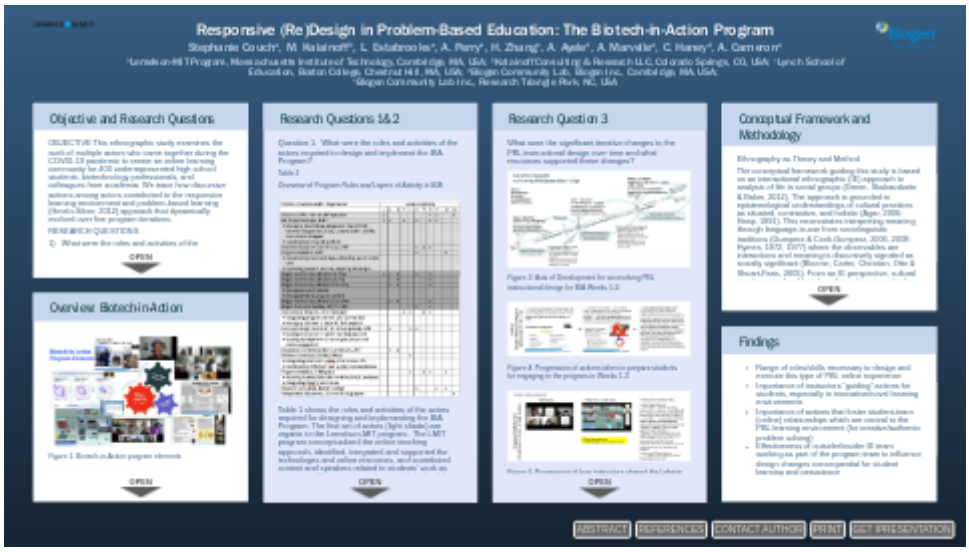
Responsive (Re)Design in Problem-Based Education: The Biotech-in-Action Program



Stephanie Couch[a], M. Kalainoff[b], L. Estabrooks[a], A. Perry[a], H. Zhang[c], A. Ayele[d], A. Marvelle[e], C. Haney[d], A. Cameron[e]

[a]Lemelson-MIT Program, Massachusetts Institute of Technology, Cambridge, MA, USA; [b]Kalainoff Consulting & Research LLC, Colorado Springs, CO, USA; [c]Lynch School of Education, Boston College, Chestnut Hill, MA, USA; [d]Biogen Community Lab, Biogen Inc., Cambridge, MA, USA; [e]Biogen Community Lab Inc., Research Triangle Park, NC, USA

Biogen Community Lab™

PRESENTED AT:

OBJECTIVE AND RESEARCH QUESTIONS

OBJECTIVE This ethnographic study examines the work of multiple actors who came together during the COVID-19 pandemic to create an online learning community for 400 underrepresented high school students, biotechnology professionals, and colleagues from academia. We trace how discursive actions among actors contributed to the responsive learning environment and problem-based learning (Hmelo-Silver, 2012) approach that dynamically evolved over five program iterations.

RESEARCH QUESTIONS

1) What were the roles and activities of the actors required to design and implement the BIA Program?

2) What were the observed actions required of actors (instructors, students, and support team) as part of the initial PBL instructional design in the BIA Program? How was BIA designed to be responsive in the multiple iterative program (re)designs?

3) What were the significant iterative changes to the PBL instructional design over time and what resources supported these changes?

OVERVIEW: BIOTECH-IN-ACTION

Figure 1. Biotech-in-Action program elements

Link to Biotech-in-Action Website (https://www.biogen.com/en_us/virtual-community-lab/biogen-mit.html)

Biogen Community Labs' programming went online in the summer of 2020 as it joined forces with MIT's Lemelson-MIT Program to preserve a summer learning opportunity for 400 high school students during the COVID-19 pandemic. The purpose of this joint work was to help young people—especially those underrepresented in STEM—to:

- discover their passion for health sciences, biotechnology, invention, and innovation;
- experience problem finding and problem solving in ways that mirror the biotechnology, university, and innovation sectors;
- expand their knowledge and laboratory skills in STEM;
- develop skills aligned with those that are essential to the future of work and career
- explorations; and
- identify their personal strengths and capabilities and next steps for growth.

