DRAFT Data Science and Data Analytic Learning Environments at Small Liberal Arts Institutions White Paper

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Driving Questions / Purpose

On March 29 and 30, Carroll University hosted an NSF funded workshop with the goal being to form a consortium of small liberal arts colleges that would work together to expand the usage of and development of next generation digital learning environments (NGDLE's) for teaching data science and data analytics (DSA). The workshop was attended by 55 people from 11 different institutions. Randomly assigned to teams based on interests, eight teams of participants worked on team building and content goals. Content consisted of NGDLE's, DSA, learning science, and team science. The consortium is working on six workstream goals, designed around four fundamental research questions: (1) How will NGDLE's prepare students for employment that requires DSA? (2) How will the design of DSA NGDLE's account for the variability of learners? (3) How will NGDLE's be assessed to measure student DSA competency? (4) How will a national consortium for digital learning at small liberal arts institutions form and function to sustain and expand the workshop outcomes? This paper summarizes the workshop and participant activities, together with consortium goals and next steps.

Participants

Using internet searches, 300+ provosts/deans were emailed workshop notices and application links. Schools targeted were small private colleges with similar endowments (i.e., less than $100,000,000). A total of 44 institutions applied to participate in the workshop. The application consisted of listing five administrators, faculty or staff, individual interests, institutional interests/plans for DSA, and willingness to do pre-workshop work. Using a methodology based on quality of application, proposed team composition, and institutional-similarity to Carroll, we selected 11 teams from across the United States, 4 from the east coast, 4 from the Midwest (including 1 from Carroll), and 3 from the west coast.. As one pulled one month before the workshop, a total of 11 institutions participated in the workshop and they are given in Figure 1. The figure also maps out primary areas of expertise and institutional interests.

Process

Pre-Workshop

As we did research for the project proposal, developing NGDLE's to teach DSA lead naturally to the need to study learning science, and in our discussions with representatives in industry, the need to study team science became apparent as well. Thus, for the project proposal, these became the four content areas of focus: NGDLE's, DSA, learning science, and team science. It also became apparent that team science could help inform how the consortium functions.

Pre-workshop guidance was given by two advising committees, one external and the other internal. These committees met every two weeks to provide guidance and advice to the grant leadership team.

School	Team Compositions														Interests			
	M	CS	NS	BU	ED	SS	DS	AH	IT	NG	HS	DE	AS	DH	AC	GE	M	G
Carroll University	1	1		2					1						X	X	X	X
Drury University (Missouri)	1		1	1	2				1						X	X	X	X
Emmanuel College	1	1	1		1				1	1					X	X	X	
Franklin University (Ohio)	1						2		2	1	1				X	X	X	X
Hiram College (Ohio)	1	1	1	1	1			1		1		1			X	X	X	X
LaGrange College (Georgia)				2	1			1	1		1				X	X	X	
Merrimack College (Massachusetts)		1		1		1		1	1	1	1					X	X	X
Pacific Lutheran University (Washington)				3		1			1	1						X	X	
Presbyterian College (South Carolina)	1						2	1	1				1	1				
Ripon College (Wisconsin)	1	1	1					1	1		1		1	1		X	X	
Seattle Pacific (Washington)	1	1											2	2		X	X	
	8	5	2	12	1	5	2	1	5	5	0	5	1	3	5	6	11	3

M = mathematics

CS = computer science

NS = other natural science

BU = business, accounting, economics, information systems

ED = education

SS = other social sciences

DS = data science, analytics

AH = arts & humanities

IT = IT specialist

NG = NGDLE's or academic technology

HS = health science

DE = dean or provost

AS = assessment director

DH = digital humanities, digital librarian, other librarian

AC = across curriculum

GE = general education

CE = certificate

M = Major/Minor/Certificate

G = Graduate

Figure 1

Meeting agendas consisted of discussing and planning workshop and pre-workshop activities and logistics. Participants are thanked at the end of this report.

For pre-workshop work, some of which was done virtually using Microsoft Teams, institutional teams were given short introductory materials on NGDLE's, DSA, learning science, and team science. Then, to get participants thinking in the direction of the workshop, institutional teams were asked to think of a desired NGDLE for teaching DSA, and what it might do. Broadly participants cited the desire for interactive tools, real-world DSA models, and tools that adapt to individual learners.

Workshop

For the workshop, the 55 participants were randomly assigned to one of eight different teams. Five teams were grouped with participants from institutions that indicated interest in DSA at a program level (major/minor/graduate), with the other three tables populated with participants from institutions that have interest at a general education/cross-disciplinary levels.

During the two day workshop, breakout sessions for the eight teams were led by "table captains." The table captains consisted of eight Carroll faculty and staff, tasked with ensuring that discussions remained on topic and that everyone contributed. Table captains wrote notes on flip boards, and each table was equipped with a microphone whose use was optional.

