How BRIDGES can help with Engagement

Kalpathi Subramanian, Erik Saule
krs@charlotte.edu, erik.saule@gmail.com

The University of North Carolina at Charlotte

BRIDGES Workshop, June 15-17, 2026

Engagement and Motivation

- Well understood that student engagement is an important predictor of student achievement.
- Engagement can span many dimensions[1]:
  - skills engagement
  - participation/interaction engagement
  - emotional engagement
  - performance engagement
- Engagement and motivation are closely tied to each other
- How do we motivate and engage students?
- What engagement strategies can we use?

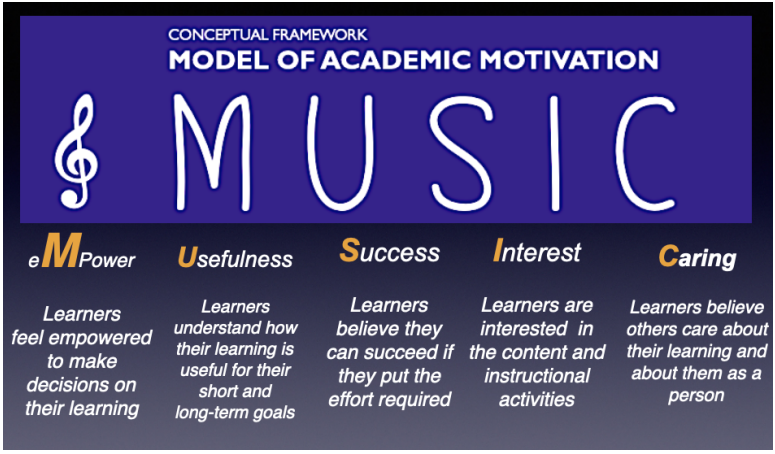
[1] Handelsman et al., A Measure of College Student Course Engagment, Journal of Educ. Res., 2005

Engagement Strategies

- **Active Learning:**
  - Pair Programming
  - Flipped classroom
  - Group work/collaboration/Light Weight Teams
  - Quizzes
- **Content Based**
  - Real world data integrated into curriculum, demonstrate relevance
  - Align with student interests, values, social relevance

BRIDGES focuses on **content based engagement**

The MUSIC Model of Engagement



[2] Jones, B.D, Motivating Students to Engage in Learning: The MUSIC Model of Academic Motivation, Intl. Journal of Teaching and Learning in Higher Ed., 2009

Engaging Students: Experiences from an OOP Course [3]

Two semesters of a project based OOP course, using student reflections after each course module

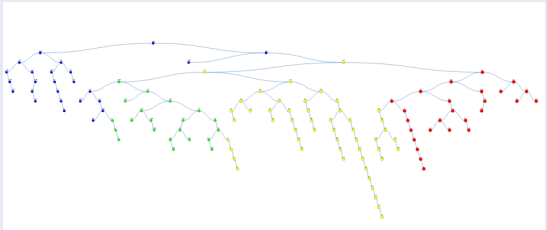
- e**M**powerment: Project choice, freedom to be creative, experimentation and tinkering
- **U**sefulness: Working with real-world data/tools, team environment
- **S**uccess: Assignments with clear instructions, predictability, reflect on personal successes/failures, feedback, challenges (in a good way!)
- **I**nterest: Fun factor, games, real world images used as part of course
- **C**aring: Sensitive to student needs, prompt feedback, deadline flexibility

[3] Subramanian et al., Influence of Course Design on Student Engagement and Motivation in an Online Course, ACM SIGCSE 2020

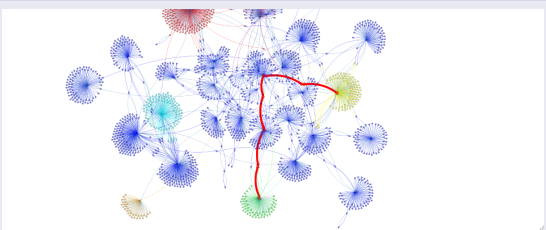
Engagement Using BRIDGES: Visual and Interactive

- BRIDGES generates **visualizations** of data structures (**that students implement!**), algorithm outputs as a mechanism for engaging students.
- Visualizations of classic CS concepts can be helpful in making them real and more meaningful.
- Student feedback has been very positive, appreciating the features of BRIDGES that enables them to **see what they code and produce**.

