6-23-2013

Measuring the Impact of Internships on Design using a Materials Activity

Craig Johnson
Central Washington University

Charles O. Pringle
Central Washington University, pringlec@cwu.edu

Nathan Davis

120th ASEE Annual Conference & Exposition
FRANKLY, WE DO GIVE A D*MN
June 23-26, 2013

Paper ID #7838

Measuring the Impact of Internships on Design using a Materials Activity

Dr. Craig Johnson P.E., Central Washington University

Dr. Johnson (P.E. Materials Engineering) is a professor coordinating the MET program at CWU and is the chair of the PNW Section of ASEE.

Prof. Charles O. Pringle, Central Washington University
Prof. Nathan Davis EIT

Measuring the Impact of Internships on Design Skills using a Materials Activity

Abstract

Our research question focused on how previous student experience, like a job 'internship', affects an ability to demonstrate engineering design skills. Principal 'student experience' focused on prior industrial experience (e.g. internships), but also included 'annual project' participation (e.g. ASME Design Challenge Teams).

The scope of this effort included the creation and application of a design activity, resulting in documents that were evaluated with a metric. The activity focused on the effect of material selection and analysis with regard to 'design performance'. Creating these activities, and using them to assess design skills is the novel aspect of this effort. Two classes (one in MET-Mechanical Engineering Technology, and one in EET-Electronics Engineering Technology) performed the design activity. The ET professors facilitated the activity during a normal class period. After the activity, the professors independently evaluated the team documents using a design metric (e.g. RADD – Requirements, Analysis, Documentation, Drawings).

A correlation was found between previous internship experience and an increased ability to design and document this skill. This correlation appeared in both MET and EET disciplines. There were consistent results between the faculty members, using the RADD metric. A conclusion from this work is that participation in internships as an undergraduate positively contributes to student's design abilities.

Introduction

Engineering design skills are targeted as an outcome necessary in our accredited courses supporting the Mechanical Engineering Technology (MET) program at Central Washington University (CWU). Specifically, we focused on ABET[1] criterion 3.B.d, "Criteria for Accrediting Engineering Technology Programs 2013-2014, General Criterion 3:B. For baccalaureate degree programs, these student outcomes must include, but are not limited to, the following learned capabilities: d. an ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives"

Our interest was to ascertain if *previous student experience* affects a student's ability to design. If we could correlate previous experience to an increase in design skills, we would be able to use the correlation to promote more student experience. Our hypothesis is that a student gains skills during internships and other asynchronous activities that improve their design skills. Our intention is to measure and evaluate this relationship. If true, this data can support increased efforts to promote student experience outside our curricula.

We use the term 'design' in a traditional sense, as in support of ABET discussions. However, the authors realize that much work has been done in this area, and our assessment is not inclusive to all aspects of design. A significant discussion of this was presented by Daly[2], et. al., and where they interviewed over twenty experienced engineers about what how they understood engineering design. They concluded that there were a half dozen 'lenses' in which can 'facilitate common ground' regarding interpretation of design skills. The depth of this study is beyond the scope of this effort. The chose a pragmatic definition (e.g. 'evidence-based decision making') of design, and used a suitable assessment method.

A significant challenge concerned a method of observing students exercising design skills. We chose to develop an education activity that focused on design. A constraint was that we wanted to evaluate students from both MET and Electronics Engineering Technology (EET) programs. To that end, we developed an activity that used material selection as the primary driver for device performance. This is the 'bridge' that we focused on, allowing a general 'design' activity be applicable to multiple disciplines.

Another challenge concerned the assessment of design skills. Based on previous work[3] a metric was selected. The metric is termed "RADD", and has been used each quarter for over five years. The metric targets four areas: 1)<u>R</u>equirements, 2)<u>A</u>nalysis, 3)<u>D</u>esign, and 4)<u>D</u>rawings (RADD). The metric has been adapted for use in assessing different media. For example, the initial use was to assess documents such as engineering proposals. Then the metric was modified to assess presentations, such as Design Reviews. For this effort, we chose to create a RADD metric to evaluate an engineering report submitted by students completing the design activity (Appendix A).

Since our intention was directed at comparisons of design abilities, and not the absolute measurement these abilities, we chose not to engage in a search for other assessment instruments. A cursory search reveals many instruments such as the CEDA, PCT, PSVT-R mentioned in a recent JEE article[4].

A constraint on this approach was that the activity primarily used teams. We targeted seniors, so they had formal instruction in design. We chose to implement the activity with teams because it reflected typical work scenarios and because it was logistically prudent. So even if a single engineering report reflected two to more students, the report itself could be evaluated with the RADD metric efficiently. Any data would be attributed to the team.

