

**Visualizing the Mapping of Outcomes, Content, and Curriculum between
programs to support transfer
Project 2017-39-LO**

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Goal

The goal of this project is to build a web-based tool called *Trail* to visualize outcomes, curriculum, and content of one or more programs to support development of student pathways.

Background

This project was developed from two previous projects funded by the Ontario Council on Articulation and Transfer (ONCAT). The first project was conducted in 2015 (Zakani *et al.*, 2016), and involved the creation of a framework to compare engineering technology diploma programs and engineering degree programs in Ontario. This was primarily accomplished by comparing selected courses and skills that were found to be part of most engineering programs, such as Calculus and Physics.

In 2016, the second project (Waller *et al.*, 2017) focused on engineering discipline-specific program comparisons using parts of the Zakani *et al.* (2016) framework to compare electrical engineering to electrical engineering technology and mechanical engineering to mechanical engineering technology. Information visualizations of large data sets of information was a key technique used in the analysis in both the Zakani *et al.* (2016) and Waller *et al.* (2017) studies.

The idea for the current research project came from the extensive use of visualizations in the two previous ONCAT-funded projects. One of the primary goals of the current project is to enable those working with transfers to produce similar visualizations to help support student transfer and mobility in Ontario and possibly lead to bridging programs or pathways between programs and institutions.

Information visualizations can be a useful way to display data, particularly data that may otherwise only be available in text-form. They can also help identify trends, similarities, connections and gaps between courses or programs.

Focus Groups to gather information for web app

Two focus groups were organized in June 2017 to discuss how a web-based tool could help support student transfer by comparing two or more programs. People working with transfers were invited to participate in one of two focus groups held in June 2017 in Kingston and Toronto. In total, 31 participants from six different sectors (engineering, business, nursing, kinesiology, psychology, applied information science) attended, either in-person (24) or remotely (7).

The focus groups drew participants from across Ontario from 19 different institutions (8 universities and 11 colleges). Participating institutions were: Brock University, Carleton University, Centennial College, Conestoga College, Durham College, Fanshawe College, Georgian College, Humber College, Lakehead University, Laurentian University, Niagara College,

Nipissing University, Queen's University, Seneca College, St. Clair College, St. Lawrence College, University of Ontario Institute of Technology, Western University, York University.

A broad spectrum of institutional stakeholders were in attendance at both focus groups, highlighting the intersectionality of transfer-related issues. A list of stakeholders who attended appears below:

Academic Quality Lead	Enrolment Services and Strategic Partnerships
Academic Manager (Nursing Program)	International Recruitment Officer
Admission Assistant	Registrar's Office
Assistant Professor	Manager
Assistant Registrar	Transfer Credit Advisor
Associate Dean	Pathways and Credit Transfer Coordinator
Associate Professor	Program Coordinator (Bachelor of Applied Health Information Science)
Business Program Contact	Program Head
Chair (Admissions Committee)	Program Manager
Credit Transfer Officer	Student Advisor
Curriculum Consultant	Undergraduate Academic Advisor
Dean	
Director (School of Kinesiology)	
Director (Centre for Academic Excellence)	

Focus group participants were sent a pre-focus group survey. Complete tables of results for questions 1 and 2 (identified below) can be found in Appendix A. The following is an annotated discussion of the results:

1. *What information do you typically have when assessing student transfers coming into (or going out of) your program?*

Of the 21 programs that responded, the most common information available when assessing student transfers are transcripts and course syllabi. Just over half use course learning outcomes and about one-third utilize institutional information.

2. *What information would you ideally like to have (but do not) when assessing student transfers coming into (or going out of) your program?*

Of the 21 programs that responded, those that do not currently use course learning outcomes or institutional information to assess transfer would like to and the majority of respondents reported that they would also use program learning outcomes, if they were available.

3. *What do you think are the most common barriers to transfers in your program?*

The most common barriers to transfer, grouped by theme are:

Time

- The entire transfer process can be time-consuming.
- The time it takes to process applications can be very long.

- It is challenging to organize the timely receipt of information.
- The turn-around time to have credits assessed must be considered.
- It is often difficult for students to start the process before they arrive.
- Faculty must take time to evaluate equivalent courses.

Equivalency

- There is a misconception that college and university courses cannot be equivalent.
- There is often a culture of treating all universities as equal.
- What is the best method for determining course-to-course equivalencies?
- Sometimes two courses may be co-requisites at a receiving institution, but if only one of the two has been taken at the original institution, it is difficult to grant any transfer credits.

