Curricular Analytics Project

Results

Overview

(https://ueru.org/curricular-analytics)

1. Examining the complexity of degree programs by looking at pre-requisites, co-requisites and “blocking” courses.

2. Continuing from previous research looking specifically at engineering degrees.

3. Mason is part of a study that includes 20+ institutions funded by ASCENDIUM EDUCATIONAL GROUP.

    3.1. CAP’s research universities were selected for participation because they educate undergraduates 30 percent or more of whom are Pell Grant recipients, and because they are highly committed to equitable undergraduate student success.

    3.2. The goal of the project is to validate the relationship between curricular structure and equitable student outcomes and explore, support, and document change management practices designed at making use of valid data for curricular change.

    3.3. CAP is a three-year project, from September 2021 to August 2024.

    3.4. The project requires two rounds of data collection:

        3.4.1. UG curricular information;

        3.4.2. de-identified student demographics and academic performance data.

4. CAP’s goals include validating the value of Curricular Analytics, demonstrating how universities might use validated data, and in so doing reduce barriers to timely student success and expand possibility for integration of high-impact practices.

Overview

Example

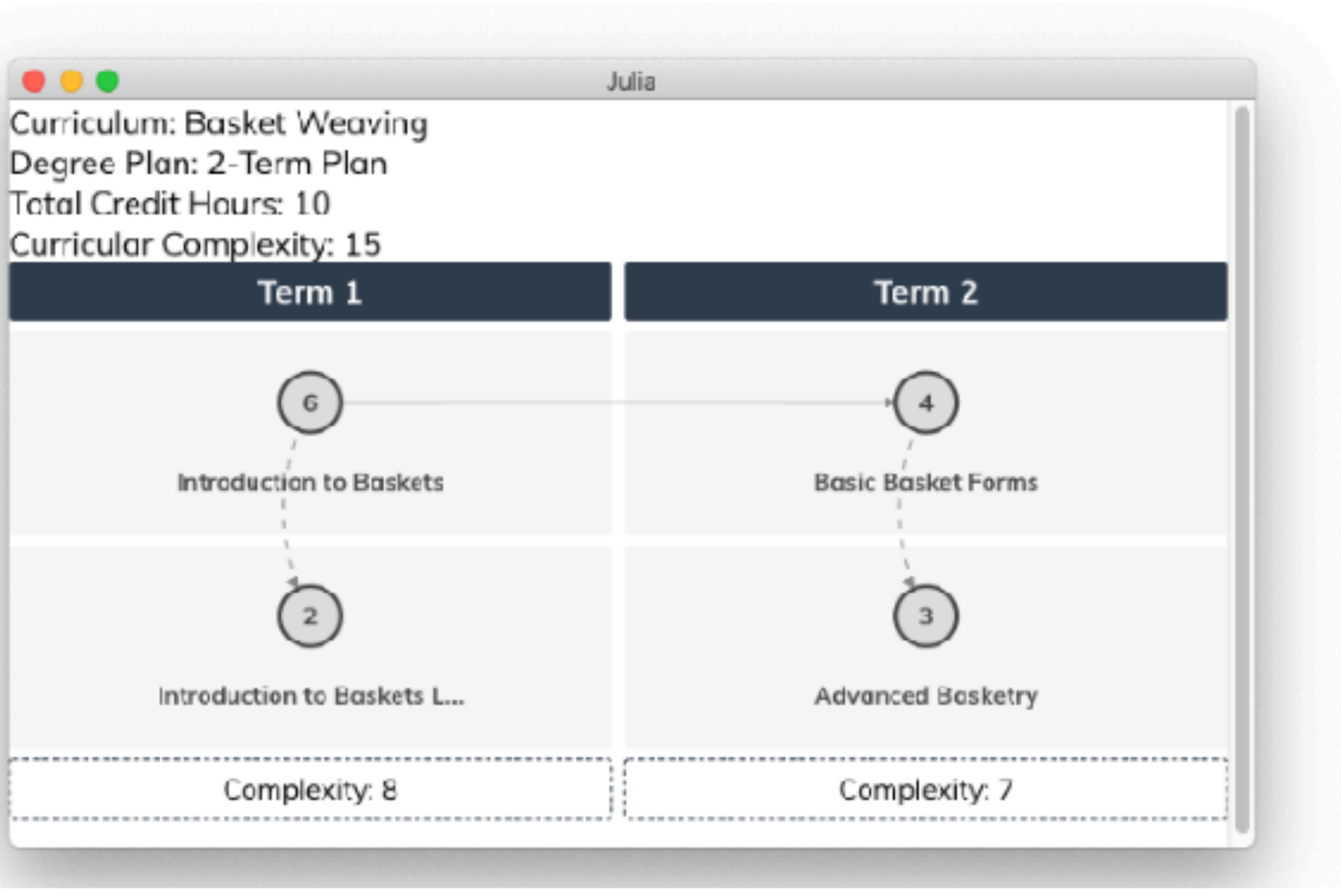
Consider the Basket Weaving curriculum, consisting of the following four courses:

- BW 101 : Introduction to Baskets, 3 credits
- BW 101L : Introduction to Baskets Lab, 1 credit; strict co-requisite: BW 101
- BW 111 : Basic Basket Forms, 3 credits; prerequisite: BW 101
- BW 201 : Advanced Basketry, 3 credits; co-requisite: BW 111

The following degree plan completes this curriculum in two terms while satisfying all of the requisite relationships:

- Term 1: BW 101, BW 101L
- Term 2: BW 111, BW 201

A visual representation of this degree plan is shown below. The solid arrow in this figure represents a prerequisite relationship, while the dashed arrows represent co-requisite relationships.



Overview

- **Prerequisite** - course A must be completed prior to attempting course B.
- **Co-requisite** – course A may be taken prior to or at the same time as attempting course B.
- **Strict co-requisite** : course A must be taken at the same time as course B

In addition to the three traditional requisite types above we have created three more designations for use in our visualizations. In the definitions below assume we are examining some course C:

- **Pre Corequisite Field** - All of the courses that must be completed prior to attempting course C. This includes direct requisites and any requisites of the direct requisite courses.
- **Unblocked** - Courses that can be taken immediately following the completion of course C.
- **Unblocked Field** – All of the courses that contain course C in their pre corequisite field.

CAP Previous Research

Does Curricular Complexity Imply Program Quality?