Methodology

To test our hypothesis, we created teams that represented different 'student experience', and then assessed their design skills. After assessing design performance, correlations could be made.

Teams were created to reflect our hypothesis. First we used a survey to identify individual student skills (Appendix B). These data were then processed and teams created comprised of 'experienced' vs. 'non-experienced' students.

To promote a timely pursuit of this research, we chose to constrain the design activity to one event. By the end of the activity, the team would submit an engineering report (physical or electronically). The engineering report would reflect the effort of the team (of whatever size).

The facilitator enacted the activity and assessed the work using the RADD metric. At this level of effort, it was not possible to triangulate (e.g. use a three methods) to support our methodology.

Design Activities:

We developed two design activities: one for each Engineering Technology (ET) discipline. An activity that required materials analysis was created, because of its cross-disciplinary aspects. The activities were also constrained such that any required support data could be found in the student textbooks. Also, the activities were timed to fit in a normal class period (50 minutes).

The EET activity concerns the design of an inductor (Appendix C). In this scenario, the major focus was the size of the device, dependent on material choices. The intention was not to make the design decision difficult, but to offer a scenario that allowed the students to document the various aspects of the design process.

The MET activity concerned the design of a gear (Appendix D). This activity also focused on allowing the students to promote different designs, with different materials, based on their constraints and calculations. The same time was allotted for each ET activity.

Results:

Data was processed for each of the MET and EET design activities. Tables 1 and 2 display the RADD data for each program. Teams are listed on the left margin. Indications of 'experienced' vs. 'non-experienced' are listed in the second column of each table. The RADD data descriptions are recorded across the top, with related data below. And a total for RADD is given on the far right margin in both raw number and percentage.

ID	Exp?	Requirement	Analysis	Documents	Drawings	Total #/%
MET Team 1	Yes	11 of 15 =.73	4of10=.4	4of20=25%	7 of 10= 70%	26/47
MET Team 2	No	9 or 60%	7or 70%	4 or 20%	8 or 80%	28/51
MET Team 3	Yes	11 or 73%	6or 60%	4 or 20%	8 or 80%	29/53
MET Team 4	Yes	12 or 80%	4or 40%	7 or 35%	5 or 50%	25/45
MET Team 5	Yes	13 or 87%	7or 70%	4 or 20%	5 or 50%	32/58
MET Team 6	No	4 or 27%	0	0	6 or 60%	14/25

Table 1: Data of "R, A, D, D, total" for the MET student documents.

ID	Exp?	Requirement	Analysis	Documents	Drawings	Total #/%
EET Team 1	No	1	1	1	1	4/100
EET Team 2	Yes	.7	.6	.8	.5	2.6/65

EET Team 3	Yes	.8	.7	.8	.6	2.9/73
EET Team 4	No	.8	.6	.7	.7	2.8/70
EET Team 5	No	.5	.5	.7	.5	2.2/55
EET Team 6	Yes	.8	.8	.9	.8	3.3/83
EET Team 7	Yes	.9	.8	.8	.9	3.4/85
EET Team 8	No	.5	.5	.7	.5	2.2/55

Table 2: Data of "R, A, D, D, total" for the EET student documents.

The classes were given a single activity during a 50-minute time period. Student documents were collected, and then assessed by the facilitator.

Discussion

The data indicated that teams with students that had experience, demonstrated higher design skills. In the MET activity, the two teams without experience scored 25 and 51% (mean of 38%). The four teams with experience scored 45-58% (average of 51% with Stdev of 6). Though not statistically significant due to a low sample size, the data indicate that student experience does correlate to increased design skills.

The EET group results are shown in Table 2. One extreme data set, S1, was omitted due to its being more than two standard deviations out. The 'experienced' students performed at a cumulative 77% (Stdev = 9) and the 'non-experienced' students performed at a 64% (Stdev = 9). Again, low sample numbers limit the quality of the correlation, but experience appears to correlate with higher design performance.

One observation is that the EET group appears to have a higher performance rating, in general, than the MET students. This may be a factor of two different faculty members employing the same metric, each using their own interpretation. The difference was not relevant to this study, though it also supports the correlation of student experience and design performance.

Any other aspect of the students involved (e.g. GPA, other experience) was not explored in this effort. These aspects may be explored in a future study.

Conclusion

Design activities were created to produce documentation of design skills. Students that had previous experience, such as internships, and those without experience, were associated with the design documents. These documents were evaluated with a metric focusing on design skills. Our research results support the hypothesis that student experience, specifically internships, positively affects student's ability to design.

Acknowledgements

Thanks to Central Washington University students for their voluntary efforts.