Indexing USGS Earthquake



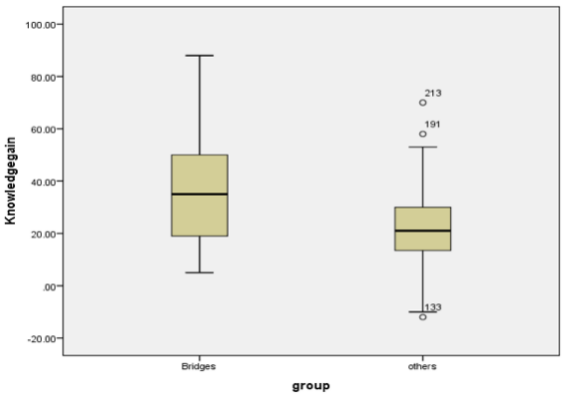
Bacon Number [IMDB Data]



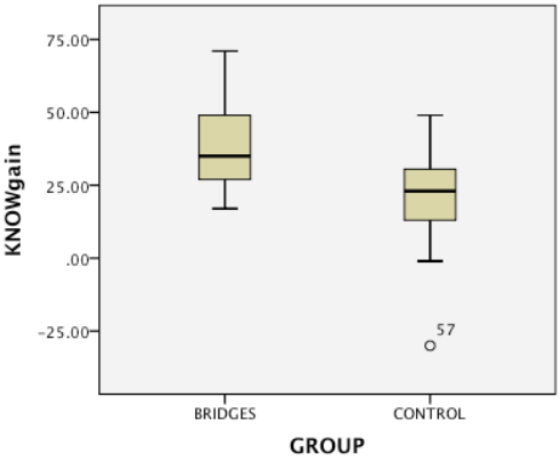
Engagement Using BRIDGES: Use Real-World Data

- Using **real-world data** in course work is an important engagement tool
- Students respond to working with data from real-world scenarios/data: weather/climate, maps, medical, census, books, music, videos, games
- Data is everywhere, the **harder part is**
  - Accessing data in a **ready-to-use form** for course work
  - Mapping the right data to course work to **meet learning objectives**.
- BRIDGES supports a number of datasets ready to use in early CS courses:
  - **Earthquake Data:**
    List<EarthquakeUSGS>eq_list = bridges.getDataSource().getEarthquakeUSGSData(100)
  - **IMDB Actor-Movie Data:**
    List<ActorMovieIMDB>am_list = bridges.getDataSource().getActorMovieIMDBData(1813)
  - **Open-Street Map Data:**
    OsmData osm_data = bridges.getDataSource().getOsmData("Charlotte, North Carolina", "default")
  - Additional datasets/applications we will look at later in the workshop