The workshop was facilitated by [Silver Rock Consulting](#), with the intent being to keep focus on workshop goals and increase work output. The grant leadership team met periodically with Silver Rock to develop workshop activities, in conjunction with recommendations from the advising committees. For the workshop itself, Silver Rock provided three facilitators, whose principle goal was to assist participants in team building and work output.

The key to success in the project proposal is the consortium. If the consortium doesn't form, then the other goals are moot. Thus, the workshop was structured around that primary goal: consortium buy-in. With that in mind, the workshop was structured as follows:

1. Community building within teams
2. Speaker on DSA (focus on industry perspective)
3. Teams discuss DSA goals
4. Speakers on Team Science (focus on working across institutions)
5. Teams discuss Team Science
6. Speakers on NGDLE's (current open source and for-profit technologies)
7. Teams discuss NGDLE's
8. Speaker on Learning Science (artificial intelligence and the future)
9. Teams discuss Learning Science
10. Teams and entire group develop shared goals (NGDLE's for teaching DSA)
11. Institutional teams discuss commitment to consortium and shared goals

Speaker Themes

Speaker descriptions and talk slides (when used) can be found here: [https://www.carrollu.edu/nsf-workshop.](https://www.carrollu.edu/nsf-workshop)

DSA Themes
Presenter: Dr. Justin Jacobs
1. Business Problem translates to Technical Problem
2. Data: Relevance, Interpretation, Reliability, Cleaning
3. Models: Cataloging, Validation, Verification
4. Communicating to Decision Makers

Team Science Themes
Presenters: Dr. Michael O'Rourke, Dr. Gaetano R. Lotrecchiano
1. Teach teamwork process
2. Seek diversity
3. Spend time to build trust
4. Deal with conflict, don't avoid it
5. Develop communication skills

NGDLE Themes
Presenters: Michael Greene, Valinda Scarbro Kennedy
1. EDUCAUSE NGDLE Functional Pillars Interoperability and Integration
   - Personalization
   - Analytics, Advising, and
   - Assessment
   - Collaboration
   - Accessibility and Universal Design
2. Respect Institutional Cultures

Learning Science Themes
Presenter: Dr. Dave L. Edyburn
1. Universal design
2. Develop life skills, including adaptive skills for changing
3. Paradigm shift in how we teach
4. Delineate between intelligence and wisdom
5. Consortium as learning network

Findings

Workshop Outcomes on Research Questions

Following are descriptions of how team discussions related to the four research questions. In each case, further work is required beyond the workshop, of course.

Research Question 1: How will the innovative digital learning environments prepare students for employment that requires DSA?

Participants identified the need for skills in data mining, cleaning, analyses, and presentation/communication to nontechnical decision makers. Interdisciplinary approaches are needed to meet the range of business needs, technical expertise, and solutions. This includes interdisciplinary work within the curriculum, including the development of communication skills. The shared focus on DSA content and open source NGDLE output was seen as a strength in this project.

Research Questions 2: How will the design of DSA digital learning environments account for the variability of learners?

Universal design in developing NGDLE's and for teaching DSA was a recurring theme. In the teaching of DSA, we need to also develop life skills, including adaptive skills for changing workspaces and job markets. We need to inspire students in DSA early as possible, and NGDLE's could help accelerate DSA learning. While learning science and NDGLE's might lead to a paradigm shift in how we teach, we need to delineate between intelligence and wisdom. For this effort to be successful, the consortium will have to function as a learning network, providing future opportunities for faculty development.

Research Question 3: How will data be collected and learning environments assessed to measure students DSA competency?

In order to develop effective assessment, effective curricular design will require faculty development, something the consortium should provide. By constructing design teams by faculty, levels, and topics, intentionality in curriculum design can lead to effective measurement. Define role of DSA in liberal arts and lifelong learning, as well as develop interdisciplinary processes that can support and engage learners more authentically. Design annual workshops/conferences for teaching DSA skills, developing expertise from a pedagogical perspective, developing methods for engaging leaners, improving/easing adoption/usage of NGDLE's for teaching DSA, and managing the wide variety of tools for the classroom. For team work in class and assessment of teamwork, develop stakeholder management, develop understanding of roles/responsibilities and identifying individual value, and develop course assignments per team science. Assessment tools need to be open source and consortium needs to supply technology support. We can use assessment and DSA to improve learning and address achievement gaps. These tools need to be seen as additions, not replacements.

Research Question 4: How will a national consortium for digital learning at small liberal arts institutions form and function to sustain and expand the workshop outcomes?

