Utilizing the CDIO syllabus to reveal CEAB Graduate Attribute Pathways in a Mechanical Engineering Program

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Abstract

A skills-based analysis of an accredited Canadian Mechanical engineering program was conducted. 44 courses were assessed using the CDIO (Conceive, Design, Implement, Operate) Initiative syllabus (Crawley et al., 2014). Network visualization software was used to map courses and the corresponding graduate attributes to three levels of development. Development of some graduate attributes, such as “Teamwork” were found not to follow the pre-requisite pathways, indicating that interventions would be required to re-align this learning journey.

Introduction

Pre-requisite pathways may not accurately reflect the development of professional skills in a program. There is an increasing emphasis on professional skills development in Canada (see Canada’s Graduate Attributes 6-12 (Canadian Engineering Accreditation Board, Canada (see Canada’s Graduate Attributes 6-12, 2017)). Network visualization offers great potential to both understand and communicate complex systems. Methodology presented in this paper can be adapted for use at any schools united under the Washington Accord (Anwar & Richards, 2015).

Methodology

- 73 CDIO syllabus items used as learning outcomes indicators for 44 core courses.
- CDIO personal, interpersonal and system building skills mapped to the 12 CEAB graduate attributes by Cloutier et al. (2012) were assigned a level of “Introduce” (I), “Teach” (T) and/or “Utilize” (U) in each course in instructor interviews.
- Eight combinations of I,T,U (and none) were collapsed into four levels of learning which established a hierarchy of pre-requisite relationships:
  1. Level 1 - “Introduce”, “Introduce/Teach”, “Introduce/Teach/Utilize” were treated as first level combinations which were independent and required no previous exposure.
  2. Level 2 - “Teach”, “Introduce/Utilize”, “Teach/Utilize” were classified as combinations dependent on Level 1 exposure to the skill.
  3. Level 3 - Utilize was deemed to be dependent on second level learning.
- 44 courses and one of three levels of the 12 graduate attributes were assigned a node, totaling 80 nodes. Nodes between the courses and assigned level of graduate attributes were linked by edges and visualized using open-source network visualization software “Gephi”
- Conducted a comparison across each graduate attribute and important courses.

Results

<table>
<thead>
<tr>
<th>Level</th>
<th>GA Pathways not Pre-requisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Important Skills</td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Pre-requisite pathways did not reflect development pathways for all professional skills. These findings will be used to inform and prioritize the implementation of professional skills modules. Future research could define relationships between GAs, and an audit of student perceptions of their skills at the end of each course could also augment the study. Categorization into three “equivalent” levels provides a good indication of comparative importance and succession of knowledge building. There are limitations associated with instructor understanding of I, T, U, which could be improved. This tool is a snapshot, but courses are always changing, and a tool for tracking and updating information is proposed.

Conclusions

Critical gaps in professional skills development were revealed through the analysis. First and second-year courses appearing on Level 3 are at risk of engaging student skills before they are properly developed. GA5-Teamwork was found to be a critical intervention point. Further and ongoing analysis is required to ensure robust alignment. Curriculum and program designers can use this student-oriented approach to inform professional skills development pathways. A tool that could store and track up-to-date GA development at the end of each term would provide more reliable data for further analysis.

References

Crawley, E. H. https://doi.org/10.1016/j.cub.2007.09.003

Acknowledgments

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