Program Design of Biotech in Action (BIA) and Opportunities for Learning

Collaborators created a state-of-the-art, one-week, fully online program that was delivered in a face-to-face virtual format in real time (synchronously) to high school students. Groups of 80 students engaged with Biogen instructors, other students, and professional mentors via Zoom for 28 hours during each of the five weeks (400 students total). During this time, students engaged in full-group discussions (29% of the time), small groups with one instructor for every 10 students (17%), smaller groups of five students for team work (41%), and in combinations of small groups: two instructors and 20 students (8%). Self-reflections via short videos at the end of the day accounted for 5% of the time. A total of 94% of the students completed the program.

RESEARCH QUESTIONS 1&2

Question 1. What were the roles and activities of the actors required to design and implement the BIA Program?

Table 2

Overview of Program Roles and Layers of Activity in BIA

Position, Function and/or Organization	Layers of Activity										
	1	2	3	4	5	6	7	8	9	10	11
Director, LMIT; Internal Ethnographer	x							x	x		x
BIA Project Manager, LMIT	x	x		x		x		x	x		
• Managing BIA working groups and flow of work between Biogen instructors, content editor, and the instructional designer • Coordinating for guest speakers											
Invention Education Coordinator, LMIT						x	x	x			
Program Assistant, LMIT						x				x	
• Coordinating team meetings, scheduling water cooler talks • Uploading research records, acquiring transcripts											
Biogen Community Lab Director (MA)	x	x	x			x		x			
Biogen Community Lab Director (NC)		x	x					x			
Biogen Community Lab Instructor (NC)		x	x					x			
• Managed student rosters • Managed/edited program content											
Biogen Community Lab Instructor (MA)		x	x					x			
Biogen Instructor Interns (x4) (NC, MA)						x		x			
Instructional Designer, Event Manager				x	x		x	x			
• Integrating program content with Canvas LMS • Managing daily run of show for BIA program											
Curricular design consultant (in virtual spaces), LMIT		x			x	x					
• Guiding instructors in online teaching practices • Guiding development of learning resources and online engagement											
Disciplinary content (biotech) consultant, LMIT		x	x								
Software Developer, Startup Tribes					x						
• Integrating Zoom and Labster into Canvas LMS • Coordinating with Zoom and Labster representatives											
Program Assistant, IT Helpdesk					x		x	x		x	
• Assisting students/educators with technical problems • Integrating Flipgrid into Canvas											
Research Consultant, Boston College						x			x	x	
Independent Researcher, External Ethnographer											x

Table 1 shows the roles and activities of the actors required for designing and implementing the BIA Program. The first set of actors (light shade) are organic to the Lemelson-MIT program. The LMIT program conceptualized the online teaching approach, identified, integrated and supported the technologes and online resources, and contributed content and speakers related to students' work as inventors. The second set of actors (dark shade) are Biogen Community Lab instructors and interns who guided students through the disciplinary content and research posters/presentations. The last set of actors were operational, technical, disciplinary, and education research consultants whose specialized skills were required to design and implement the program.

Question 2. a. What were the observed actions required of actors (instructors, students and support team) as part of the PBL instructional design? b. How was BIA designed to be responsive in the multiple iterative program (re)designs?

Figure 2. A process model for conceptualizing learning as a social construction showing actions taken by actors within the BIA PBL Instructional Design and iterative program (re)designs

The observed actions of instructors, students, and the support team are shown in Figure 2 in the context of a process model of independent processes for teaching and learning (Kalainoff & Clark, 2017). Student actions reflect how the PBL instructional design enacted by the instructors positioned them to engage at the boundary of their own disciplinary knowledge to develop an authentic research question for a neurogenerative disease and propose a technical or inventive solution. Additionally, Figure 2 shows how the daily BIA Team meetings served as the mechanism for design change, both daily and over the multiple iterations of the program.

RESEARCH QUESTION 3

What were the significant iterative changes to the PBL instructional design over time and what resources supported these changes?