Cost

There is often a cost associated with trying to transfer a course from one institution to another, and payment is often required whether the courses is considered equivalent or not.

Changes to courses

The ongoing emergence of new courses and programs, combined with continuous changes to existing courses and programs makes the tasks of maintaining and re-establishing pathways, transfers, and equivalencies quite challenging. It is difficult to keep transfer information up-to-date and accurate for every program.

Availability of Information

- Documents not always available in a standard and comparable format.
- Information is often incomplete. For example course descriptions may be available, but not course outlines.
- Sometimes a full course syllabus is unavailable.
- The quality of available documentation varies.
- Students may not always have access to required documents.

Course alignment

- Transfer decisions are usually made on an individual basis and there are often no clearly-defined parameters.
- It is difficult to assess transfers when there is a lack of familiarity with programs and courses at other institutions.
- In some cases, only certain content has been covered and it is not possible to grant partial credits.
- In the case of block transfers, often credit may have been given for a whole block of courses, however if the block doesn't align exactly, students may end up retaking certain courses they have already taken and miss-out on others.
- There is a specific difficulty that arises when assessing a transfer between credential levels (e.g. diploma to degree). Course-to-course transfer may not be appropriate, and it

is difficult to quantify and conceptualize the broad range of learning that has occurred in a program and then convert that into specific course transfer credits at the receiving program or institution.

Accreditation

In accredited program, there is often an aversion to granting too many transfer credits because of worries about meeting accreditation requirements for all graduates.

4. *Please tell us a bit about any tools, assessments or methodologies that you have found successful when dealing with transfers that you can share with us.*

The most common tips for assessing transfer, grouped by theme are:

Course syllabi online

- The more detailed an institution's website is in detailing courses or providing current course descriptions/syllabi, the easier it is to gather information.
- Information about when a course was last updated is useful.
- Some institutions have a database of courses over time.

Pathways

- Defined pathways and developed partnerships make a positive difference in student transfer.
- Pathway Curriculum guides are useful.
- Ontario System-Level Transfer Agreements for Business programs at Ontario Colleges.

Bridging Program

- Defining specific courses transfer students are required to take before progressing to the next program are essential.
- An orientation workshop, specific to a bridging program provides information about the new program and eases the transition to online learning.
- Some suggest a "backwards design" methodology to first determine where the student wants to go. Followed by a course-to-course comparison to identify gaps and advise on appropriate bridging strategies.

Students

- Dealing with students from a specific source institution becomes an unofficial pathway, since one becomes familiar with certain courses and programs through those students.
- Some institutions incorporate short concept-assessing interviews into the transfer process.
- Some institutions take into account student experience beyond academics (e.g. resume, work experience)
- Often, the students themselves are a valuable resource when gathering information about program specifics.
- Only official transcripts and course outlines are accepted.

- A student self-evaluation guide to complement other documents has helped in some programs.

Learning Outcomes

- Having well defined course and program learning outcomes is essential to successful transfer.
- The Credit Transfer Evaluation Guide encourages faculty to primarily utilize course learning outcomes when assessing credit transfer requests.

Percentage Overlap

- Some institutions have a rule of thumb on the percentage of overlap required in order to grant a direct equivalent in transfer.

Database

- Certain institutions keep their own database of equivalent courses.
- Some programs use ONCAT's database, ONTransfer.

Shared folders

- Certain programs having a shared drive between the Transfer Credit office and faculty members assessing transfers.

At each focus group, participants were asked three follow-up questions, and to discuss their answers in small groups. The questions and a summary of the focus group answers are below:

Question 1: "What information do you use to evaluate transfer now?" Many of the answers to this questions echoed the result of the pre-focus group survey. However, participants stressed the importance of learning outcomes. Program learning outcomes, course learning outcomes, and even weekly learning outcomes are regularly consulted by many of the focus group participants. Many also stressed the importance of determining the relative alignment of learning outcomes to course assessments as well as the value of properly worded learning outcomes. There were also a few additional items that participants mentioned they often use to evaluate transfer now, such as:

- List of textbooks used in the course.
- A demonstration of the degree of difficulty of a course.
- Student work samples.
- Program calendars, particularly in cases when the course outline is not clear about course weight.
- Program Accreditation maps (e.g. mapping of course outcomes/content against program level or standards level outcomes)