Results: Students in BRIDGES sections gained more knowledge



Fall 2014



Spring 2015

Results [Longitudinal]: Students in BRIDGES sections progressed faster in CS

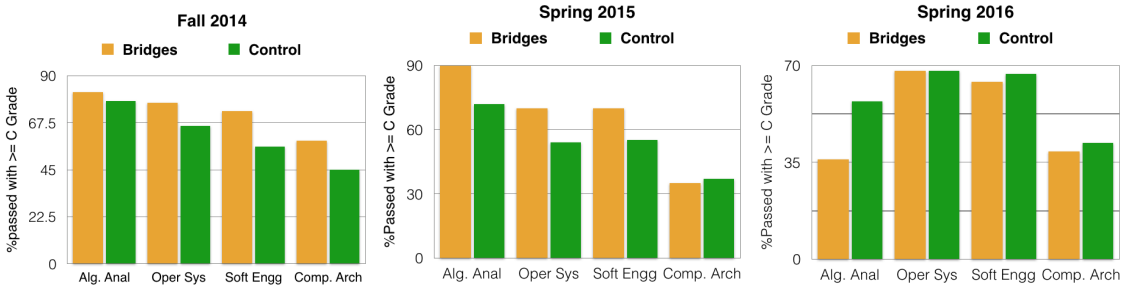
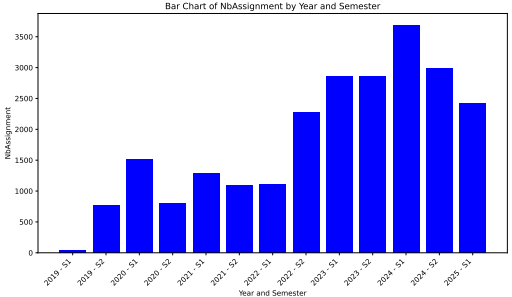
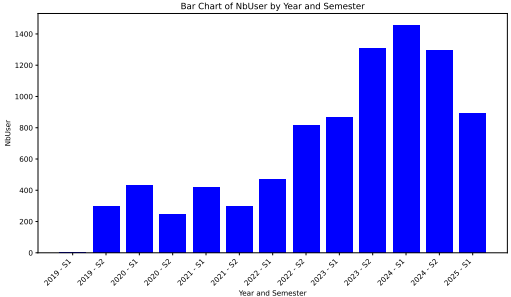


Figure: Comparing long-term student achievement between students who used the BRIDGES toolkit in the Data Structures course vs. Control group. The evaluation was performed with 3 cohorts of students (Fall 14, Spring 15, Spring 16).
Analysis performed Spring 2019.

Impact of BRIDGES

- We have an active user base
- Demonstrated knowledge gains, longitudinal studies
- Extensive survey data collected shows highly positive response to tools
- Developed over 70 BRIDGES assignments for easy adoption by instructors
- Over 10,000 BRIDGES assignments completed over the years, 25+ universities, colleges, high schools have participated





ITCS 4114: Real World Algorithms

Junior/Senior Level Elective

Module Content	Potential Assignments	Datasets
1. Data Structure Review, Math in Alg., BRIDGES setup	**Linked list of US cities, Family Tree**	US City data
2. Comp. Complexity, Sorting Alg:, Quadratic and $n \lg n$ Alg. (Mergesort, quicksort))	**Benchmarking Sorting Alg. (Quadratic vs N Log N Alg.**	Randomly generated
3. Graph Represntations, Traversals (BFS, DFS)	**DFS/BFS, Bacon Number/Path Computation**	IMDB Actor Movies, Wikidata
4. Advanced Graph Algorithms (Topological Sort, Dijkstra's Shortest Path, Prim's Minimum Spanning Tree (MST)	**Prim's MST using US Cities, Dijkstra's SSP using OpenStreetMap data, Mountain Path using Elevation data**	US Cities, OpenStreet Maps, Elevation Data
5. Searching and Indexing: Binary Search, Search Trees: Balanced Trees (AVL, Red-Black, Splay Trees), Range Search, Spatial (Quadtree, K-d Trees, Bintree)	**AVL Tree Balancing, Quadtree Constr/Search on US cities**	US Cities
6. Geometric Algorithms: Closest Pair, Convex Hull, Voronoi Diagram	**Convex Hull of US Cities, Voronoi diagram**	US Cities, Images
8. Dynamic Programming: Knapsack, Warshall's Transitive Closure, Floyds All-Pairs Shortest Paths	**Least Effort (shortest path) on Elevation Data Using Dynamic Prog Alg.**	Elevation data