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End Date
October 19, 2019

Paper Authors

Greg L. Heileman *University of Kentucky* orcid.org/0000-0002-5221-5682 biography

William G. Thompson-Arjona *University of Kentucky* biography

Orhan Abar *University of Kentucky* biography

Hayden W. Free *University of Kentucky* biography

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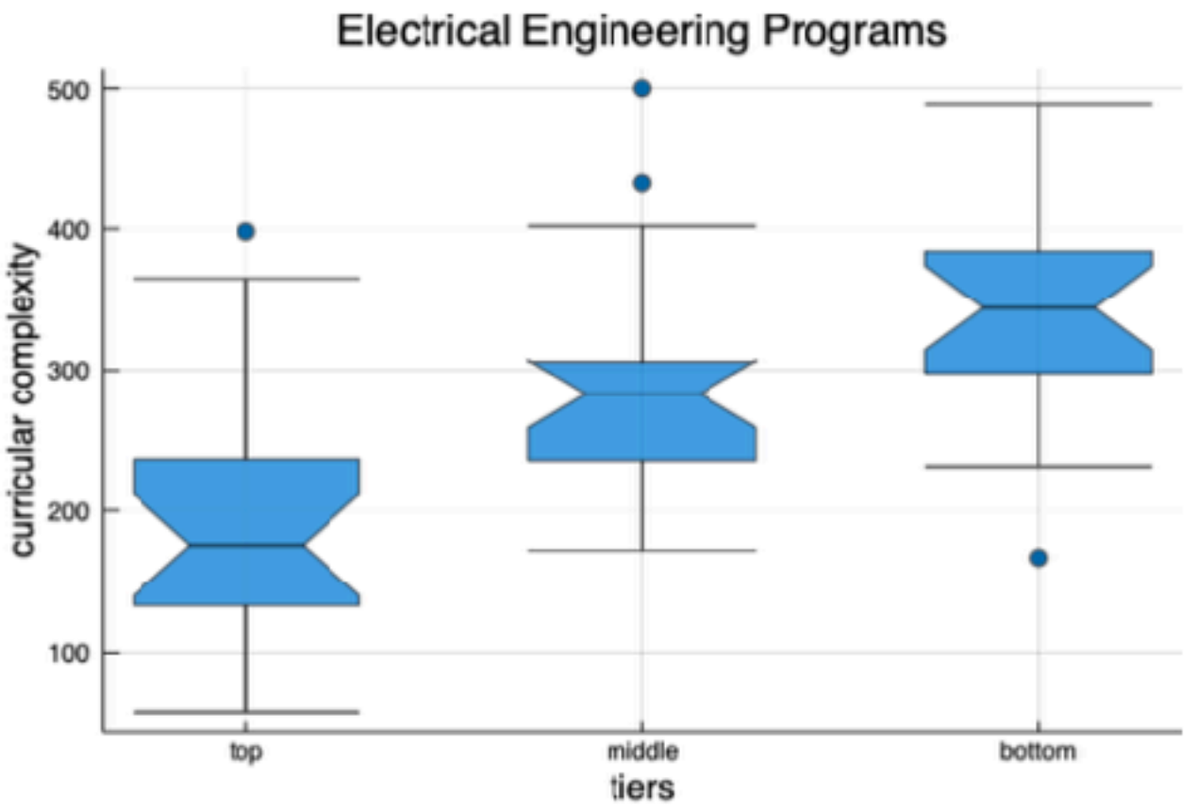
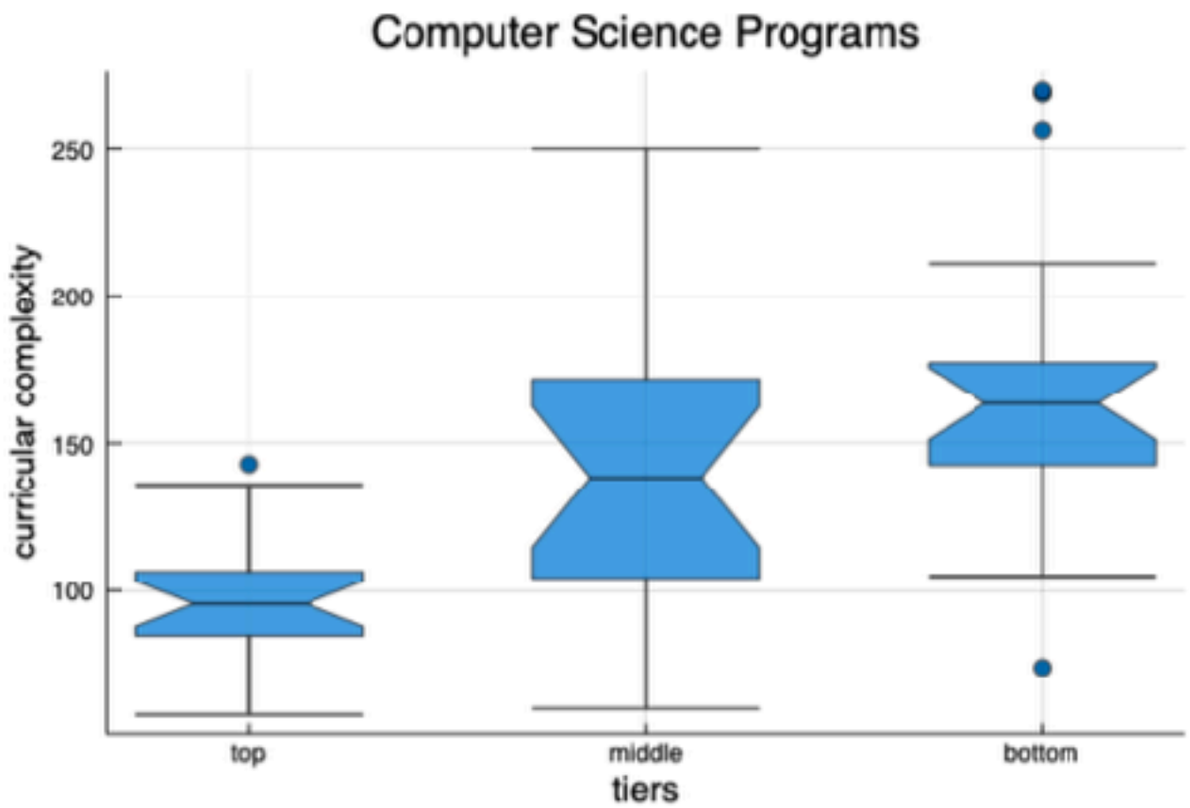
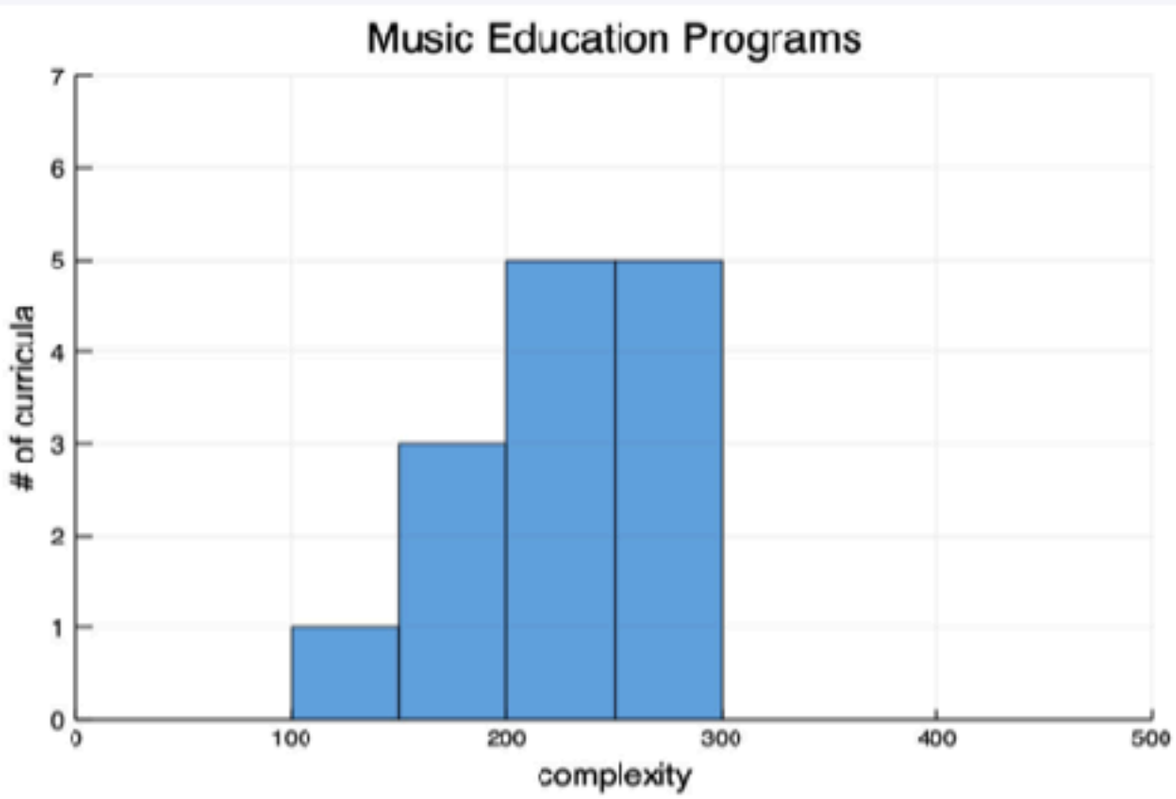
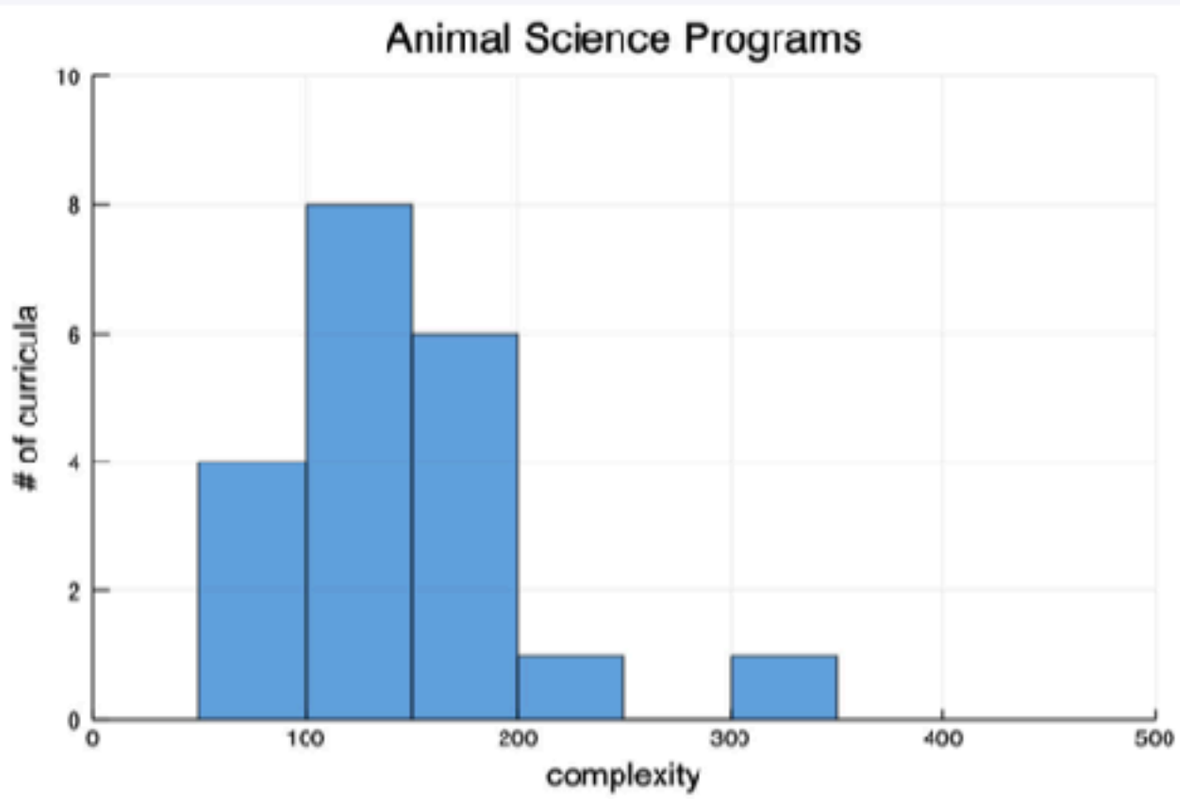
CAP Previous Research

