



WPI



Active Interactive Learning for Project-Based Education



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Using machine learning to change the world!

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WPI Center for Project-Based Learning

Support and coach higher education institutions and practitioners committed to driving equitable, sustainable, and systemic pedagogical, curricular and cultural reform so that a rapidly growing set of diverse students has multiple meaningful project-based learning (PBL) experiences.

Hub for culturally relevant PBL in higher education by developing, curating and sharing best practices that advance justice, equity, and inclusion as pillars of impactful higher education



THEORY



PRACTICE



GLOBAL



IMPACT

= WPI

Project-Based Learning

Applying	Applying knowledge to address authentic problems
Integrating	Integrating course material
Learning	Learning new topics independently
Communicating	Communicating effectively in written, oral, and visual forms
Interacting	Interacting productively with others



WPI Project Requirements

Interactive Qualifying Project (IQP)

Major Qualifying Project (MQP)

- Degree requirements, 9 CH each
- Not courses; small teams (2-4) work independently under faculty direction
- Most done with external agencies and organizations
- Many completed full-time off campus

All courses have at least one project

Curricular Fit of Projects

IQP – general education capstone; interdisciplinary research project at interface between society and technology

MQP – major capstone; integrative application of disciplinary skills and knowledge to professional-level challenge

Research projects – conducted throughout academic year and during summer

Projects Embedded in Courses – every course incorporates at least one project



Some Key Ingredients of Online Learning

Connection is key - Provide space and opportunities in the curriculum for students to build connections!

➤ **Focus on Active and Interactive Learning**

- Large and small group discussions, peer-to-peer collaborations, hands-on learning exercises, interactive online recorded video lectures
- Video lectures that embed instructional tasks, completion of short assignments to promote online engagement
- Brain and stretch breaks
- Share voice and cyberspace – let students lead short exercises to promote class community and participation

➤ **Focus on the essential goals and learning outcomes**

- Explain *what, why and how* students should demonstrate competence
- Establish regular structures, set clear expectations and communication systems, keep lessons current and relevant
- Engage students with meaningful assignments/projects that are relevant to their lives
- Allow student voice and choice

Some Key Ingredients of Online Project Advising

Connection is key - Provide space and opportunities in the curriculum for students to build connections!

- **Inclusive Practices for all Humans** – provide accommodations, captioning, use chats to include more students, Open Educational Resources
- **It is about the “Pandemic Brain”**
 - **Scale back, Scaffold/Chunk, Repeat, Repeat**
 - Less is more right now. Achieve learning objectives and teach the essentials students need to know in engaging ways
 - Grace – It doesn’t have to be perfect. Be clear and consistent!
 - Professors and students are learning these new artistic and pedagogical tools together

Challenges of Online Project-Based Learning

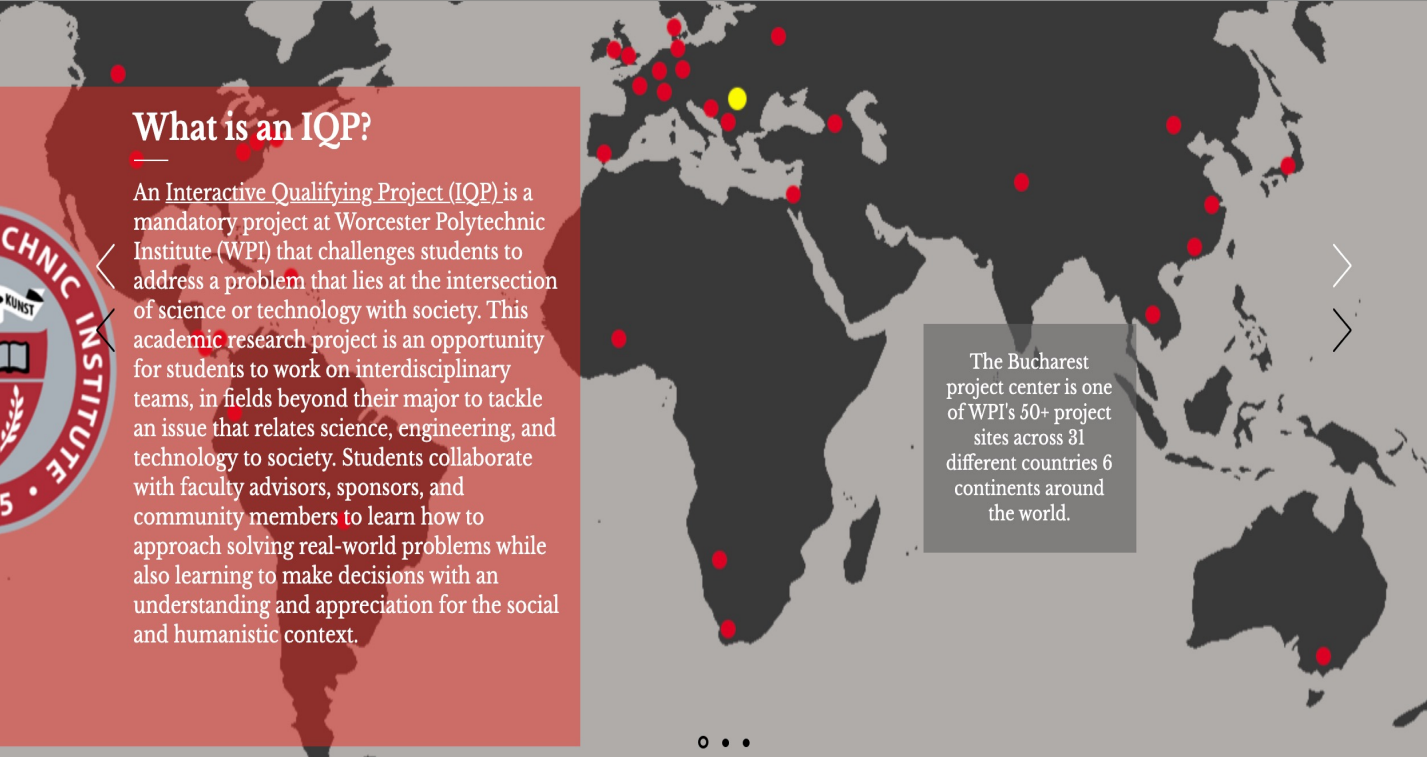
*Online education -- shared commitment among faculty and students to fully participate in creative explorations and discussions. It **requires all participants to be present, prepared, and ready to engage.***