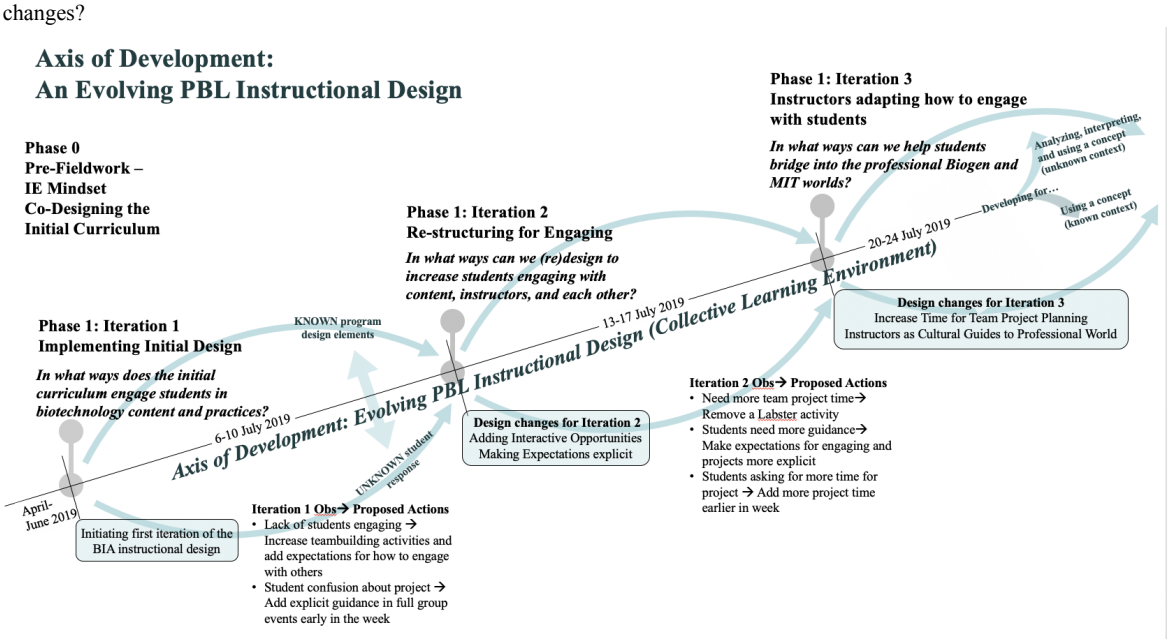


Figure 3. Axis of Development for an evolving PBL instructional design for BIA Weeks 1-3

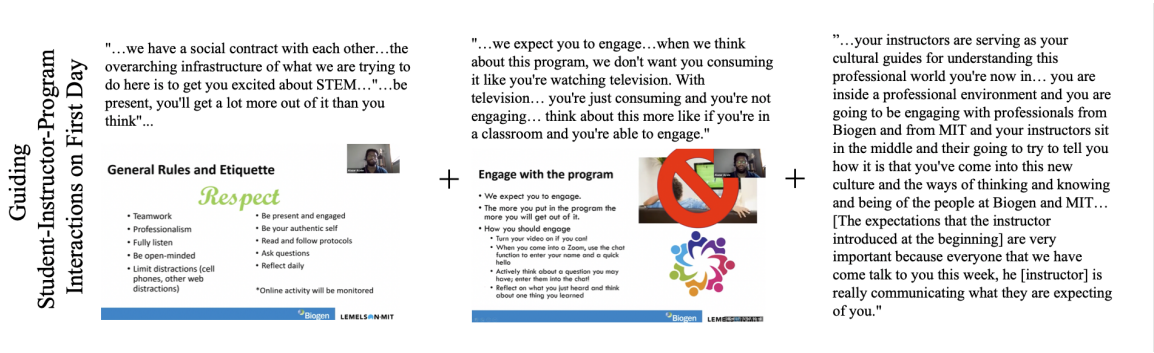


Figure 4. Progression of actions taken to prepare students for engaging in the program in Weeks 1-3