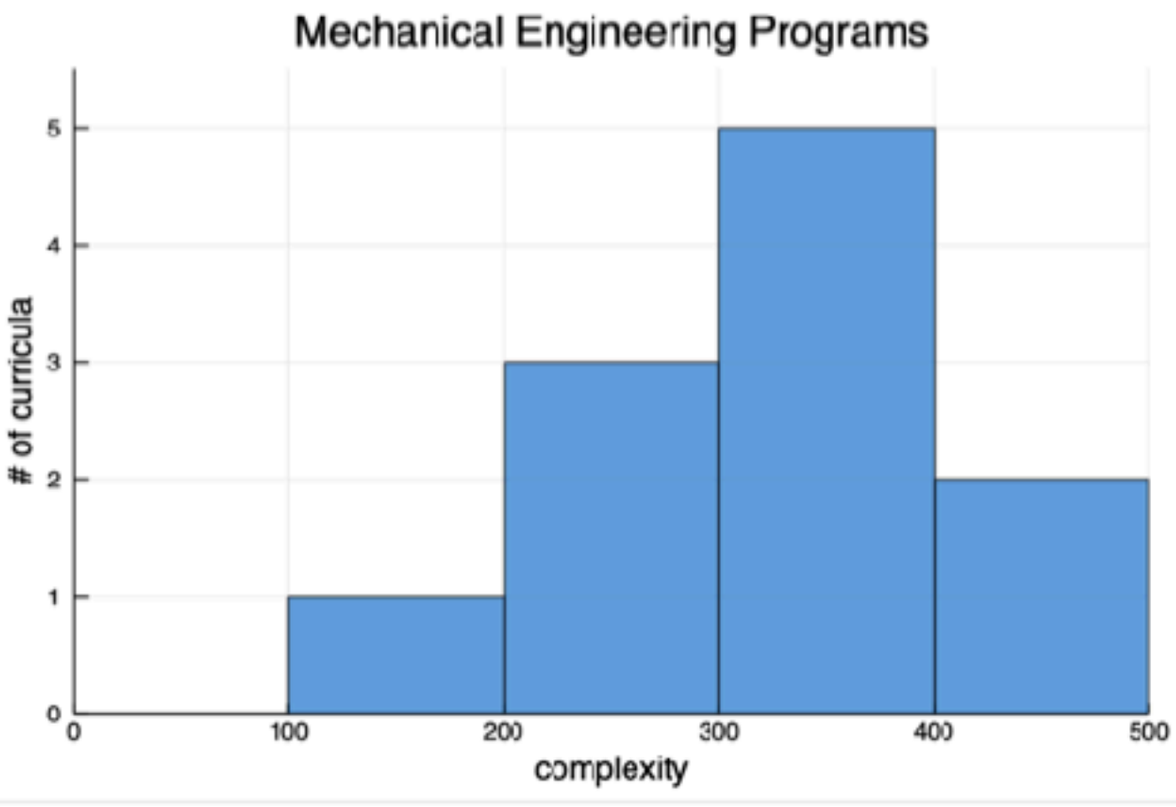


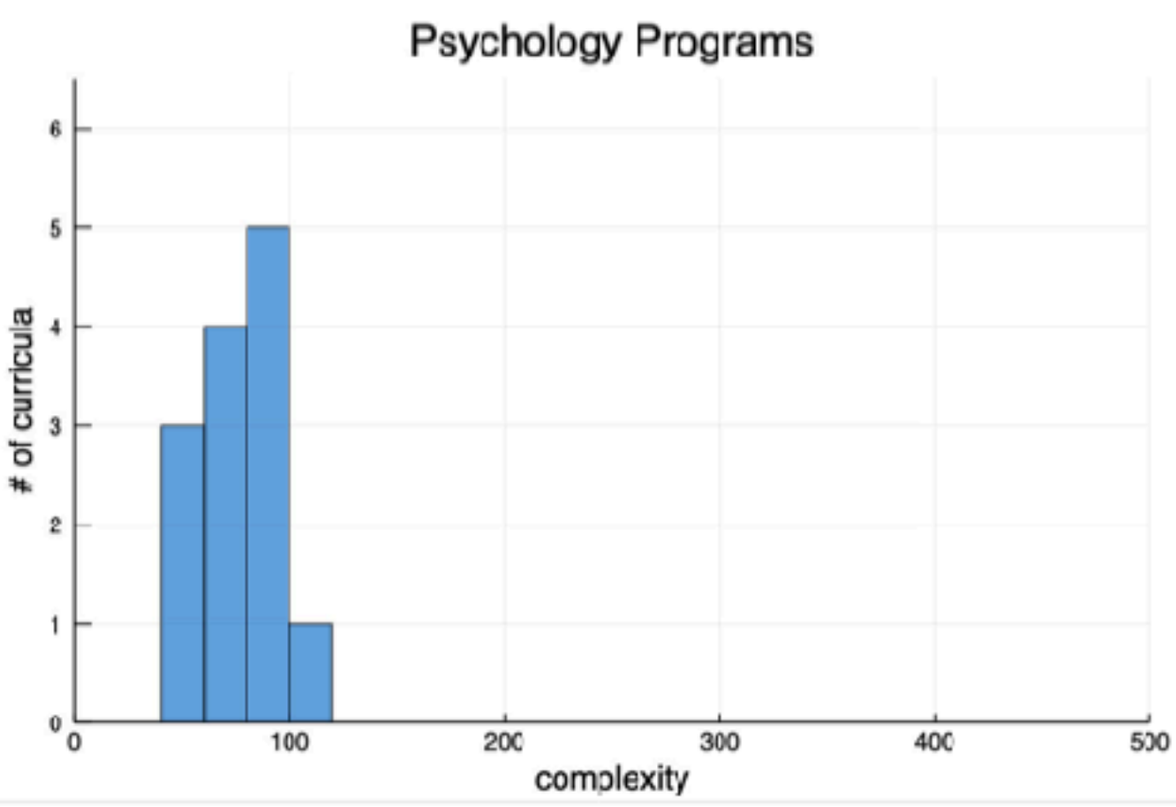


CAP Previous Research









Complexity Calculation

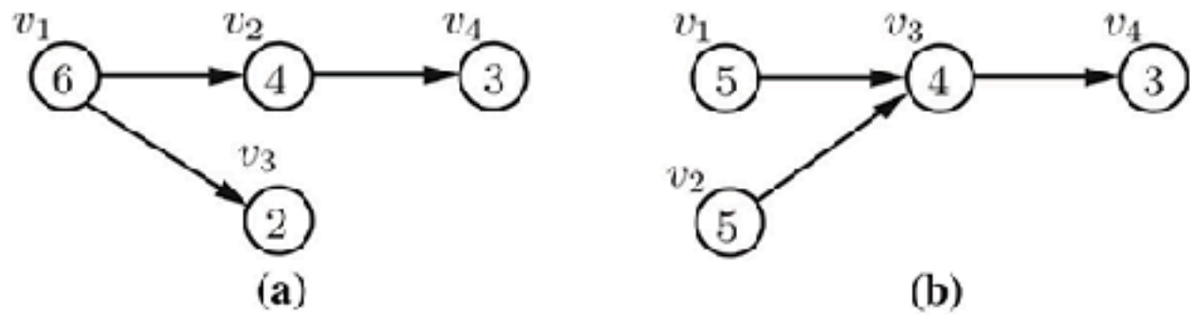
Curricular Metrics

Curriculum-based metrics are based upon the graph structure of a curriculum. Specifically, assume curriculum c consists of n courses $\{c_1, \ldots, c_n\}$, and that there are m requisite (prerequisite or co-requsitie) relationships between these courses. A curriculum graph $G_c = (V, E)$ is formed by creating a vertex set $V = \{v_1, \ldots, v_n\}$, i.e., one vertex for each course, along with an edge set $E = \{e_1, \ldots, e_m\}$, where a directed edge from vertex v_i to v_j is in E if course c_i is a requisite for course c_j.