- Remote Learning
- Remote Group Collaboration
- Focus...from a distance?

First Example: Interactive Qualitative Projects

Bucharest IQP Project Center

Home Bucharest Center Directors Projects D21 Projects D20 Virtual Events Media Contact



What is an IQP?

An Interactive Qualifying Project (IQP) is a mandatory project at Worcester Polytechnic Institute (WPI) that challenges students to address a problem that lies at the intersection of science or technology with society. This academic research project is an opportunity for students to work on interdisciplinary teams, in fields beyond their major to tackle an issue that relates science, engineering, and technology to society. Students collaborate with faculty advisors, sponsors, and community members to learn how to approach solving real-world problems while also learning to make decisions with an understanding and appreciation for the social and humanistic context.

The Bucharest project center is one of WPI's 50+ project sites across 31 different countries 6 continents around the world.

Bucharest IQP Project Center

[Home](#)[Bucharest Center Directors](#)[Projects D21](#)[Projects D20](#)[Virtual Events](#)[Media](#)[Contact](#)

W. A. Bland Addison, PhD
Associate Professor of History
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I believe it is important for American students to understand the intellectual their way of viewing the world as well as the cultural perspectives of other world. I have taught a variety of intellectual history courses about Western civilizations. Such cross-cultural understanding is fundamental in appreciating other peoples and this is a first step toward building a better, more peaceful world. The practical experience of working with and learning from other peoples' work on real world problems is more effective in cultivating empathy for the humanity among all peoples, no matter cultural differences. This personal philosophy has led me to advise students on hundreds of projects at 12 of WPI's 35 global project centers and to serve for a decade as the co-director of the Morocco Project Center. My experience this term working virtually with our very engaging collaborators in Romania has reinforced my commitment to global project education.

Rodica Neamtu, PhD
Associate Teaching Professor
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I see embedding project-based learning into cross-cultural experiences as a great step towards raising awareness to the problems faced by our global society and engaging our students in solving these problems. Co-directing a project center in Romania allows me to contribute to building a strong connection between the two cultures that I am deeply anchored in. I am committed to help our students explore other cultures, understand the issues that they are facing, and become part of impactful initiatives to mitigate them. Advising project teams is one of the most engaging and rewarding aspects of my work.

Bucharest D2020 Students

Project Collaborators

Project Advisors

AmCham Romania

Colinele Transilvaniei

Learning Center

Pollen Allergies

Urban Wetlands



Learning Goals

- ✓ Building Key Knowledge, Understanding, and Success Skills, both discipline-specific and transferrable
- ✓ Formulate Questions that are engaging and challenging
- ✓ Learn to Perform Authentic Sustained Inquiry by asking questions, and finding resources with real-world context and impact
- ✓ Build Reflection Opportunities by enabling students to reflect on learning, the effectiveness of their inquiry, the quality of their work, and obstacles
- ✓ Learn to use critique and revision by incorporating feedback to improve their process and products
- ✓ Deliver quality projects/reports by explaining, displaying and presenting it beyond the classroom
- ✓ Apply knowledge to the real world
- ✓ Solve problems
- ✓ Answer complex questions
- ✓ Create high quality products
- ✓ Critical thinking in service of problem solving
- ✓ Collaboration
- ✓ Self-management

Challenges



Objectives

- (1) Keep these projects impactful and helpful for our Romanian collaborators, while maintaining the goals and outcome of the IQP experience intact
- (2) Address our students' disappointment and frustration and turn them into productive resources
- (3) Keep the Romanian spirit alive and give our cohort the best experience without traveling

Virtual Quest

Bucharest IQP Project Center

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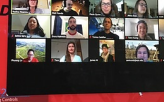
[Contact](#)

which has produced numerous documentaries on Romania. During this cultural event, Mr. Dimancescu was able to provide the Bucharest cohort with valuable insight into Romanian customs and culture.

In preparation for this event, the students in groups of two or three chose a topic that related to Romanian culture and built a bubble chart around it. During the quest event, these charts were presented to Mr. Dimancescu which helped lead into deeper discussions revolving around the topics.

Guest: Mr. D

30, 2020 Meeting
/vpl.zoom.us/j/840195...



One of eight bubble maps created by Worcester Polytechnic Institute IQP-Romania interns— the one above on the topic of "Romanian Caves".