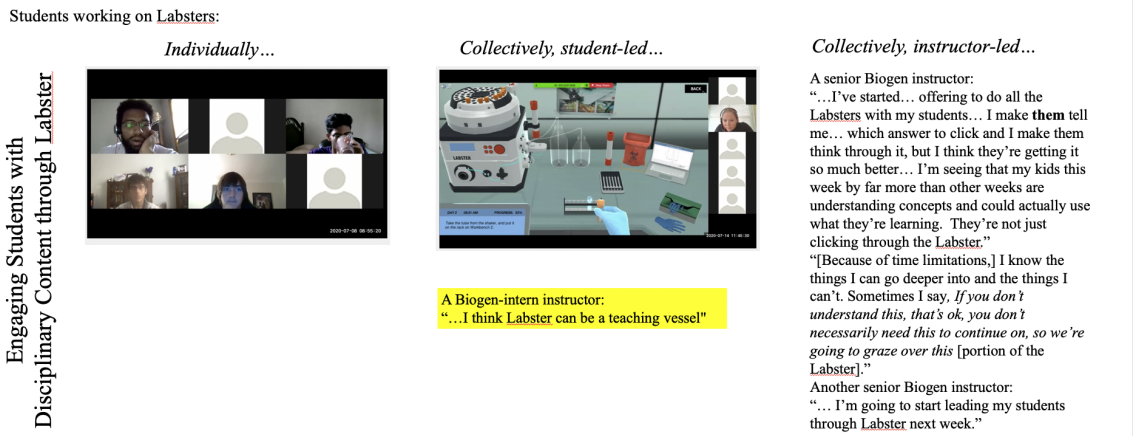


Figure 5. Progression of how instructors shaped the Labster learning environment(s) in Weeks 1-3

Figure 3 is an overview of the significant iterative changes to the PBL instructional design in the first three weeks (of five) of the program; all five weeks were analyzed but significant changes with respect to the design occurred in the first three. Although there are many facets (axes) of development over time occurring in the program, in this study, we are focusing on the PBL instructional design (axis) as a layer of analysis. This representation shows the primary structural changes made as a response to observed student take up (or not) of the program activities: adding interactive opportunities for student-teams to build teamwork early in the program and explicitly guiding students with program expectations for how students should be engaging.

Figure 4 shows the progression of this explicit guidance for interacting/engaging in program activities through framegrabs and discourse taken from video of Day 1 welcome and program orientation. From Week 1 to 2, a slide that provided more guidance was added. From Weeks 2 to 3, speakers added a reframing of expectations in terms of positioning instructors as cultural guides for students.

In addition to structural changes, instructor and support team interactions during daily BIA Team meetings also guided collective changes to individual actions of instructors with their own groups of students. Figure 5 shows the overtime progression of how the majority of instructors positioned themselves as guides of the disciplinary content in Labster activites in Weeks 1-3.

CONCEPTUAL FRAMEWORK AND METHODOLOGY

Ethnography as Theory and Method

The conceptual framework guiding this study is based on an interactional ethnographic (IE) approach to analysis of life in social groups (Green, Skukauskaite & Baker, 2012). The approach is grounded in epistemological understandings of cultural practices as situated, contrastive, and holistic (Agar, 2006: Heap, 1991). This necessitates interpreting meaning through language-in-use from sociolinguistic traditions (Gumperz & Cook-Gumperz, 2006, 2008: Hymes, 1972, 1977) where the observables are interactions and meaning is discursively signaled as socially significant (Bloome, Carter, Christian, Otto & Shuart-Faris, 2005). From an IE perspective, cultural practices, and problem-based practices in particular, are continuously developing and can be traced across time, actors and events through intertextual (Bloome et al., 2005) ties. Central to this methodology is using insider/outsider ethnographers (first and second authors) (Green & Bridges, 2018) who, working with instructors, conducted IE analyses continuously to inform modifications to the multiple program iterations.

