase consistency of ratings between the two faculty interviewers.

Prior Work

This work builds on the strong multi-disciplinary foundation of work on experiential education and investigates within engineering education the use of personal narrative or storytelling as a reflective practice that aids transfer in experiential learning. According to the book *Make it Stick - the science of successful learning*[1], we are easily tricked by illusions of knowing so we often need to be prompted to do the types of activities that lead to learning that sticks and transfers. Effective learning interventions should be spaced in time (long enough that it is a struggle to remember), interwoven with other topics (so you are learning patterns or mental models and when they apply), and include elaboration and reflection to help deepen the pathways and connections for greater recall and transfer[1].

The reflective component is widely understood to be critical to experiential learning, but until recently the impact of specific reflective activities was not widely addressed in engineering education literature. For example, a 2014 ASEE Conference paper *Integrating Reflection into Engineering Education*[2] states: "What is striking about the body of research on reflection in engineering education is the limited number of publications." Further highlighting the challenge, the article *Aligning Reflection in the Cooperative Education Curriculum*[3] points out there is limited empirical evidence that reflection increases student learning and calls it a 'wicked' issue. On a positive note, in 2014 the Consortium to Promote Reflection in Engineering Education (CPREE) was established, and some members of that consortium did a more exhaustive study of reflection in engineering education for ASEE 2015[4], reporting that although the number of ASEE papers with reflection as the main focus was still modest, the number that had it as a serious thread was more substantial and was on an overall increasing trend. Essays were reported to be the most common form of reflective activity, and portfolios, surveys and discussion questions were also mentioned.

The specific reflective practice of interest in our work is personal narrative, and although it has not been addressed often in engineering education, the use of narrative or storytelling in education has a strong multi-disciplinary foundation. The field of teacher education speaks of narrative curricula[5], Kolb and colleagues address *Conversation as Experiential Learning*[6], and a paper in the Higher Education Academy discusses the use of storytelling to enhance learning[7]. One recent paper from the 2017 ASEE Conference titled *The Use of Narrative in Engineering Education*[8] takes a broad look at the use of narrative, and specifically uses personal narrative pedagogy to enhance student learning in topical areas such as problem solving, values and ethics. The activities used in this study required students to construct personal narratives at different levels of activity from reflections on prior experiences.

Research Study Details and Results

The written endorsement activity (low treatment) was very similar to a student request for a recommendation letter, but with the specification to be very specific with the skills that they wanted highlighted or endorsed, and the evidence that supported their request. The in-person endorsement request (high treatment) included the following instructions: "When proposing the meeting, include a meeting agenda with topical points that you plan to make in support of your request. Focus on your senior design project work to date, but you may also reference other experiences/work. This meeting will be similar to an in-person interview. You will have approximately 5 minutes to make your case directly, and there will be about 10 minutes of questions and feedback. Make sure you're ready to do the following:

1. Clearly state/explain the skill(s) for which you are requesting the endorsement
2. Specifically address what you hope they would be able to say about you and your work
3. Identify examples from your portfolio of your work and experiences on this or any other project on which they could base their recommendation or endorsement. Be sure to

provide links or other ways the work that you reference can be accessed.

[In other words: Explain why you believe your skill(s)/experience warrant the endorsement and provide evidence through specific experiences.]"

The faculty script we followed for each in-person request for endorsement included up to 5 minutes for the student to make their case for an endorsement, then about 5 minutes for the faculty member to ask questions for clarification or to encourage connection with other experiences, to use "what if" questions about alternative scenarios, and to give feedback and coaching suggestions to the student.

For the interview, we allowed students to pick their own perceived area of strength from three categories - teamwork, integrity and professionalism, or technical skills. Based on their response, we asked a recall question (focused on simply recalling a prior experience) followed by a transfer question (focused on relating a prior experience to a new scenario) in their selected topic area. They were told they had 3 minutes to answer each question, and that it was to their benefit to use that time to be complete or thorough in their answers. We would stop the interviewee if they were off track or did not have a good response and would note if we had to redirect or prompt them with another question. As an example, the questions used for Teamwork are included below.

"Teamwork Recall:

We are interested in hiring engineers who work well in teams and contribute to team effectiveness. Please provide a detailed example or story from your Senior design 1st semester experience that demonstrates how you made your team more effective.

Teamwork Transfer:

Assume that you are on a project team in Senior design in the second semester that is struggling with even work distribution and getting all members to make meaningful contributions to the project work.

A. Please describe how you would attempt to make the team more effective.

B. Please provide an example or story from any of your prior experiences (either positive or negative, not limited to engineering projects) that you think impacted your response or in some way provides evidence that you would respond that way."

At the end of each interview we gave the interviewee feedback in order to help them further develop their interview skills, and if we had not completed it during the interview we assigned a 0-5 rating of their performance in the three research categories (recall, transfer, storytelling) and made additional grading and assessment notes using the standard rating rubric.