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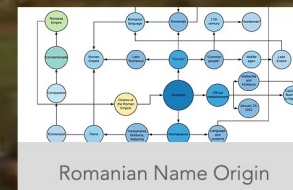
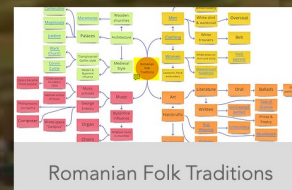
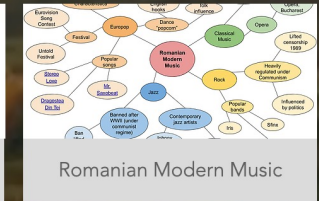
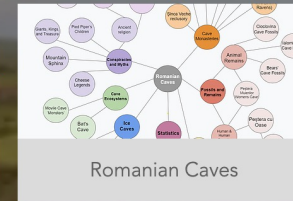
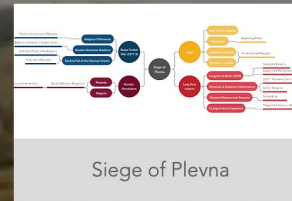


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Education: BA / University of South Carolina MA / University of Virginia MPhil / Columbia University PhD / Columbia University



Dan Dimancescu
Emerg. Co-Gen of Romania (Honorary)
BS Master Atlanta / Washington, D.C.
BS Master Foundation Conservation
Capitania - FCC (Bosco, Romania)
Education: Darmstadt College
Fletcher School of Law and Diplomacy
Harvard Business School

Below are the bubble charts created by each of the groups:



Romanian History



Tablets from Tartaria (Disputes) - Sarah

-Predated the Minoan writing (earliest in Europe), but some argue it's not a writing system

-Could be instead proto-writing or glyphs. Some also argue religious symbols because it was at a burial site

-Doubts about true antiquity

-The tablets were originally soft to the touch because they were covered with limestone and exposed to high humidity

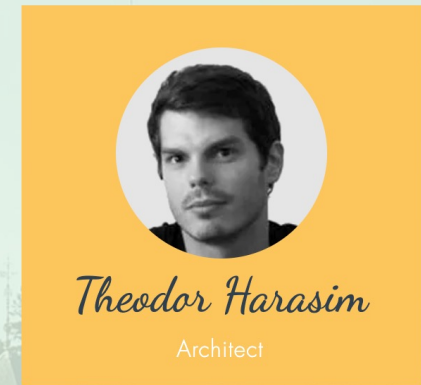
-Conservation department baked them to harden them, but this took away any possibility of

Romanian Architecture

Romanian Architecture with Mr. Theodor Harasim

The virtual event with Romanian architect Theodor Harasim exposed the Bucharest cohort to a variety of architecture spanning throughout hundreds of years. Previously, Mr. Harasim had researched the relationship between the man-made environment and natural landscape. He is also a registered architect in Madrid and currently resides in New York, working on architecture and design practice.

Mr. Harasim led the Bucharest project groups on a “tour” of four cities in Romania (Sinaia, Brasov, Sibiu, and Bucharest) highlighting the historical and cultural significance of Romanian Architecture. At each destination, he would encourage the students to briefly discuss what they had learned and found interesting before delving into each landmark's structural importance and unique features.



Landmarks Highlighted in the Presentation

Virtual Cuisine

HOME → NEWS & EVENTS →
STUDENTS EXPLORE SIGHTS, SMELLS, HISTORY, AND ART OF ROMANIA...REMOTELY



Virtual Trips



Virtual Reports and Presentation

HOME → NEWS & EVENTS →

STUDENTS PRESENT GLOBAL PROJECTS REMOTELY; GOALS, IMPACT ARE ANYTHING BUT REMOTE



**Students Present Global Projects Remotely; Goals, Impact
Are Anything but Remote**

Student Reflections

HOME → NEWS & EVENTS → STUDENTS IN BUCHAREST PROJECT CENTER REFLECT ON THEIR GLOBAL IMPACT

Students in Bucharest Project Center Reflect on Their Global Impact

June 22, 2020

This is the final installment of a three-part article about how the Bucharest, Romania Project Center pivoted to working remotely in D-Term. Here, team members reflect on their experience.

June 22, 2020

If there's one thing that's evident when students from the [Bucharest, Romania Project Center](#) reflect on their D-Term project work—work that ranged from redesigning learning centers for youths and retirees, to saving urban green spaces—it's the feeling they share of having made a global impact without leaving the United States.

Members of the five student teams, who were unable to travel in early spring due to the COVID-19 pandemic, recently reflected on the time they spent learning about Romania's politics, food, and culture while working on their [Interactive Qualifying Projects \(IQP\)](#). Co-directors [Bogdan Vernescu](#), vice provost for research; [Rodica Neamtu](#), associate teaching professor of computer science; and advisor [Bland Addison](#), associate professor of Humanities and Arts, facilitated a smorgasbord of activities via teleconference to offer the group an in-depth look at the country. This culminated at the end of the term when each student group remotely presented their polished reports and recommendations to their sponsors in Romania.

Second Example: Research and MQP Projects

Research Area 1 – Interdisciplinary research with Materials Science, Aerospace Engineering, Mechanical Engineering: Developing machine learning algorithms to automate microscopic image analysis and interpretation for biomedical and aerospace applications.

Research Area 2: Mobile Health Care Apps for (1) Mindfulness, and (2) Helping Visually Impaired People Stay Updated on Local News with Audio Journal, and (3) Augmentative and Alternative Communication for people with disabilities.