Modes of inquiry

Multiple forms of analysis and triangulation of data, including what actors proposed to each other and what was taken up by others, supported our exploring of the multiple iterations of the developing program. Taxonomic analysis (Spradley, 2006) was used to document the network of actors and their roles and relationships. Discourse analysis of video records (Green, Skukauskaite, Dixon & Cordova, 2007) and texts produced grounded accounts as the basis for contrastive analysis of the week-to-week changes to the program and how these changes were taken up by students.

Data sources

Program artifacts, video records (of the full group sessions (5 weeks), selected small groups sessions (7 instructor-weeks), and BIA Team meetings 25)) and ethnographer fieldnotes provide first-hand accounts of over time challenges and decisions. Iterative changes and student responses to the iterative changes are further explored in ten student and eight instructor interviews.

Table 1. Study Methodology

	Research Question	Data/Records Used	Data Shown	Conceptual/Methodological Element (Literature)
1	Who were the actors who designed the BIA Program and what were their stakeholder interests and contributions?	Program records of design and planning meetings	Table of BIA planning/design actors	Taxonomic Analysis (Spradley, 1979)
2a	What were the actions required of instructors and students as part of the initial PBL instructional design in the BIA Program?	Fieldnotes of Week1 of Full Group meetings, Small Group meetings for one instructor, and Daily BIA Team meetings	Representation of instructor and student actions	Discourse Analysis (Bloome, et al., 2005) Developmental Model for Teaching and Learning (Kalainoff & Clark, 2017)
2b	In what ways was the BIA Program responsive in the multiple iterative program (re)designs?	Fieldnotes from Daily BIA Team meetings for Weeks 1-5	Table tracing the key program actions, student responses, and program decisions/changes by topic and cycle of activity	Discourse Analysis (Bloome, et al., 2005) Cycles of Activity (Green & Meyer, 1991)
3	What were the significant iterative changes to the PBL instructional design over time and what resources supported these changes?	Table of key program changes from Q2 Select Video Records of BIA team mtgs-Frame grabs	Axes of Development for the PBL instructional design Transcript segments	Discourse Analysis (Bloome, et al., 2005) Cycles of Activity (Green & Meyer, 1991) Developmental Model for Teaching and Learning (Kalainoff & Clark, 2017)

FINDINGS

- Range of roles/skills necessary to design and execute this type of PBL online experience
- Importance of instructors “guiding” actions for students, especially in innovative/novel learning environments
- Importance of actions that foster student-team (online) relationships which are central to the PBL learning environment (for creative/authentic problem solving)
- Effectiveness of outsider/insider IE team working as part of the program team to influence design changes consequential for student learning and persistence

ABSTRACT

Objective This ethnographic study examines the work of multiple actors who came together during the COVID-19 pandemic to create an online learning community for 400 underrepresented high school students, biotechnology professionals, and colleagues from academia. We trace how discursive actions among actors contributed to the responsive learning environment and problem-based learning approach that dynamically evolved over five program iterations. Conceptual Framework: Ethnography as Theory and Method The conceptual framework guiding this study is based on an interactional ethnographic (IE) approach to analysis of life in social groups (Green, Skukauskaite & Baker, 2012). The approach is grounded in epistemological understandings of cultural practices as situated, contrastive, and holistic (Agar, 2006: Heap, 1991). This necessitates interpreting meaning through language-in-use from sociolinguistic traditions (Gumperz & Cook-Gumperz, 2006, 2008: Hymes, 1972, 1977) where the observables are interactions and meaning is discursively signaled as socially significant (Bloome, Carter, Christian, Otto & Shuart-Faris, 2005). From an IE perspective, cultural practices, and problem-based practices in particular, are continuously developing and can be traced across time, actors and events through intertextual (Bloome et al., 2005) ties. Central to this methodology is using insider/outsider ethnographers (first and second authors) (Green & Bridges, 2018) who, working with instructors, conducted IE analyses continuously to inform modifications to the multiple program iterations. Modes of inquiry Multiple forms of analysis and triangulation of data, including what actors proposed to each other and what was taken up by others, supported our exploring of the multiple iterations of the developing program. Taxonomic analysis (Spradley, 2006) was used to document the network of actors and their roles and relationships. Discourse analysis of video records (Green, Skukauskaite, Dixon & Cordova, 2007) and texts produced grounded accounts as the basis for contrastive analysis of the week-to-week changes to the program and how these changes were taken up by students. Data sources Program artifacts, such as pre and post student experience surveysvideo records, and transcripts, provide first-hand accounts of over time challenges and decisions. Iterative changes and student responses to the iterative changes are further explored in ten student and eight instructor interviews. Results In a series of contrastive analyses of discourse, activity, and events, this study shows the overtime challenges and the team's iterative responses to (re)designing the program to improve the effectiveness of problem-based instructional practices. For example, one of the challenges in Week 1 identified by instructors and recognized by ethnographers in their observations was lack of student-student engagement, which instructors addressed by adding additional team-based opportunities early in the week. The study also made visible the roles and relationships of actors and the expertise required to create this type of complex program. Scholarly significance This study contributes a warranted account of iterative change to problem-based instructional practices in an online environment. This study also contributes methodological directions by showing how an interactional ethnographic perspective can be used to uncover the layers of work required to negotiate any change process especially within the complex social and cultural environments of collaborative endeavors between academia and industry.