The 94 students interviewed included 14 students for whom English was a second language, and we had to remove the results from six of those international students because language issues clearly impacted their participation in the treatment or our ability to assess their learning in the interview setting. This communication issue, which obviously impacts those students' ability to perform within the team, will be a subject of further study. Of the six students removed, one was in the high treatment group, two were in the low treatment group, and three were in the control. This left 88 total students in the study, nine in the high treatment, 22 in the low treatment, and 57 in the control. The relatively low number of students in the high treatment was an unintentional result of how we conducted our random student assignment. To avoid bias, the students who received the high level of instructor interaction for the endorsement had their interview with a different faculty member who was unaware that they were part of the treatment group.

The average recall ratings (on the scale of 0 – 5) for the low and high treatment groups compared to the control showed very little difference (control=3.386, low=3.436, high=3.689) and the t-test for 2 independent means confirmed there was no significant difference (p-value for low vs. control = 0.388 and for high vs. control = 0.149). The average ratings of transfer and storytelling in the interviews showed no statistically significant difference between the low treatment and control but did show a significant difference between the high treatment and control and between the high treatment and the low treatment at $p < 0.05$. Table 1 below shows the mean rating and the p-value for the t-test for 2 independent means for transfer and storytelling, where p_c gives the p-value in comparison to control and p_l in comparison to the low treatment.

Table 1: Summary of Interview Results and Statistics

	Control (n=57)	Low (n=22)	High (n=9)
Transfer	3.435	3.255 p_c= 0.164	4.022 p_c= 0.024 p_l= 0.006
Storytelling	3.161	3.136 p_c= 0.441	3.889 p_c= 0.0028 p_l= 0.0034

Our hypothesis going in to the study was that the low treatment would have a small positive impact on all three ratings and that the high treatment would have a large positive impact. The fact that the written endorsement request with no interaction (low treatment) had no significant impact on recall, transfer or storytelling was disappointing but not surprising. It seemed to be treated as a standard assignment which students are good at compartmentalizing - so any

lessons are quickly forgotten and have little impact beyond the one assignment. The in-person endorsement request including dialogue and personal narrative (high treatment) produced a mean rating for recall slightly higher than the control but the increase was not statistically significant. This result was not consistent with our hypothesis, but we had expected the treatment to have a larger impact on transfer than recall, and we believe with a larger sample size and more resolution in the ratings we will see a significant difference in the future. The most promising result is that the high treatment was shown to significantly impact the ability of students to transfer learning from one experience to another, and their ability to tell a story or provide a compelling narrative account of a project experience. This result is consistent with the qualitative observations of the faculty and the comments received from the students. The interactive dialogue in the high treatment was expected to have the most significant impact in preparing the students to think about how their learning in one context transfers to another, and that seems to be reflected in the larger impacts on transfer and storytelling ability.

Notably, almost all students took the in-person endorsement requests and the interviews quite seriously. The tone of the personal interviews seemed quite like a genuine job interview. There was a significant distribution of student performance on the assessment: the lowest performer (a native English speaker) experienced interview anxiety and received minimum scores, and the highest performer had maximum scores in all categories. In conversation after the interviews, many students commented that they found the interview activity to be useful, especially regarding preparation for their upcoming job interviews. Many students had never participated in a simulated or actual job interview before the activity. Notably, the pedagogical approach taken by the instructors in this capstone course and its prerequisite involves a lot of in-person meetings to report on work; by the time of the assessment interview, students would have been at least quite familiar with the experience of answering questions in a setting similar to the assessment. Some students were clearly at ease in the assessment interview, and some were visibly nervous. From the instructor perspective, for a relatively short time investment per student the interviews provided significant perspective on students' various backgrounds and some insight into each individual student's prior experiences, helping with the important goal of better understanding and relating to our students.

One improvement for future studies will be to modify the 0 - 5 rating scale. Although we used non-integer values (3.5 for performance between a 3 and a 4), future rating scales will have more resolution to allow more differentiation between performance levels.

Conclusions and Future Work

At this point all conclusions are preliminary due to the relatively low sizes of the treatment groups, but the results concerning the significant impact of an interactive endorsement request on subsequent transfer of learning from experience provides a promising foundation and will help direct our future work. Other treatments that have even more potential to impact transfer, such as interactive engineering case studies, are being developed for future testing. Further refinements of the use of interviews as an assessment for transfer are planned, in addition to refinements in the rating scale and expansion of the interview team beyond engineering faculty to include others from outside the college with human resources expertise.

Since the faculty co-authors have and will continue to devote significant time to creating rich learning experiences for students, we are convinced of the necessity to make those experiences matter as much as possible for student learning. We believe that any advancements in this area can have a significant impact on the overall goal of improving the professional formation of engineers, not limited to their college experiences, but throughout their careers.

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