Research Area 3: Improving Human-Computer Interaction with Real-time Brain Input.

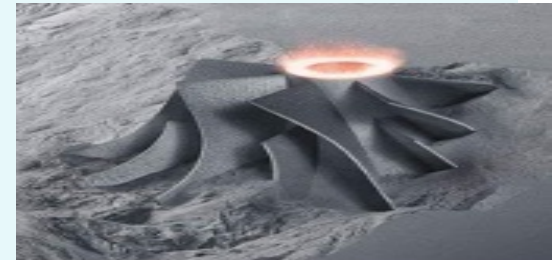
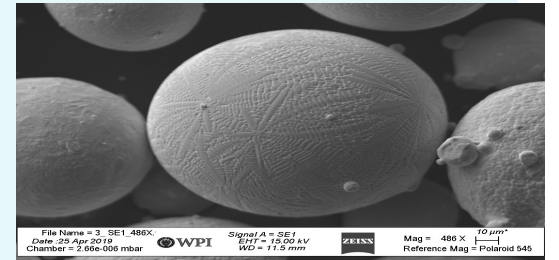
Research Area 4: Data Series Exploration and Analytics.

Research Area 1: Data-Driven Additive Manufacturing

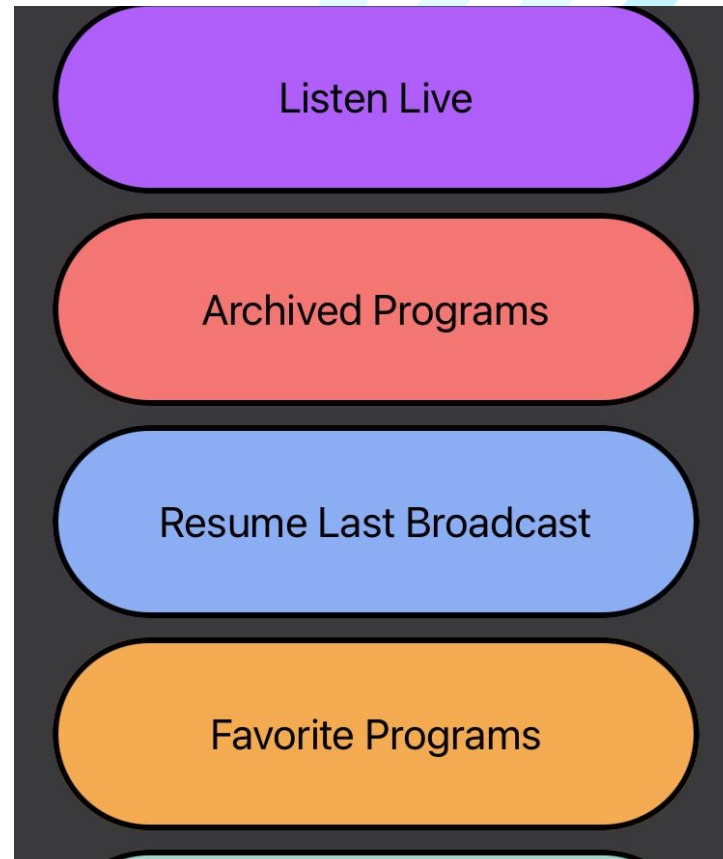
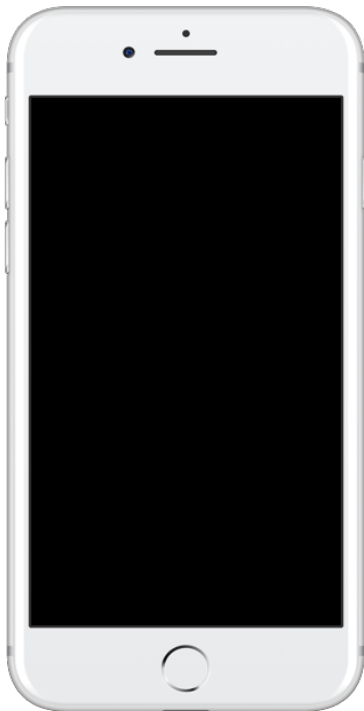
Problem: Powder-based AM processes, such as cold spray, require the use of feedstock powder with specific characteristics, such as controlled particle size and shape distributions. This necessitates the use of precise and accurate particle characterization techniques to measure powder properties.

Vision: Develop an image analysis method for particle size and shape characterization using ML.