Question 2: "If you were to setup a multi-institutional transfer agreement between diploma programs and degrees in your discipline, what information would you use?" It was challenging for many focus group participants to think about block transfers, bridging programs or

pathways because the consensus was that every case of student transfer is unique in its own way. Below is a list of some key ideas that came out of the discussions:

- Begin with learning outcomes. Many institutions, particularly the colleges, put a lot of effort into the wording of the learning outcomes and aligning learning outcomes with course assessments.
- Consider the context of learning outcomes. For example: Does 'create' at the college level mean the same as 'create' at the university level? Not necessarily. What is the student creating?
- Examine the past performance of other students. Even without official pathways between programs, it is often possible to discern how students from certain institutions or programs will fare compared to students from certain others programs or institutions.
- If possible, keep track of conversations between instructors regarding course equivalencies. This is particularly useful when the conversations are between college and university instructors, as universities are sometimes reluctant to grant a specified credit.
- Keep in mind any accreditation requirements of the program as well as the professional registration status of previous instructors.

Question 3: "What analysis, comparison, and/or visualization would you find useful to accomplish Question 2?" The results of the third question were combined with the original idea for the web-app and contributions from those participating in the focus group into a list of *technical requirements*.

Technical Requirements

The web-app should be able to accomplish the following:

- Provide the most up-to-date, real-time information on courses, programs, outcomes, etc.
- Course-to-course comparison
- Program-to-program comparison
- Gap Analysis – show overlaps and gaps between two or more courses or programs.
- Heat Map – show percentage of content overlap between two or more courses or programs.
- The ability to go beyond Bloom's taxonomy. Future iterations of the tool may be able to compare courses using the ICE framework, SOLO taxonomy, etc.
- Record past equivalencies – show other courses or programs that have been considered equivalent.
- Keep track of existing pathways and institutional agreements
- Be customizable – allow users to change views and parameters at different points when using the tool
- Be flexible – allow users to look at the same information in different ways

Additional Information gathered through focus group conversations can be found in Appendix B.

Trail – The Web Application

Trail is an interactive web app that is able to extract the verbs from course or program learning outcomes, categorize the verbs according to Bloom's and SOLO taxonomies and output a series of visualizations that will help the user compare multiple courses or programs.

Text Extraction

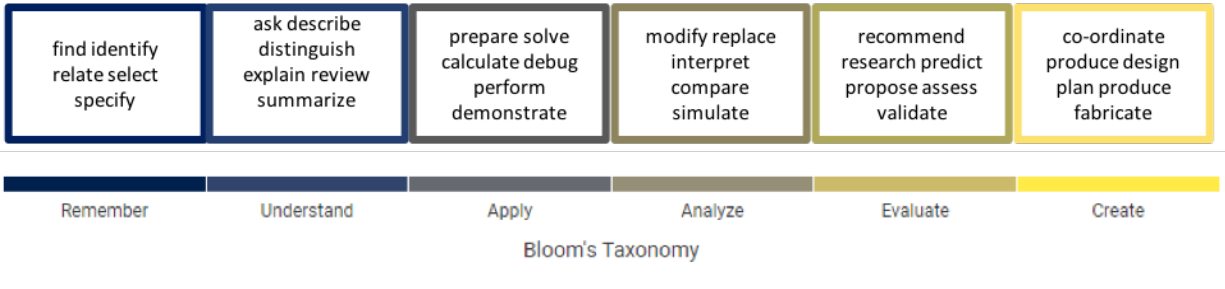
The web-app communicates with a text extraction Application Programming Interface (API) developed by Sahib Singh Budhiraja and Vijay Mago of Lakehead University using Python and Java (Budhiraja and Mago, 2018). Many course syllabi, which include course learning outcomes, are available in PDF format and the format varies widely. The Lakehead text extraction system treats each PDF document like an image and does a pixel by pixel analysis of the document to determine where the learning outcomes appear and accurately extract them from the document

The general process, as described by Budhiraja and Mago (2018) is as follows:

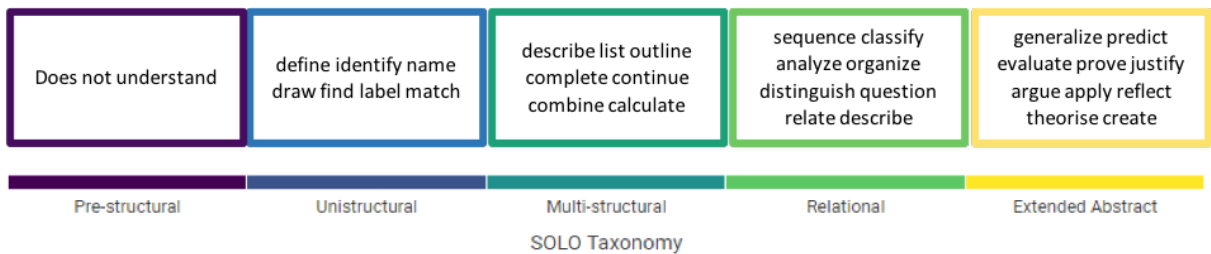
- The document is converted from a PDF document to an HTML file. This allows pertinent information to be extracted from the HTML tags.
- The code locates relevant headings using formatting information and a set of keywords associated with learning outcomes.
- The relevant headings are used to mark the beginning and end of the relevant text that will be extracted.
- The code then analyzes the specific layout of the document to determine the location and specific format (bulleted list, text in multiple columns) of the required text (learning outcomes).
- The text is then extracted using the beginning/end markers and the layout information.
- The text is extracted in one continuous string and is subsequently divided into sentences and paragraphs to match the original formatting, by inserting bullets, spaces and periods.

Categorizing Learning Outcomes

The learning outcomes are categorized using two different taxonomies – Bloom's revised taxonomy, and SOLO taxonomy. Bloom's revised taxonomy is a hierarchy of cognitive skills (Anderson *et al* 2001). The figure below shows Bloom's revised taxonomy with learning outcomes example verbs at each cognitive level. The hierarchy starts at the left and narrows towards the right.



Structure of Observed Learning Outcomes (SOLO) taxonomy is a systematic way of describing how a learner's performance changes in complexity when mastering tasks (Biggs and Collis, 1982). The figure below shows the SOLO taxonomy with learning outcomes example verbs at each level.



The Web Application

Trail includes:

- Landing page (login)
- Frequently Asked Questions (FAQs)
- How to Use
- Background
- Contact Us
- Comparison tool

The comparison tool allows the user to find gaps and overlaps between learning outcomes of two or more courses or programs. The user begins by uploading either a PDF or CSV document containing learning outcomes directly into the app. The file should contain the course name, course code, and learning outcomes. The user also has the option to manually input this information, by typing or cutting and pasting the information into the main text box (see Figure 1).

Program Details

Institution

Program name

(4.43 KB)[Select files](#)

100%

Figure 1. Main input window for Trail.

The “Visualize” button generates a series of visualizations, which use Bloom’s revised taxonomy and SOLO taxonomy in order to classify the given learning outcomes. The visualizations include tree maps (see Figures 2 and 3), pie charts (see Figure 6), and a heat map (see Figure 8). The user can print the visualizations, or download them as a PNG, PDF, or SVG image, which can then be saved or sent by email.