Bibliography:

1. ABET, http://www.abet.org/DisplayTemplates/DocsHandbook.aspx?id=3150, TAC Criteria 2013-2014.
2. Daly, S.R., et al, "What Does it Mean to Design?", JEE, Vol. 101, No.2, April 2012.
3. Oncina, C., Johnson, C.H., "Use of MET Capstone Course RADDical Metric", ASEE Conference, 2005.
4. Charyton, et al, "Assessing Creativity Specific to Engineering with the Revised Creative Engineering Design Assessment", JEE, Vol. 100, No. 4, October 2011.

Appendix A: Assessment Metric

Assessment Metric (RADD):

Score on a [0 vs. 0.5 vs. 1] scale on how well the individual satisfied the requirement
0 = Did not satisfy the requirement
0.5 = Partially satisfied the requirement
1 =Completely satisfied the requirement

		Name of speaker	2	3	4	5	6	7	8	9	10	11	12
REQUIREMENTS													
Did they…	Define the problem												
	Specify appropriate requirements												
	Articulate the benefits of their design												
	REQUIREMENTS SUB TOTAL												
ANALYSIS													
Did they…	Discuss their analysis. Complete?												
	Communicate a clear objective												
	ANALYSIS SUB TOTAL												
DESIGN													
Did they…	Assess the risk of their design												
	Assess the cost of their design												
	Articulate its performance												
	Articulate the schedule												
	DESIGN SUB TOTAL												
DRAWINGS													
Did they…	Include sufficient drawings/sketches												
	Include detail (e.g. analysis parameters)												
	DRAWINGS SUB TOTAL												
GRAND TOTAL													

Appendix B Survey Assessing ‘Student Experience’

Student assessment instrument regarding ‘Student Experience’

YOUR NAME:
____

IN THE LAST TWO YEARS, HAVE YOU DONE AN ENGINEERING INTERNSHIP?

If so, please provide name(s):____

____

IN THE LAST TWO YEARS, HAVE YOU HAD AN ENGINEERING JOB/POSITION?

If so, please provide name(s):____

____

IN THE LAST TWO YEARS, HAVE YOU PARTICIPATED IN A DESIGN EVENT?

This includes ASME RC BAJA, ASME DESIGN COMPETITION, ELECTRATHON

Name: ____

____

Appendix C: Materials Design Activity for Electronics Engineering Technology

EET 332

Instructions to Students:

Form teams of three to propose a design within the allotted one-hour time. An electronic document will be submitted.

Problem Statement:

An engineering firm required a 24 mH inductor designed for an instrument. The bidding process for the contract requires that two designs must be submitted. The firm has several core materials available on site, including Permalloy, Silectron, and relay steel. The contract specifies that any of these three materials, in addition to air, may be used as the core material.

Function statement:

Propose two designs for a 24 mH inductor. Select your core materials, then use Figure 2.27 on Page 29 of your text book to determine the permeability of the materials you plan to use. Assume that the core of the inductor will not enter saturation.

Requirements:

- Specify the gauge of wire used in the design.
- Specify the number of turns, cross sectional area, and length of each inductor.
- Provide a mechanical drawing of each inductor.
- Submit a one-page summary of your design following standard engineering homework guidelines. Include a recommendation based on the physical characteristics of the two designs.

Deliverable:

Via electronic media send a memo, detailing your proposal, to the engineering firm (e.g. your instructor or Blackboard™ venue). Please make sure that you have certain information in this memo, as follows:

- List your team members and the engineering firm
- Restate the problem, criteria, assumptions, solution, and proposal

Appendix D: Materials Design Activity for Mechanical Engineering Technology

MET 419

Instructions to Students:

Form teams of three to propose a design within the allotted one-hour time. An electronic document will be submitted.

Problem Statement:

An engineering firm required a gear for an automotive winch. The 10HP winch drive shaft has a one inch spur gear that needs to transmit power to a six inch mate. The small gears is failing, and substitute materials are sought.

Function statement:

Propose a design for the spur gear. Select the materials you plan to use, and specify the gear. Assume a relatively short lifetime for the system.

Requirements:

- Specify the gear material used in the design.
- Specify the gear itself, with all parameters
- Provide a mechanical drawing and or sketch of the gear.
- Submit a one-page summary of your design following standard engineering homework guidelines. Include a recommendation based on the physical characteristics of your design.

Deliverable:

Via electronic media send a memo, detailing your proposal, to the engineering firm (e.g. your instructor or Blackboard™ venue). Please make sure that you have certain information in this memo, as follows:

- List your team members and the engineering firm
- Restate the problem, criteria, assumptions, solution, and proposal