Structural Complexity

The curricular complexity of a course is meant to capture the impact of curricular structure on student progression. Through experimentation, we have found that a simple linear combination of the delay and blocking factors described above provides a good measure for quantifying the structural complexity of a curriculum. Specifically, we have found a high correlation between increased structural complexity and decreased graduation rates.

As an example of the structural complexity metric, consider the same four-course curricula shown above. The compleixty factor of each course, which is simply the sum of the course's delay and blocking factors, are shown inside of the course vertices in this figure.



Complexity Calculation

Centrality

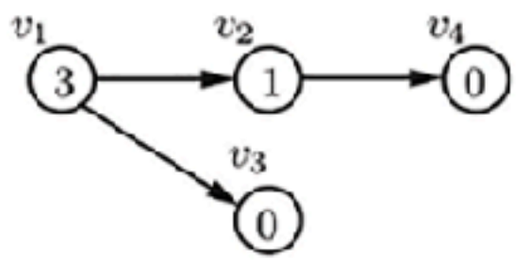
A course can be thought of as being central to a curriculum if it requires a number of foundational courses as prerequisites, and the course itself serves as a prerequisite to many additional discipline-specific courses in the curriculum. The centrality metric is meant to capture this notion.

We define the centrality of source and sink vertices to be 0. For all other course vertices, consider all of the long paths (i.e., unique paths from a source to a sink) containing course vertex v_i. The centrality of v_i is given by the sum of these path lengths. As an example of the centrality metric, consider the same four-course curricula shown above. The centrality factor of each course are shown inside of the vertices in the figure below. In the case of the curriculum in part (a), there is one long path of length three that includes course v_2, hence its centrality is 3, while in part (b), there are two long paths of length three that include course v_2, hence its centrality is 6.

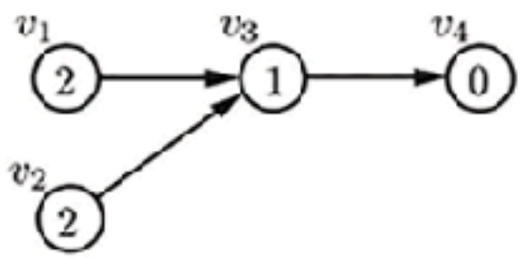
Blocking Factor

The blocking factor is an important curriculum-based metric because it measures the extent to which one course blocks the ability to take other courses in the curriculum. That is, a course with a high blocking factor acts as a gateway to many other courses in the curriculum. Students who are unable to pass the gateway course will be blocked from taking many other courses in the curriculum.

We define the blocking factor of a course c_i as the number of courses in the corresponding curriculum graph that are reachable from v_i. As examples of the blocking factor metric, conisder the two four-course curricula graphs, with course vertices v_1, v_2, v_3 and v_4, shown below. In part (a) of this figure, v_1 is a prerequisite for courses v_2 and v_3, and v_2 is a prerequisite for course v_4, while in part (b), courses v_1 and v_2 are prerequisites for course v_3, and v_3 is a prerequisite for course v_4. The blocking factor of each course are shown inside of the course vertices in this figure.



(a)



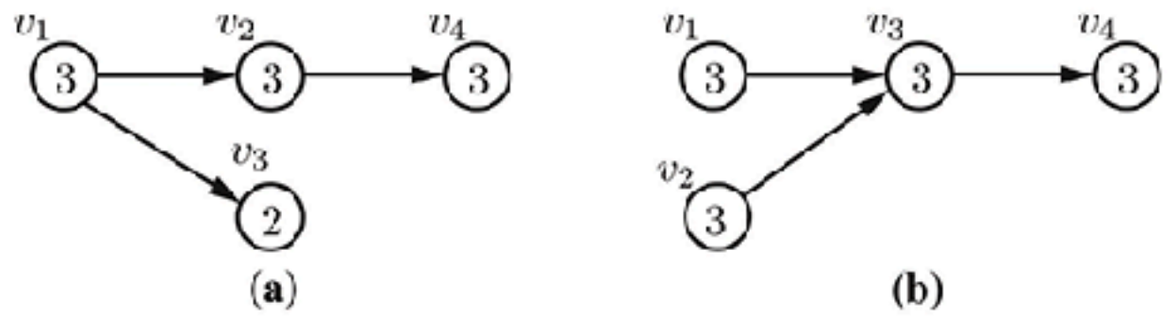
(b)

Complexity Calculation

Delay Factor

Many curricula, particularly those in science, technology engineering and math (STEM) fields, contain a set of courses that must be completed in sequential order. The ability to successfully navigate these long pathways without delay is critical for student success and on-time graduation. If any course on the pathway is not completed on time, the student will then be delayed in completing the entire pathway by one term. The delay factor metric allows us to quanity this effect.

We define the delay factor of course vertex c_i to be the length of the longest path in the corresponding curriculum graph that contains v_i. As an example of the delay factor metric, consider the same four-course curricula shown above. The delay factor of each course are shown inside of the course vertices in the figure below.



