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Applied CR·I·Tical Thinking

How Engineering and Computing Students Demonstrate Critical Thinking During Required Co-op Work Experiences

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Establishment of an Initiative (2012)

- Anonymous Alumni Donor gave RIT money to establish an initiative in applied critical thinking to be named after a professor in the College of Business that greatly influenced the donor and was known for the teaching of applied critical thinking
  - Chair, Faculty Fellow, Advisory Boards
  - Activities
    - Speakers, Awards, Faculty Programs

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Applied Critical Thinking

- The RIT general education student learning outcomes:
  - Use relevant evidence gathered through accepted scholarly methods and properly acknowledge sources of information
  - Analyze or construct arguments considering their premises, assumptions, contexts, and conclusions, and anticipating counterarguments
  - Reach sound conclusions based on logical analysis of evidence
  - Demonstrate creative or innovative approaches to assignments
- Critical thinking is accomplished by analysis of information to assess veracity and relationships; use of hypothesis and experimental results; application of multidisciplinary methods to support evaluation and possible creation of new ideas, products or views. Critical thinking also seeks to resolve weaknesses in thinking such as insufficient inquiry, ambiguity, unexamined assumptions, biases, and subjectivity.

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RIT is a co-op school

- 64% of our degrees require students to complete at least 1 co-op experience to earn their degree
  - 44% require more than one (31% require 4)
- Co-op is defined as full time (35 or more hours per week) employment for a semester (10-15 weeks)

Co-op Employer Survey

- 5-point Likert-type scale with a choice for not applicable
- Rated on: **critical thinking**, creativity and innovation, writing, communication, cultural diversity, information literacy, initiative, collaboration/teamwork, ethics, self-reflection, leadership, reliability, quality of work, quantity of work, quality of technical preparation, overall performance, and finally asks if the student would be competitive for permanent appointment (yes/no).

Research Questions

- RQ1: Were there differences in critical thinking scores amongst the students from different colleges?
- RQ2: Was there a change in the critical thinking co-op score from a student's first co-op experience to their last?
- RQ3: Is there a difference in critical thinking score for a student who does an optional co-op versus a required co-op?
- RQ4: Is there a difference in critical thinking score for a student who does a summer co-op versus a semester (fall or spring) co-op?
- RQ5: Is there a relationship between the number of co-ops a student completes and their critical thinking score?

Data

- Data from: colleges of applied sciences and technology, business, computing, engineering, health science and technology, imaging arts and sciences, liberal arts, and science
- Academic years 2014-2015 to 2016-2017 inclusive (three academic years). We are considering an academic year to include a fall term, spring term, and summer term.
- Critical thinking ratings for 3594 unique students
  - 2115 (59%) completed multiple co-ops
  - 7195 total co-ops completed

Number of co-ops completed	Number of students	% of overall
1	1479	41%
2	1078	30%
3	655	18%
4	320	9%
5	62	2%

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Results: Differences by College

College	Mean Rating	Std. Dev.	Mean Diff.	d
Business	4.32	0.75		
			0.01	<.01
Imaging Arts & Sciences	4.32	0.74		
			0.02	0.05
Liberal Arts	4.29	0.72		
			0.11	0.15
Computing	4.18	0.70		
			0.22	0.31
Engineering	3.96	0.71		
			0.02	0.03
Applied Science & Tech	3.94	0.72		

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Results: Change in score first -> last co-op

Difference (last score – first score)	Number of students	% of overall
-4	1	0.005%
-3	6	0.2%
-2	58	2%
-1	354	16%
0	1029	49%
1	507	24%
2	136	6%
3	12	0.5%
4	1	0.005%

More Results

- Required vs Optional
  - Rating on required co-ops (M = 4.18, SD = .70) were lower than those on optional co-ops (M = 4.41, SD = .66), t (292) = 2.94, p = .004, d = 0.34, by a medium effect.
- Semester vs Summer
  - Students who completed co-ops during the semester (M = 4.04, SD = .71) were rated slightly worse than those who completed co-ops over the summer (M = 4.18, SD = .72), t (3592) = 5.89, p < .001, d = 0.21.
- Number of co-ops
  - We found that number of co-ops was not related to average score, r = -.002, p = .90.

Conclusions & Future Work

- Bad news for our traditional "critical thinkers"?
- Alumni data about critical thinking
- Inclusion of student learning outcomes for critical thinking that specifically address problem solving integrated into our already existing general education requirements
- Degree-program level learning objectives targeting critical thinking and problem solving in domain-specific ways.
- Students are showing high level of ability in critical thinking - an average rating of 4.1