Mechanical Engineering A



Click on verb to view details

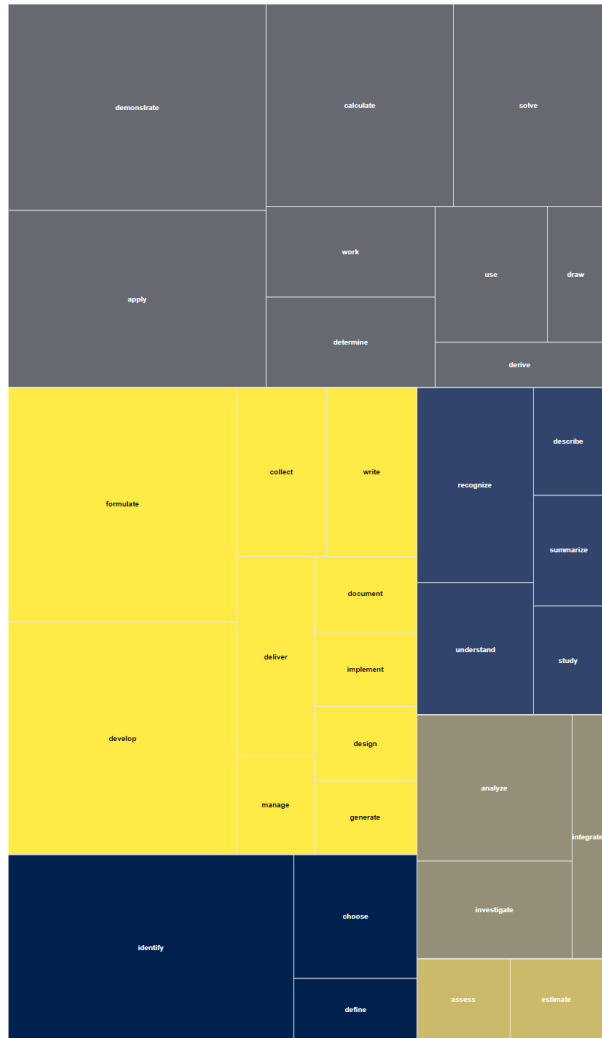


Remember Understand Apply Analyze Evaluate Create
Bloom's Taxonomy

Mechanical Engineering B



Click on verb to view details



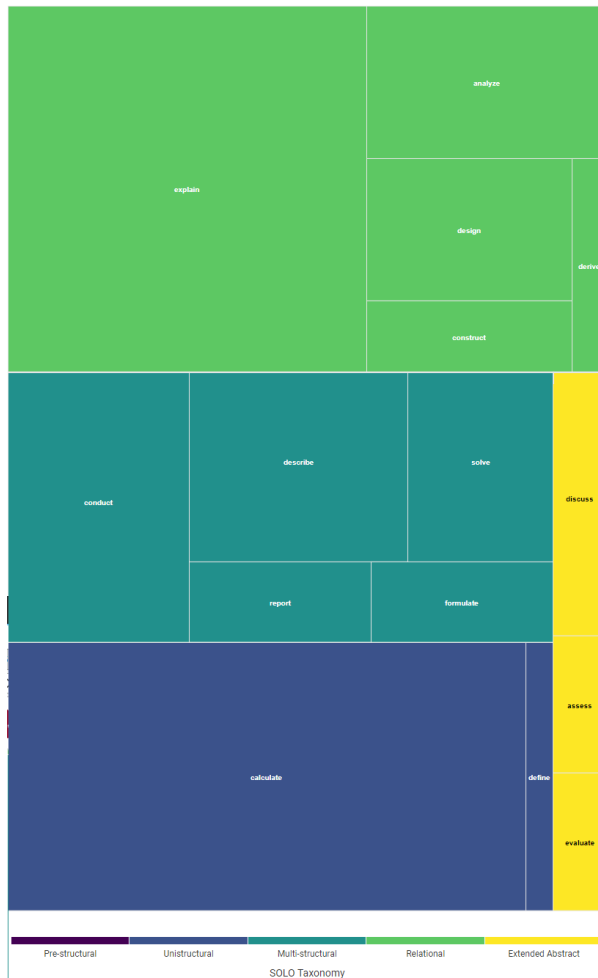
Remember Understand Apply Analyze Evaluate Create
Bloom's Taxonomy

Figure 2. Example of tree maps for two different programs, where the verbs for each outcome have been categorized according to Bloom's revised taxonomy

Mechanical Engineering A



Click on verb to view details



Mechanical Engineering B



Click on verb to view details



Figure 3. Example of a tree map showing learning outcome verbs categorized according to SOLO taxonomy



Figure 4. Tree map legend showing revised Bloom's taxonomy

The tree map is made up of rectangles where the area of each rectangle represents the frequency with which the verb appears in the learning outcomes for that course or program.

The colour of the rectangle represents the Bloom's taxonomy level (see Figure 4) or the SOLO category. The tree map also has several useful features, such as the ability to "zoom-in". The user can click on a verb box, and a text box will appear showing:

- The number of outcomes in the program (or course) where the verb appears,
- The learning outcome and which course it came from (see Figure 5)