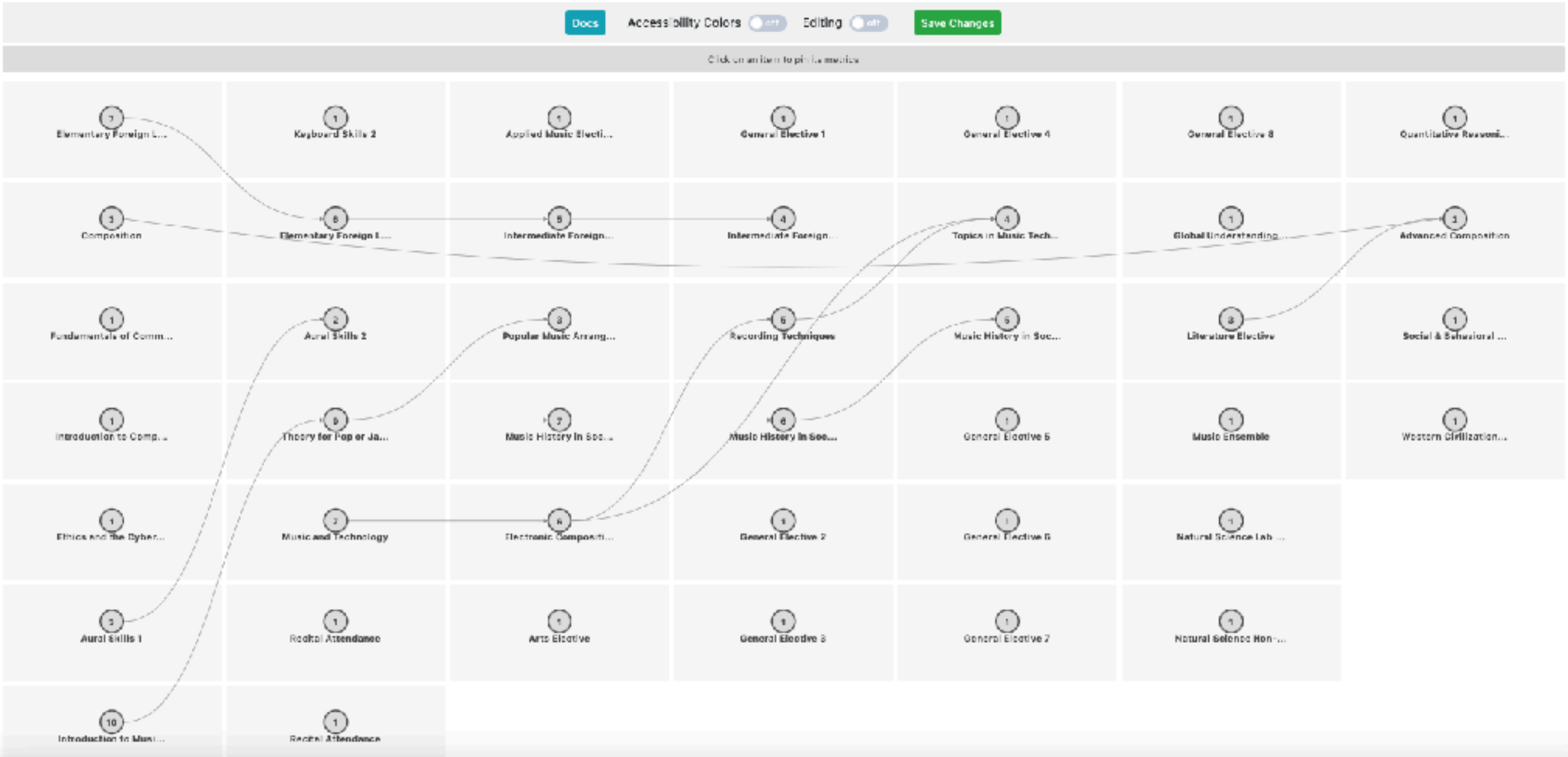
Results for a Program

BA Music, Concentration in Music Technology

Organization: George Mason University

Curricular Complexity: 126

Credit Hours: 120



Results for a Program

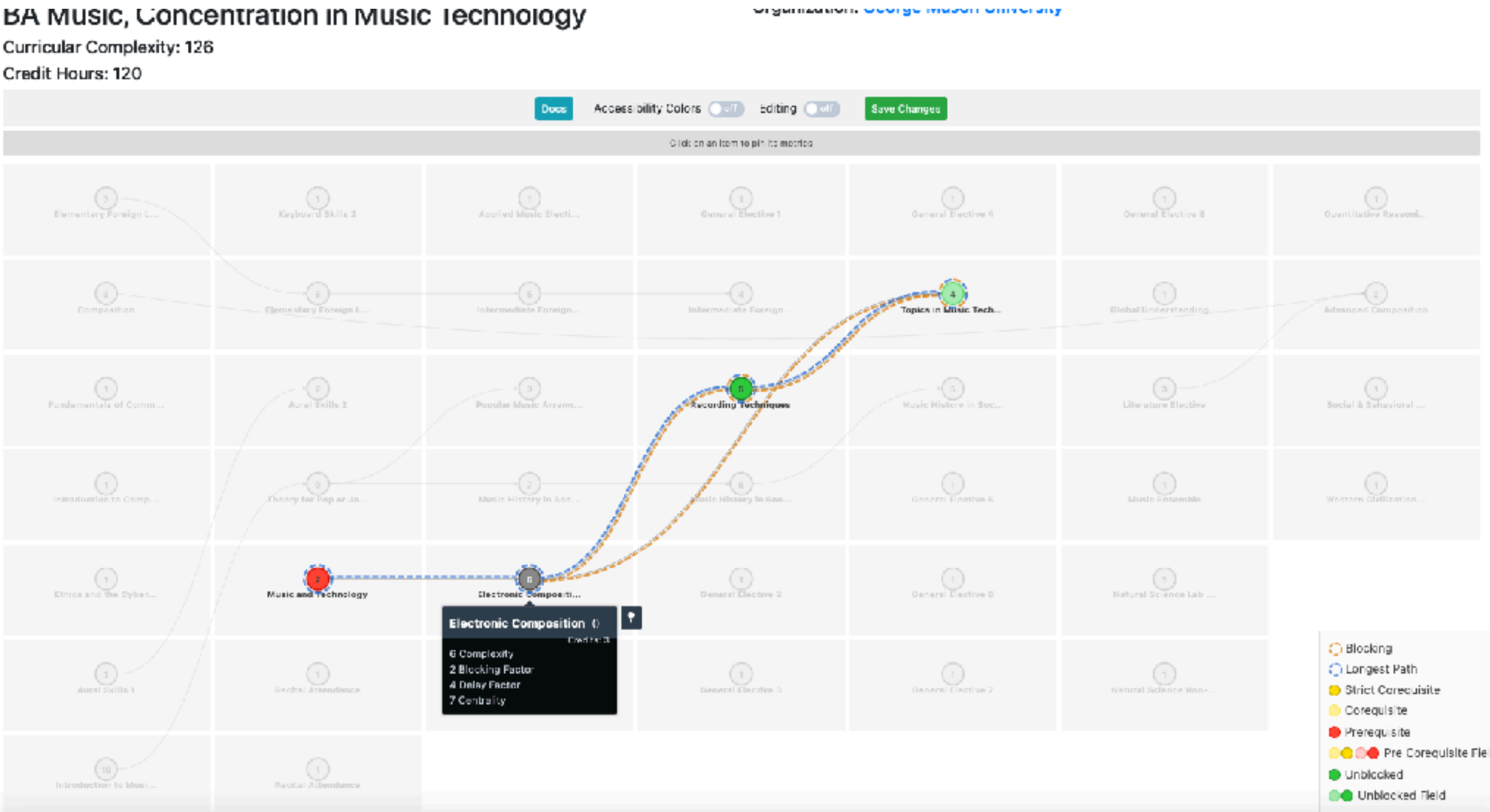
BA Music, Concentration in Music Technology