REFERENCES

Agar, M. (2006). Culture: Can you take it anywhere? International Journal of Qualitative Methods. 5(2), 1-12. Retrieved Nov 20, 2011, from http://www.ualberta.ca/~iiqm/backissues/5_2/pdf/agar.pdf

Bloome, D., Carter, S., Christian, B., Otto, S., & Shuart-Faris, N. (2005). Discourse analysis and the study of classroom language and literacy events: A microethnographic perspective. New York: Routledge.

Green, J., & Bridges, S. (2018). Interactional Ethnography. In Fisher, F., Hmelo-Silver, C. E., Goldman, S. R., & Reimann, P. (Eds.), International handbook of the learning sciences (pp. 475-488). Abingdon: Routledge.

Green, J. L., Skukauskaite, A., & Baker, W. D. (2012). Ethnography as epistemology: An introduction to educational ethnography. In J. Arthur, M. J. Waring, R. Coe & L. V. Hedges (Eds.), Research methodologies and methods in education (pp. 309-321). London: Sage.

Green, J., Skukauskaite, A., Dixon, C., & Cordova, R. (2007). Epistemological issues in the analysis of video records: Interactional ethnography as a logic of inquiry. In R. Goldman, R. Pea, B. Barron & S. J. Denny (Eds.), Video research in the learning sciences (pp. 115-132). Mahwah, NJ: Lawrence Erlbaum Associates.

Gumperz, J., & Cook-Gumperz, J. (2006). J. Interactional sociolinguistics in the study of schooling. In J. Cook-Gumperz (Ed.), Social construction of literacy (2nd Ed). Cambridge University Press.

Gumperz, J., & Cook-Gumperz, J. (2008). Studying language, culture, and society: Sociolinguistics or linguistic anthropology? Journal of Sociolinguistics, 12(4), 532-545.

Heap, J. (1991). A situated perspective on what counts as reading. In C. Baker and A. Luke (Eds.), Towards a critical sociology of reading pedagogy (pp. 103-139). Philadelphia: John Benjamins.

Hmelo-Silver, C. E. (2012). International perspectives on problem-based learning: Contexts, cultures, challenges, and adaptations. Interdisciplinary Journal of Problem-Based Learning, 6(1), 10-15. https://doi.org/10.7771/1541-5015.1310

Hymes, D. (1972). Toward ethnographies of communication: The analysis of communicative events. In P. P. Giglioli (Ed.), Language and social context (pp. 21-44). Harmondsworth: Penguin Books.

Hymes, D. (1977). Critique. Anthropology and Education Quarterly, VIII(2), 91-93.

Kalainoff, M. Z. & Clark, M. G. (2017). Developing a logic-of-inquiry-for-action through a developmental framework for making epistemic cognition visible. In Clark M., Gruber C. (Eds.). Leader Development Deconstructed (pp. 209-248). Annals of Theoretical Psychology, Vol 15. Cham: Springer.

Spradley, J. (2006). Participant observation. New York: Holt, Rhinehart, and Winston.