Projects: Interdisciplinary CS, DS, ME, MS, Chem team



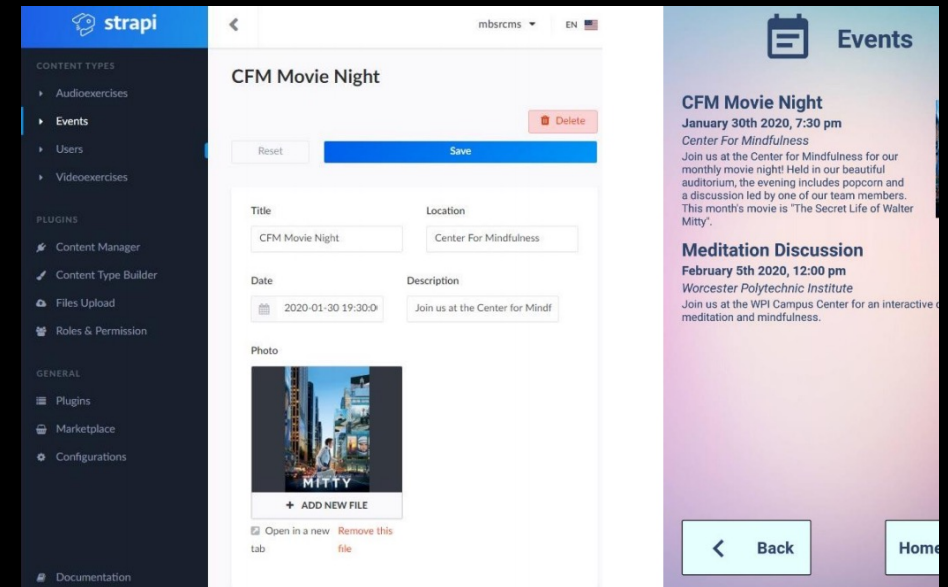
Research Area 2: Mobile Healthcare Audio Journal Application



- An iOS App to enable blind and visually impaired people to access the services of Audio Journal in Worcester.
- Project involves expanding existing app with new features such as voice control and embedding ML for personalized services

Mindfulness-Based Stress Reduction Mobile Application

Expand access, raise awareness, and build upon a prototype app for a full-stack mobile solution to provide a platform for mindfulness content.



- Experience with:
 - JavaScript (node.js, React Native), REST APIs, MongoDB
- Potential Projects
 - Incorporate live stream functionality to practice with others in real-time
 - Embed ML to optimize user customization



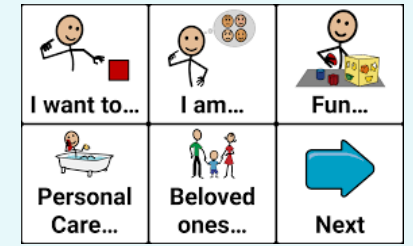
Mobile Health Care Apps for Augmentative and Alternative Communication

Problem: More than 1 billion people with disabilities worldwide at high risk of social and academic exclusion

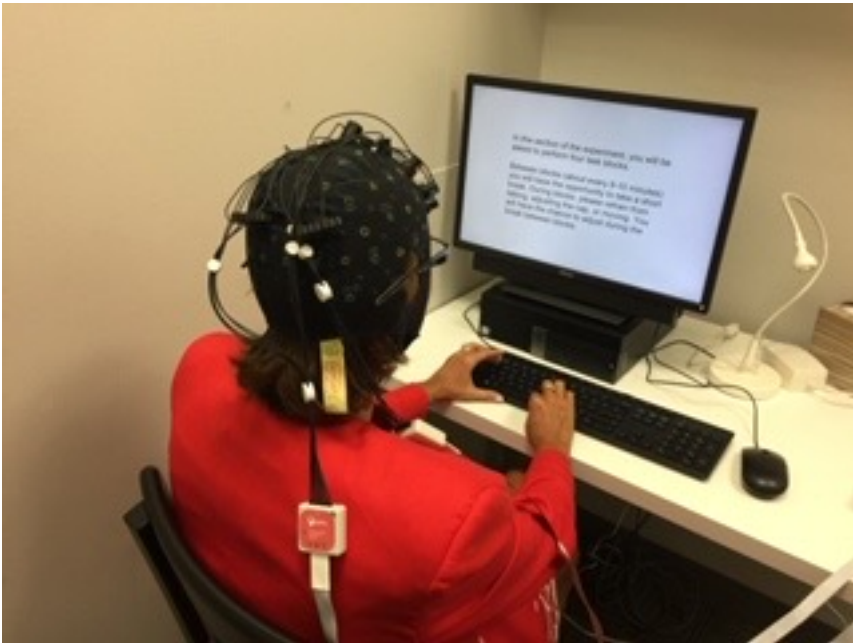
Vision: Adaptive interface for diverse disabilities and patients

Projects: Apps:

- LIVOX – natural language processing, machine learning
- Using NLP and ML to predict user needs and facilitate conversation



Research Area 3: Improving Human Computer Interaction with Brain Input



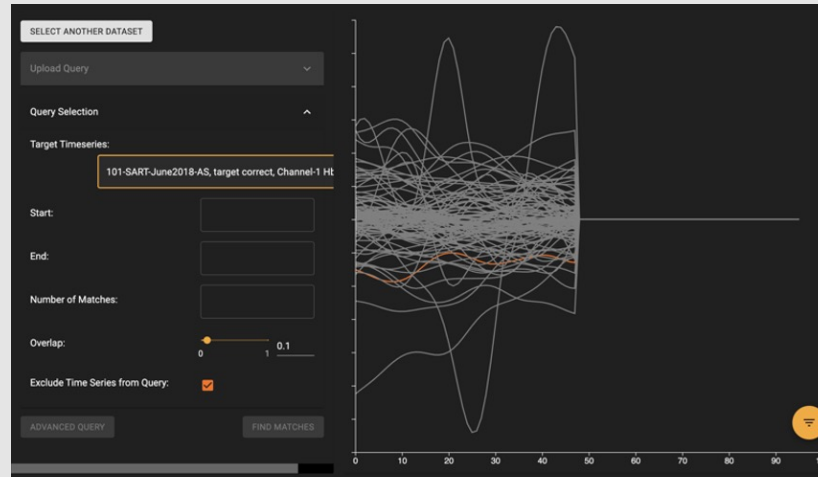
Goal: expand bandwidth between human & computer

Vision: identify signals people naturally give off and adapt systems appropriately

Projects:

- develop robust software to enhance dashboard for data processing and visualization.
- explore data science and machine learning approaches to classify brain data.