For the consortium to function, for enduring connections between partnering schools and industry to strengthen and grow, we must:
1. Share resources
2. Work as a learning network, embracing an openness to learn
3. Respect cultural differences, listen to multiple perspectives, and be aware of competition dynamics
4. Identify shared curriculum development and teaching commonalities
5. Open source output for all
6. Share good and bad, be open to change, have open collaborative participation that is judgment free
7. Have active annual workshops/conferences for continuing momentum
8. Pool resources, but find outside funding
9. Take advantage of synergies in academic, government and industry partnerships
10. Provide technology support, and provide/develop tools that respect different institutional cultures
11. Work as an incubator

Surprises & Tensions

- We learned that some participants attended the workshop because they had been told to do so by administrators.
- Continuing work after the workshop is the greatest challenge.

- We did not expect team science to become the unifying theme in the workshop.

Recommendations

Workshop Consortium Goals

Upon completion of teams identifying shared goals, those goals were summarized in six broad categories: DSA at a program level (major/minor/graduate), NGDLE's, DSA at the general education level, Learning science and universal design, consortium governance, and DSA across disciplines. Drafts of the six were edited by the participants, and the final product is as follows.

Mission: In the context of Small Liberal Arts Colleges, ethics considerations as part of all aspects, and repository considerations for all aspects.
1. Standardize Data Science (distinguish from Data Analytics): determine competencies for industry recognized certification (focus on standardizing students or curriculum) –
     a. Intelligence vs. Wisdom: know which questions to ask in the future
2. Define robust and effective NGDLE characteristics, in support of data analytics programs, (1 tool to rule them all) aligned with current LMSs and campus cultures
3. Design effective interdisciplinary approaches to Data Science & for a general education level (Course Share, Shared repository of assignments/curricula/etc, Ethics)
4. Integrate learning science into pedagogy while considering universal design of learning, and inclusive pedagogy
5. Design and develop consortium (governance, protocols, resources, direction, mission, ethics)
6. Define discipline specific learning clusters

Participants were then regrouped into institutional teams and worked on where their interests fit, where appropriate, and whether institutions and/or individuals would commit to working in the consortium. At least one participant from each institution committed, with a total of 37 of the 55 making a commitment. In our view, the greatest challenge to the consortium isn't the NGDLE technology, nor the content of DSA, but it is continuing work after the workshop. People are busy as is. It will take further funding to buy time and resources for the consortium to function.

Those who volunteered for one of the six goals, which were labeled "workstreams," were then asked to come up with next steps to be completed within three months of the workshop. Following are the next steps for each group.

Workstreams Next Steps

Workstream 1 (DSA Content – 8 members)
1. Google drive for sharing and comparison of resources
2. Divide into two groups to study major/minor in
     a. Data Science (computer, courses)
     b. Data Analytics (broad data analysis focus)

Workstream 2 (NGDLE's – 3 members)
1. Create a shared online space
2. Gather requirements
3. Assess landscape – what is available and hot/useful/trending
4. Recruit members

Workstream 3 (DSA Gen Ed-Level – 7 members)
1. "Share Out" – Google Cloud
    a. (form for assignments)
    b. Repository
2. "Gen. Ed:" (discussion document)
    a. Need data literacy (what is it that we need)
3. Program Level: (First Draft)
    a. What
    b. Alumni
    c. Ethics
    d. Industry Skills

Workstream 4 (Learning Science and Universal Design – 7 members)
1. Identify curriculum that exists
2. Identify inclusive practices for DSA

Workstream 5 (Governance – 7 members)
1. Meeting schedule
2. White paper describing what a consortium might look like
    a. Best practices
    b. Create a vision

Workstream 6 (Cross Discipline – 5 members)
1. Reach out to other schools for interest
2. Create repositories based on disciplines
    a. Business
    b. DSA
    c. Mathematics
3. Create repositories based on tools
    a. Textbooks
    b. Ted Talks
    c. Papers

Next Steps for Carroll University

Short-term, June through August 2019, Carroll University led implementation of a Business Model Canvas for the consortium. The Canvas has nine elements – key partners, key activities, value propositions, customer relationships, customer segments, channels, cost structure, revenue streams – together which will provide a coherent view of key drivers. The Canvas delivers focus, flexibility and transparency during consortium development. On August 15, 2019 representatives from Workshop 1 institution teams and Fortune 500 industries convened on the Carroll campus to engage in a day long facilitated workshop that confirmed the model (Figure 1) and built the tasks and timeline to launch the consortium (Figure 2). The August 15 workshop was facilitated by Triple Ten Consulting who helped focus on working with IHE and industry in developing multi-year experience management strategic plans.