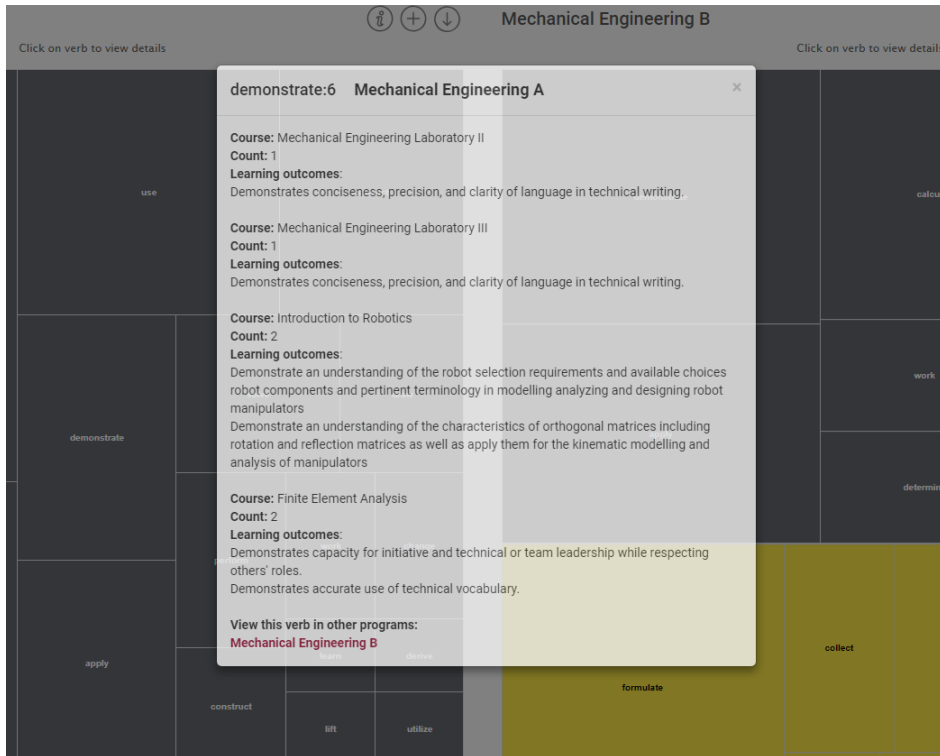


Figure 5. Hover box shows the corresponding course/program and learning outcome for each verb on the tree map.

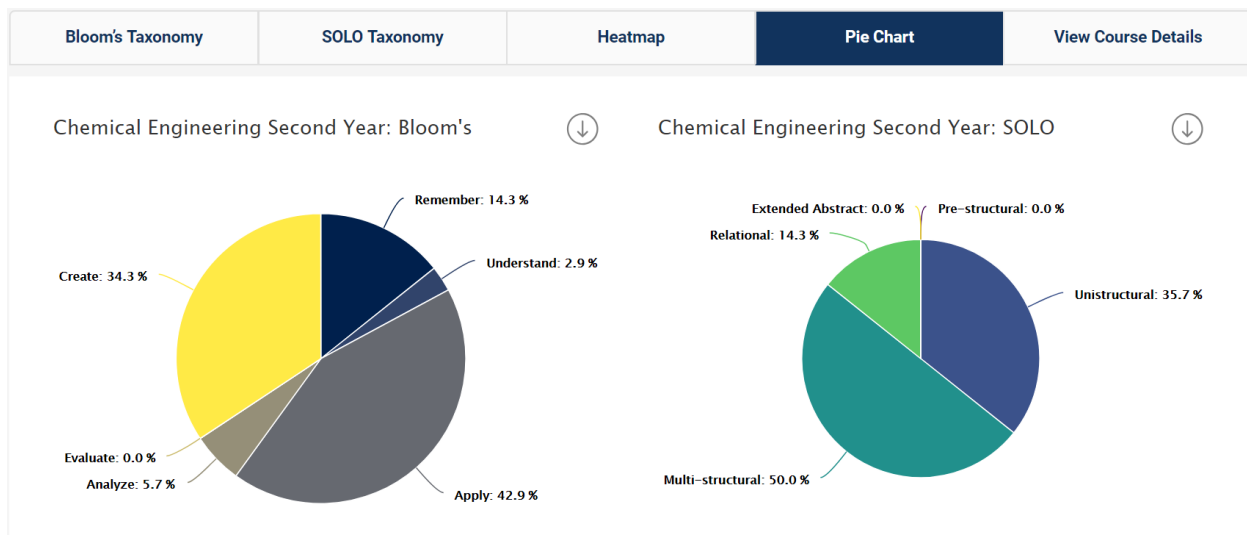


Figure 6. Examples of pie charts, showing the percentage of learning outcomes in each category of both Bloom's and the SOLO taxonomies.

The user can upload learning outcomes from another program to see how the learning outcomes compare to those of the first program by clicking the “Compare to another program/course” button (see Figure 5).