Research Area 4: BrainEx Data Mining Tool



The screenshot displays the 'EXPLORE CLUSTER' section of the BrainEx Data Mining Tool. It includes a 'RETURN TO HOMEPAGE' button, a 'Size of Cluster' slider (1 to 2450), a 'Length of Cluster Subsequences' slider (1 to 10), and a 'Show Average' checkbox. Below these are 'APPLY FILTERS' and 'Features to Show' checkboxes for 'Cluster Size', 'Subsequence Length', 'Subject Name', and 'Event Name'. To the right, a table lists clusters with their size, subsequence length, and the percentage of matches for Channel-1 and Channel-2.

Cluster Size	Subsequence Length	Channel Name: Channel-1 HbO	Channel Name: Channel-2 HbO
2450	3	51.42%	48.57%
2448	1	50.74%	49.26%
2435	4	51.17%	48.83%
2282	5	50.88%	49.12%
2064	7	50.82%	49.18%
1843	2	52.41%	47.59%
1702	6	49.71%	50.29%
1683	8	47.12%	52.88%
1606	10	48.63%	51.37%
1319	9	53.3%	46.7%
1242	2	57.09%	42.91%
1209	9	52.44%	47.56%
1020	3	58.63%	41.37%
956	10	63.18%	36.82%
841	1	62.54%	37.46%
808	4	58.04%	41.96%
783	5	57.22%	42.78%
768	6	57.55%	42.45%
648	8	66.67%	33.33%
643	1	74.34%	25.66%

Time Series
Exploration

Advanced
Analytics

Pattern
Recognition

fNIRs
Modeling

My Approach to Advising Online & Hybrid Projects



Strategies for Online/Hybrid Project Advising

- Accountability – let students teach each other
- Collaborative concept mapping – map ideas and explore them
- Collaborative resources – sharing among groups
- “Think-pair-repair” – ask a questions and let students work to find answers by working in pairs (also works in classroom)
- Empower students to self-manage (zoom-coding, daily 15-min briefings)
- Build leadership skills by having students rotate as meeting leaders and note-takers

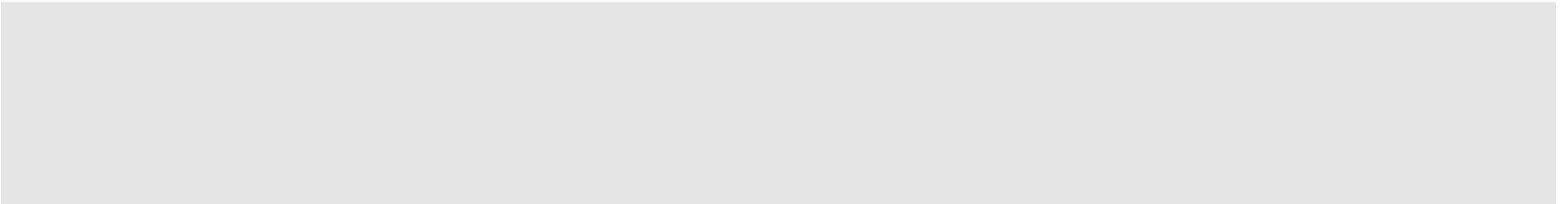
Hybrid vs Online Projects

- Connection is key
- Hybrid is better
- Build community
- If possible, interleave work with fun – outdoor meetings, ice cream social “elevator speeches”
- Connect diverse groups

Hybrid Works Better



Third Example: Developing and Refining Projects for Computer Science Courses



Why Add Projects to CS Courses?

- Increased Student Engagement through Smaller Groups
- Authentic Assessment
- Deeper Connection to Content
- Use Real-World Problems as a Challenge and Inspiration
- Connect Theory and Practice
- Building Community by Connecting Smaller Numbers of Students
- Expand and Enrich Feedback to Students through Peer Review
- Interdisciplinary Opportunities for Students to Apply and Learn Skills

Open-Ended Versus Structured Projects

- Open-Ended - the students are given the outcome, but have freedom of the choice of how to get there
 - Based on student interest
 - More investment in the outcome
 - Increased sense of ownership
 -
- Structured - the students are given the methods and tools
 - More control for instructor on the choice of tools/concepts
 - Easier to use rubrics for feedback
 - More managed student choice
 -