Organization: George Mason University

Curricular Complexity: 126

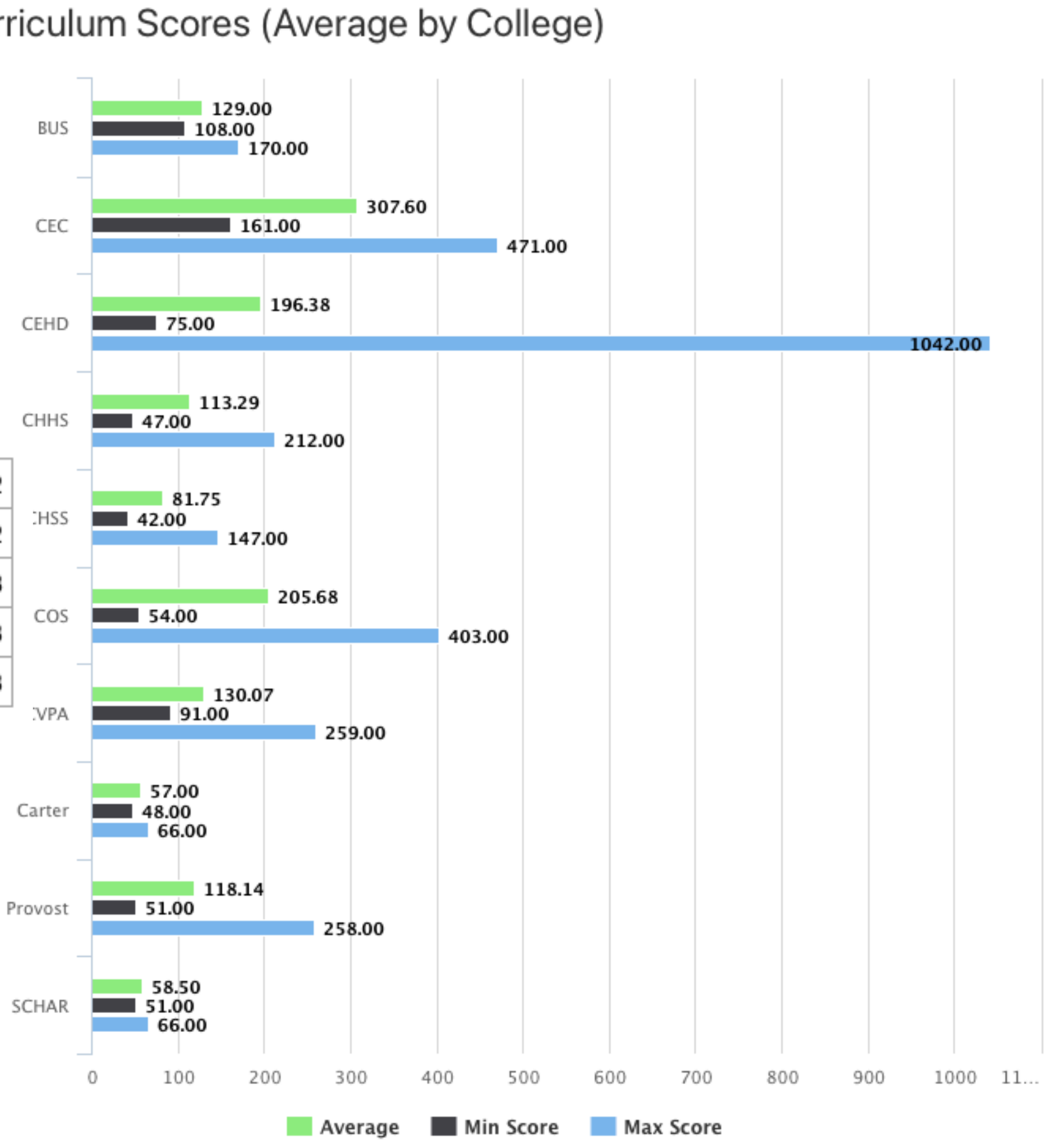
Credit Hours: 120

Results for a Program



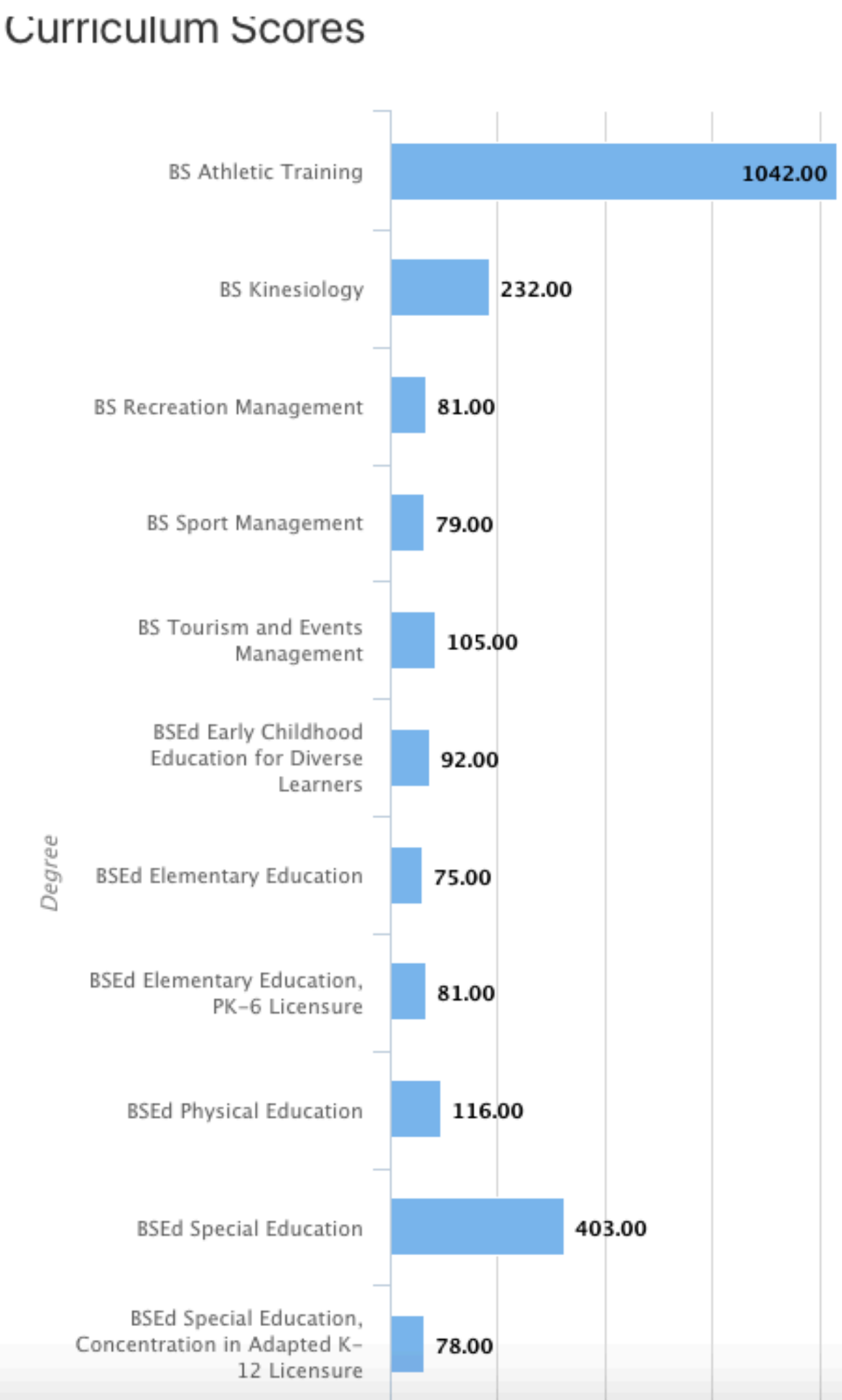
Mason's Results Overall

High	1042
Low	42
Mean	145.98
Median	103
Mode	63



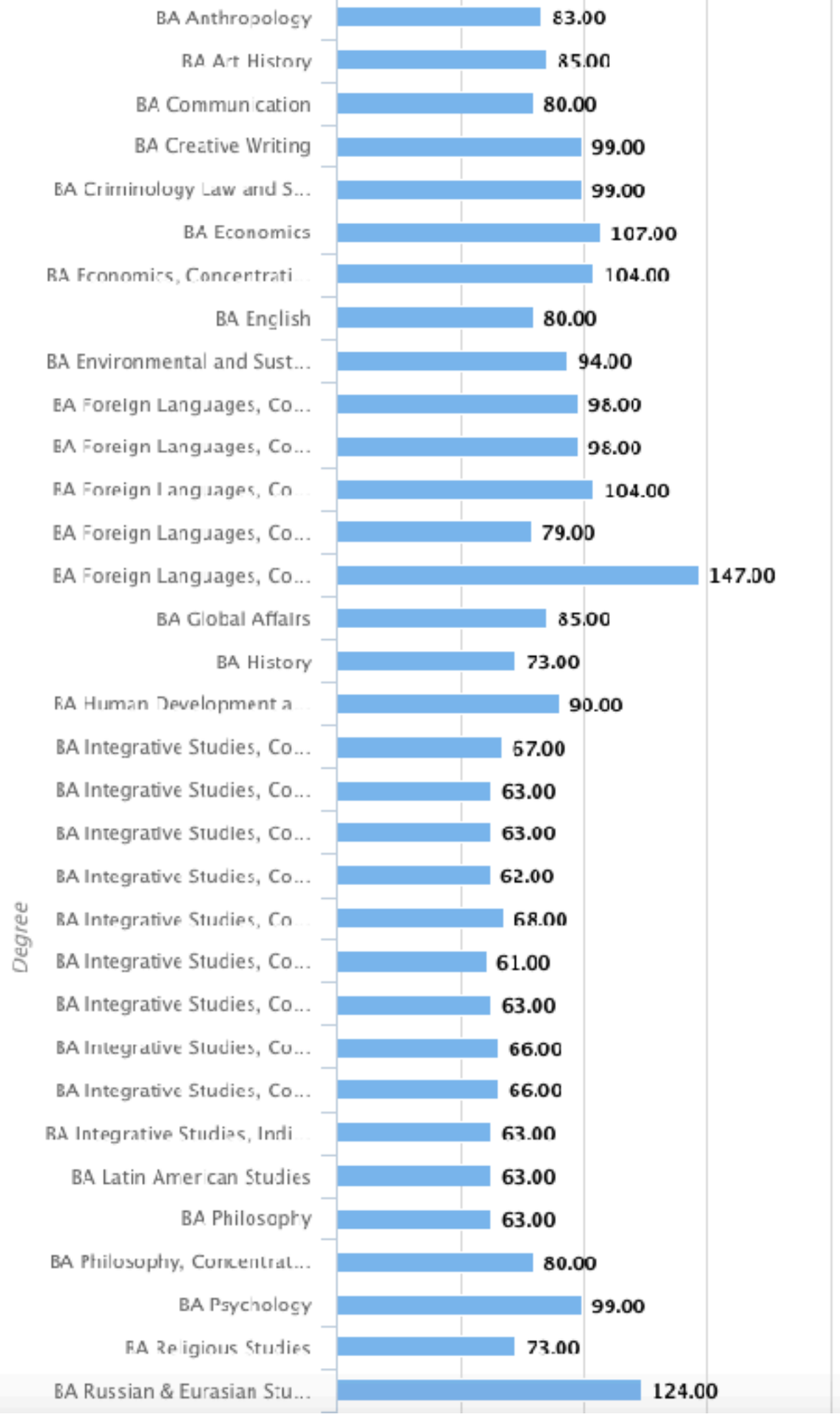
Data by College

CEHD



Data by College

CHSS



Take Aways

Visit https://go.gmu.edu/CurricularAnalytics
to view the breakdown by college and program

Rather than looking at just the number, the CAP project recommends reviewing:

- **Long chains of prerequisites of 6-7+**
- **Few numbers of free electives**
- **Delay of general education requirement into later terms**
- **Bottleneck courses**
  - **Courses with a high “Centrality Measure”**
  - **Courses with many prerequisites**

Reach out to me jguessfo@gmu.edu if you would like to see the details of your programs.