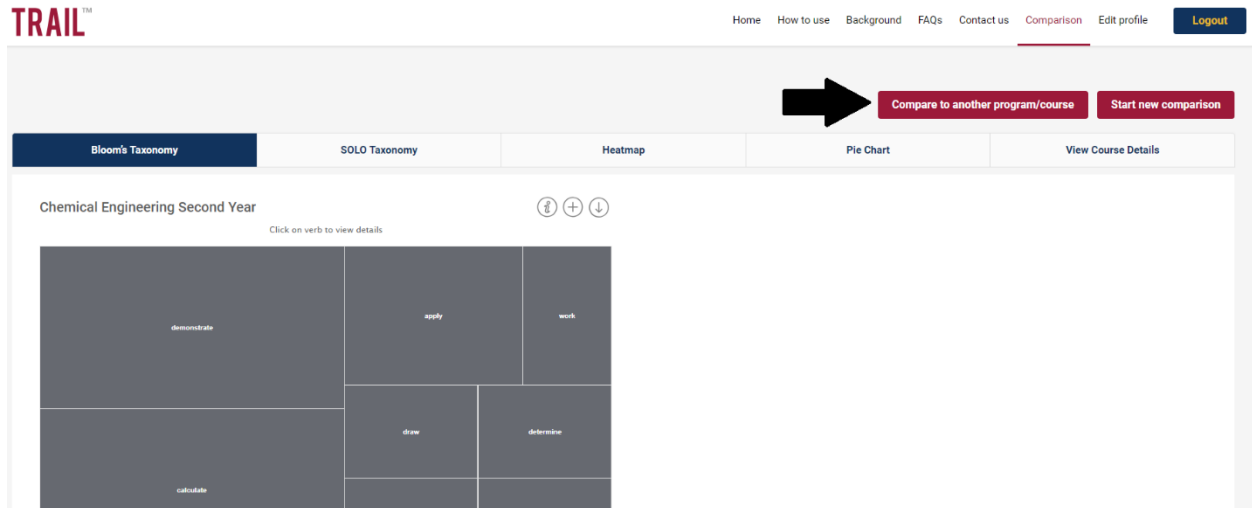


Figure 7. Image showing how to add another course of program

Once the user has uploaded the file containing the new program learning outcomes, they can see the visualizations for both programs side by side. The heat map in particular helps to highlight the gaps and overlaps between the two programs.

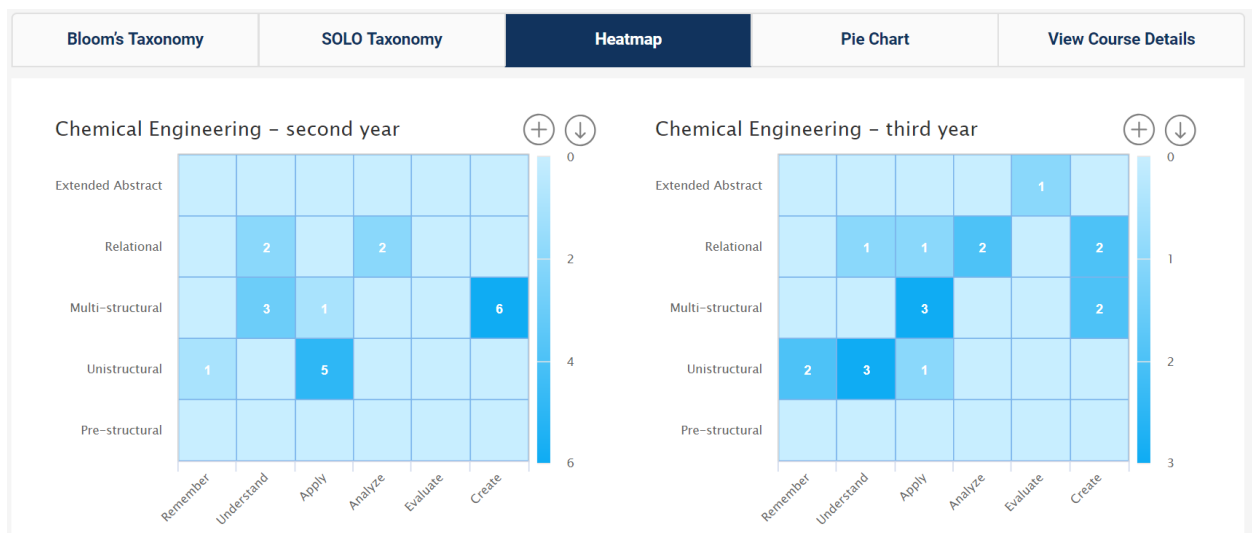


Figure 8. Example of a heat map, for two different programs, showing the learning outcomes categorized by both Bloom's and the SOLO taxonomies.