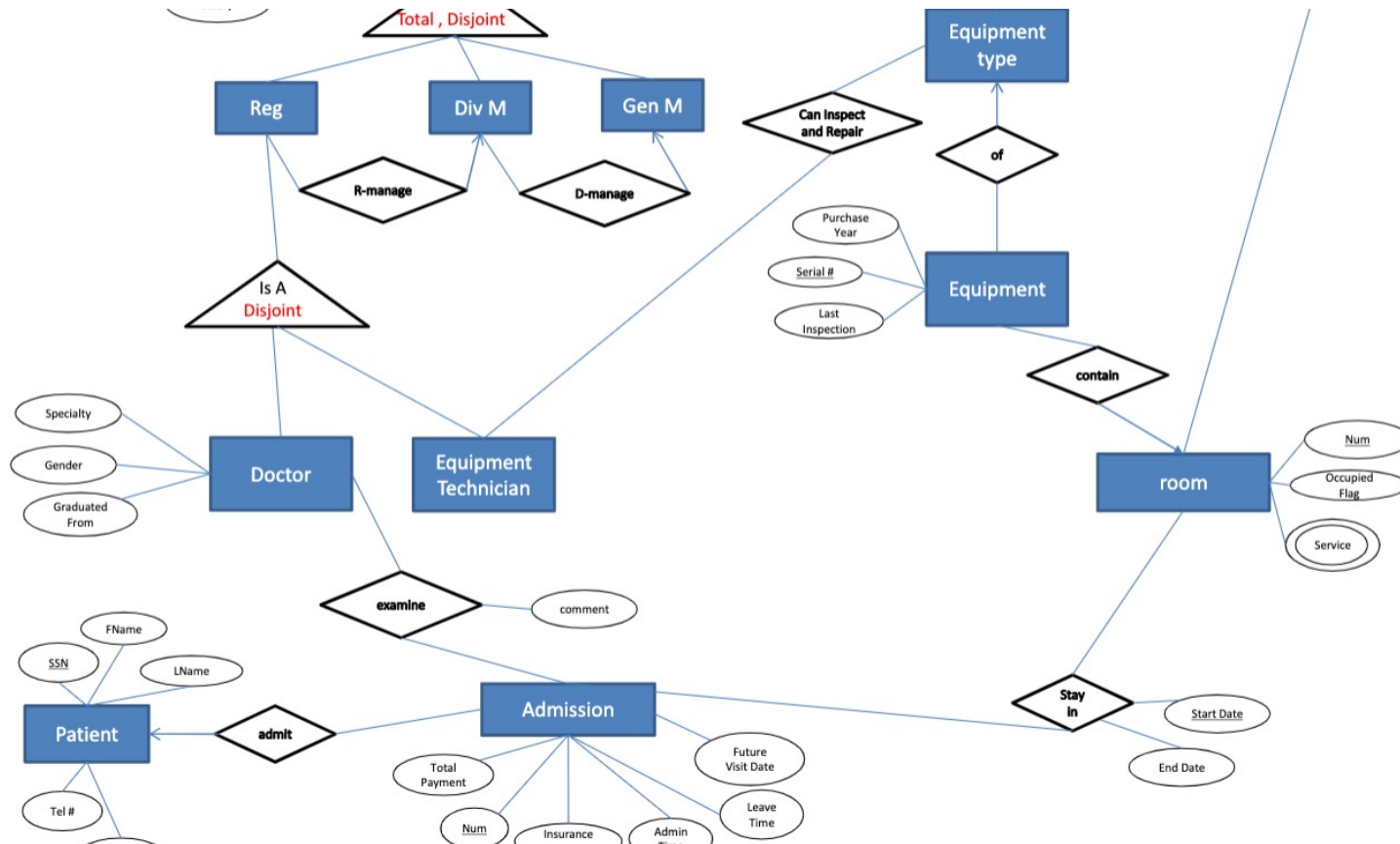
Example Open-Ended Project:
CS graduate
Database
course, 14
weeks, average
55 students

Open-ended project geared towards the design, implementation and evaluation of a database management application for customers. The customer could be an organization on campus or a real company. The focus is on the design and full implementation of the database and its associated application.

- Data needs to be imported or scraped from a source, no “fake data” entered manually is accepted.
- This is a group project where the recommended size of a team is 3-5 students.

The milestones for the project include: (1) Project Intent; (2) Project Proposal; (3) Project Progress; (4) Final Presentations and Deliverables.

Example Structured Project: Computer Science, Databases, Sophomore/Junior Level, 90 Students



Students complete the design of a databases for a general medical application. Technical, social, and financial parameters are incorporated into the design process.

Project highlights student choice within structured scaffolding. Areas of student choice include:

- Selection of constraints
 - Primary constraints
 - Triggers
- Reporting tools
 - Views
 - Dashboards
- Proposed workflow

Project Type Choices

Structured

- Good for freshmen/sophomores to help guide them through the steps
- Great for showing content knowledge
- Can align with standards or themes
- Enable instructor to spend more time giving feedback/learning new topics because there are fewer new topics/areas

Open-Ended

- Juniors/seniors/graduate students to enable them to design and implement a full-stack application
- Real-world projects
- Choice leads to motivation and great creativity
- Portfolios

Advantages

Open Ended

- Based on student Interest
- More investment in the outcome
- Increased sense of ownership

Structured

- More control for instructor on the choice of tools/concepts
- Easier to use rubrics for feedback

Helpful Hints for Both Project Types



Expectations

Clear guidelines
Rubrics
Examples



Breaking projects into smaller pieces



Formative Feedback

Clarifications
Graded vs. Ungraded
Instructor and Peer Review



Multiple Check-ins

Higher level accountability
Self/Peer Evaluations

Group Formation Strategies

- Random vs. Preassigned
- Diversity and Isolation
- Schedule Matching
- Using tools such as catme.org



CATME
SMARTER Teamwork



[Help](#)
[For More CATME Info](#)

LOGIN

Email Address:

Password:

Login

[Forgot your password?](#)

System Statistics

All Time Surveys: **145102** // Active Instructors: **8245** // Active Students: **1639103**

Benefits to Group Work

- Connect smaller numbers of students in groups
- Increased engagement
- Sense of ownership
- Foster collaborative thinking
- Time management



Ways to Build Small Group Communities



Give students class time for initial meeting, even on zoom, breakout rooms



Give ideas for communication methods

Email
Slack
Discord
Teams
Within LMS



Team building activities



Asset mapping

Why is peer- review helpful?