The consortium model (Figure 1) features a two pronged academic-industry approach that 1) engages in economic and labor market analyses of needed skills for future workplaces and 2) accesses talent pathways at small liberal arts IHE and prototypes innovative DSA NGDLEs. The Consortium Launch Plan (Figure 2) consists of administrative, governance, content, technology platforms, faculty readiness, and NGDLE launch tasks, task duration, and task start and finish dates.
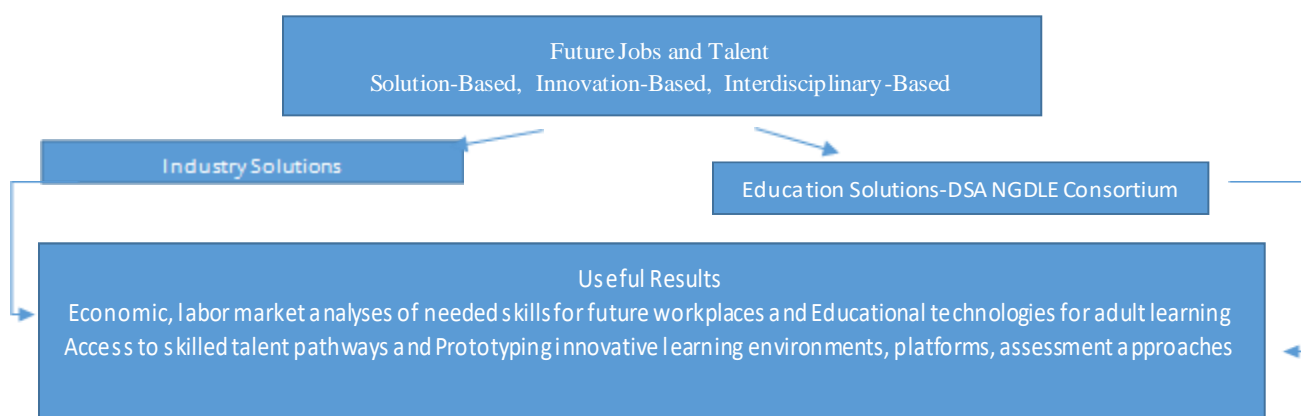
Figure 1
Consortium Model

Figure 2
Consortium Launch Plan

TASK	DURATION	START	FINISH
Administrative	98d	08/19/19	01/01/20
Identify implementation plan lead	10d	08/19/19	08/30/19
Identify administrative resource	10d	08/19/19	08/30/19
Complete "Pitch Deck" for all schools to use	22d	09/01/19	09/30/19
Complete high-level flow of all "widgets" through the Consortium	22d	09/01/19	09/30/19
How do students flow through the consortium	22d	09/01/19	09/30/19
How does faculty flow through the consortium	22d	09/01/19	09/30/19
How does an industry partner flow through the consortium	22d	09/01/19	09/30/19
How do projects flow through the consortium	22d	09/01/19	09/30/19
Pitch for Funding	1d	01/01/20	01/01/20
Branding & Identity	66d	09/01/19	11/29/19

Governance	153d	09/01/19	03/31/20
Confirm initial members	11d	09/01/19	09/13/19
Identify champions from each school	11d	09/01/19	09/13/19
Institutional evaluation of all schools	22d	09/01/19	09/30/19
Develop value proposition for desired founding members	22d	09/01/19	09/30/19
Consortium Readiness Survey	22d	09/01/19	09/30/19
Form Steering Committee	23d	10/01/19	10/31/19
Governance Structure	23d	10/01/19	10/31/19
Quantitative Goal Setting (OKRs/KPIs)	23d	10/01/19	10/31/19
Execution/Engagement Model	23d	10/01/19	10/31/19
Determine Founding Members	21d	11/01/19	11/29/19
Create Goal Groups	23d	12/01/19	12/31/19
Attract Members	23d	01/01/20	01/31/20
Acquire Members	21d	02/01/20	02/28/20
Onboard Members	23d	03/01/20	03/31/20
Content	218d	09/01/19	06/30/20
Inventory of What Schools Have Already	22d	09/01/19	09/30/19
Develop Format for Shared Material	23d	01/01/20	01/31/20
Develop Plan for Assets	23d	01/01/20	01/31/20
Conduct Pilots/Micro-Pilots	43d	02/01/20	03/31/20
Library of Case Studies	22d	06/01/20	06/30/20
Technology Platforms	153d	09/01/19	03/31/20
Inventory What Schools Have Already	22d	09/01/19	09/30/19
Identify Platform(s) to Leverage Going Forward	23d	12/01/19	12/31/19
Conduct Pilots/Micro-Pilots	43d	02/01/20	03/31/20
Faculty Readiness	22d	06/01/20	06/30/20
Faculty Resources Identified & Assigned	22d	06/01/20	06/30/20
Faculty Trained & Developed in NGDLE	22d	06/01/20	06/30/20
Launch NGDLE	22d	09/01/20	09/30/20

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