Conclusion

Using the web app Trail, users have the ability to visually identify similarities and gaps between different courses or programs. For example, Figure 2 shows a tree map for two different Mechanical Engineering programs. Mechanical Engineering A (the program on the left) has more learning outcomes in the “Apply” category of the revised Bloom’s taxonomy than Mechanical Engineering B (the program on the right). Conversely, Mechanical Engineering B has more learning outcomes in the “Create” category of Bloom’s. If the user were attempting to create a bridging program for students transferring from Mechanical Engineering A to Mechanical Engineering B, the bridge would need more courses with learning outcomes in the “create” category.

In order to stay within budget and time constraints, the project was pared down from the original wish list formed with feedback from the focus groups, however Trail is a useful tool for comparing the learning outcomes of multiple programs or courses, which can help in the creation of bridging programs or pathways between programs and institutions in Ontario.

References

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Zakani, S., Frank, B., Turner, R., and Kaupp, J. (2016). Framework for transferability between engineering and technology programs.

Appendix A

1. What information do you typically have when assessing student transfers coming into (or going out of) your program?

Table 1. Transfer information. Information that is typically available when assessing student transfers

Program	Transcripts	Course syllabi	CLOs	PLOs	Institutional information	Course success rates	other
1	✓	✓			✓		
2	✓	✓	✓				
3	✓						
4	✓	✓	✓			✓	☀
5	✓	✓	✓				
6	✓	✓	✓				
7	✓				✓		
8	✓	✓					*
9	✓	✓			✓		
10	✓	✓	✓				
11	✓	✓			✓		
12	✓	✓	✓				
13	✓	✓	✓				
14	✓	✓	✓				
15	✓	✓	✓		✓		
16	✓	✓	✓	✓			•
17	✓	✓			✓		
18			✓	✓			
19	✓	✓					
20		✓	✓				•
21	✓	✓			✓		

☀ - course textbook list

* - Some syllabi include info on course and program level learning outcomes

• - Credit Transfer Request Form

• - Sometimes additional information is required from student

2. What information would you ideally *like to have* (but do not) when assessing student transfers coming into (or going out of) your program?

Table 2. Ideal transfer information. Information that institutions would like to have (but do not) when assessing student transfers

Program	Transcripts	Course syllabi	CLOs	PLOs	Institutional information	Course success rates	other
1					✓		
2							
3		✓	✓	✓	✓	✓	
4							
5				✓			☀
6				✓	✓		
7		✓	✓	✓			
8			✓	✓	✓	✓	*
9			✓	✓			
10				✓			
11							
12							
13				✓	✓		
14				✓	✓	✓	
15							
16							•
17			✓	✓			
18							
19			✓	✓	✓		•
20				✓			
21							

☀ - course content details

* - Sample exam paper, project assigned etc.

• - Credit Transfer Request Form

• - Program quality (reliability of the grade results)

Appendix B

Additional Information gathered through focus group conversations

Bringing together so many people who work with transfers at the focus groups had several benefits, primarily: 1) gathering information that is necessary for the creation of the web-app for the current research project; and 2) participants had the opportunity to share experiences, information and ideas. The following is a summary of additional information regarding student transfer that was gathered and can be used to support student mobility.

Assessments. In many college courses (particularly in engineering and business programs), students are marked on a final product, whereas in university courses, students are typically marked on how well they know the theory behind creating the final product.

Cultural Mismatch. Often, transfers are more successful from college business to university business programs as well as from technology to engineering programs when compared to transfers from college technology to university science programs. In the case of both the business and engineering programs, this may be due to more overlap in courses or because both sets of programs are a combination of theory and practice, whereas pure science degrees have a lot more theory built into them. So, when students with technology diplomas, having transcripts replete with practice elements, want to transfer into a university science program, those working with transfers at the university usually assume there must be essential theory elements missing from the technology curriculum in order to make room for so much practice.

Job readiness. Students from technology programs are typically accepted to be well-prepared to enter the workforce. Students coming from degree programs may not be. The degree has prepared them to be not “job-ready” but “job capable”, where the first job after leaving university is informally considered part of their training.

Value of Mobility. More institutions need to be aware that students value the ability to move around easily between programs and institutions thereby increasing their choices and their chance at success.

Encouraging institutions to make Learning Outcomes publicly available. Hopefully the successful incorporation of the web-app as a tool for aiding student transfer will encourage more institutions to make course information publicly available.