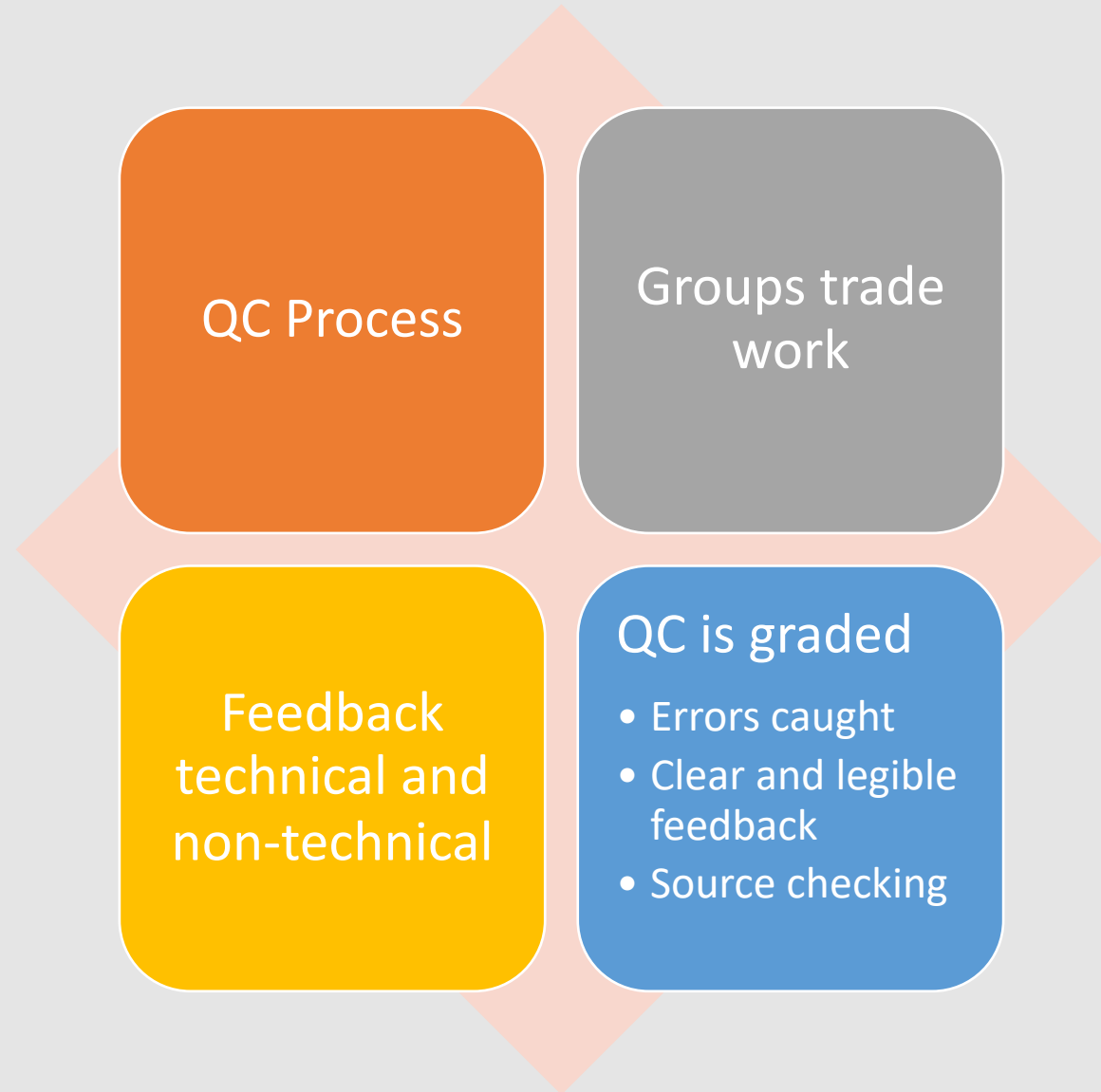
Giving students roles so they understand their responsibilities

Allows delegating

How to motivate peer review

Self & Peer evaluations

Peer Review and Quality Control



QC Rubric

	5 pts	3 pts	1 pts	0 pts
Errors Identification (5 points on main rubric)	All calculation errors were found	1 calculation error was not identified	2 calculation errors were not identified	3 or more calculation errors were not identified
Clear and Legible Feedback (5 points on main rubric)	The root cause of the error is identified, and the change required to correct this action is shown. Corrective actions have clear feedback.	The root cause is not always identified, but changes are shown. Corrective actions have clear feedback.	Corrective actions are not clear, some changes are unclear or incorrect	Incorrect changes/corrections are given. Feedback is unclear/not decipherable.
Source Checking (5 points on main rubric)	All sources have been checked for credibility and your check of the sources is communicated to the other team clearly.	All sources have been checked for credibility but your source check communication to the other team is somewhat unclear.	Most sources have been checked and your source check communication to the other team is somewhat unclear.	Sources were not checked or the source checking was not communicated to the other team.

QC Benefits

QC Benefits

Student



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Professor



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Conclusion

Project-Based Education empowers students

- *global education*
- *capstone and research projects*
- *projects embedded in courses*

Active learning is essential

Communication is KEY

Questions, comments, future collaborations?

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Thank
you!