The Rapid Model: Initial Results from Testing a Model to Set Up a Course Sharing Consortia for STEM Programs at the Graduate Level

Dr. Thomas L Acker, Northern Arizona University

Dr. Tom Acker is a Professor of Mechanical Engineering at Northern Arizona University, where he has been since 1996. He holds a Ph.D. in Mechanical Engineering from Colorado State University. His duties include teaching and performing research related to energy systems, power system modeling, renewable energy, thermodynamics, and fluid mechanics. His research in wind energy relates to and wind flow modeling for distributed wind applications, optimization of off-grid energy systems, wind turbine aerodynamics, and wind integration on the electrical system. He has worked extensively with the National Renewable Energy Laboratory and the International Energy Agency on grid integration of wind and hydropower technologies. He is a member of the editorial board of Wind Engineering, serves on the board for the North American Wind Energy Academy, and is President of the board for the Western Energy Futures Institute.

Dr. Nena E. Bloom, Northern Arizona University

Dr. Nena Bloom is an evaluator and education researcher at the Center for Science Teaching and Learning at Northern Arizona University. The primary area of her work is evaluating STEM education projects that focus on opportunities for, and retention of, K-20 students in STEM areas, majors and fields. She also conducts education research focusing on questions about professional development for educators and how educators support student learning in STEM.

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Abstract

Skilled candidates with graduate training are in critical need in the wind energy industry. To prepare for employment in the industry requires both general training (e.g., an engineering degree, a business degree, etc.) and specialized training (e.g., wind energy resource assessment, wind turbine design, environmental impacts training, etc.). Consequently, it is challenging for one educational institution to provide the depth and breadth of course offerings and educational opportunities required. This challenge exists in many multidisciplinary and rapidly evolving fields. WindU is a collaborative National Science Foundation funded effort to respond to this need, by developing and testing a model to establish an expandable, multi-university, multi-disciplinary consortium in STEM graduate education. The consortium consists of multiple universities across the United States who have expertise in wind energy and share distance learning courses. The goal is to both broaden learning opportunities for current students, and to open up the pool of possible students interested in this field. Expanding educational opportunities by developing online delivery of wind energy graduate courses is one strategy to address much needed diversity in the field. Building upon the literature of previous successful consortium development, a new replicable model for setting up a consortium was created, called the *Rapid* model, with the name reflecting the goal to implement a new consortium within one year. Researchers conducted a study to determine the effectiveness of the model, through observing program meetings, interviewing faculty, staff and administrators engaged in the consortium development work, and examining course sharing outcomes. Researchers identified a number of aspects of the model most important for establishing the consortium, including the importance of external facilitation, committed faculty, staff and administrators, and useful tools and procedures. The research also identified some areas for model modification. This replicable model adds to the knowledge base concerning establishment of an expandable university consortium in graduate STEM education.

Introduction

Wind power is now a major source of energy in the U.S. electric power system. Over the past two decades, the annual growth rate for wind power capacity installations in the United States has averaged over 20%. In 1995, less than 0.1% of the net electricity generation in the U.S. came from wind power; by 2019, nearly 7.5% of the net generation came from wind power [1]. The pace of technological change embodied in this rapid growth drives the need to educate substantially more highly-trained engineers and scientists. According to the *U.S. Energy and Employment Report* [2], there were nearly 115,000 people working in the U.S. wind energy industry, and consequently this sector has the third-largest share of electric power generation

employment. The U.S. Department of Energy's (DOE's) *Wind Vision* report sets forth plausible scenarios in which 20% of the U.S. electrical energy requirement in 2030 is served by wind energy, and 35% by 2050 [3]. The estimated number of jobs in these scenarios, both direct and indirect, necessary to achieve the proposed levels of wind energy penetration are approximately 350,000 in 2030 and 600,000 by 2050, substantially greater than today's level. Focusing on jobs requiring graduate-level education, the U.S. may need more than 50,000 graduate-educated professionals to support 20% wind energy by 2030, four times the current levels [4]. Keyser and Tegen [5] project an expected annual need for just over 1,000 new hires with graduate degrees (master's, Ph.D., or law) to meet the 2050 goal of 35% wind energy, requiring between 100 to 350 university programs to meet this need, depending upon the number of graduates in these programs that take employment in wind energy (20% and 60%, respectively). There are currently about 20 university programs that offer graduate-level courses or programs related to wind energy, far less than what is needed [1]. The pace of technological change embodied in this rapid growth drives the need to educate substantially more highly-trained engineers and scientists.

Because of the wide range of jobs in the wind industry, wind energy is multi-disciplinary, involving mechanical, electrical, civil, and environmental engineering, construction management, computer science, environmental science, atmospheric sciences, project management, policy, legal, and business, to name several. Given this interdisciplinary nature, it is a challenge for any single university to adequately prepare students for the variety of career paths critical in this field. It is also important to note that graduate educated individuals are needed not just to deploy and operate existing wind energy technology, but to evolve the technology to be more efficient, cost effective, and adaptable to the electricity grid. As progressively larger and technologically more sophisticated turbines are designed and built, both onshore and off, and as wind plants continue to provide an ever-larger fraction of the energy supply, there are significant scientific and engineering challenges to be addressed such as materials and structures, grid integration, and energy storage [6], [7]. In planning for the future, universities, and members of the North American Wind Energy Academy (NAWEA), identified a number of strategies to address the lack of university programs, most of which rely on collaboration. These include coordinating wind energy curriculum development and course offerings across universities in order to expand the breadth, frequency and depth of course offerings available to students; working with industry and other organizations to develop wind energy programs and courses; cooperating with international wind energy educational programs; developing and promoting program and course certification to guarantee quality; offering more wind energy certificate programs and degrees; and providing more online courses.

In addition to the need for wind energy graduate programs, Leventhal [8] reported that employment in the wind energy workforce has "lower-than-average" diversity. This led the U.S. Department of Energy [9] to articulate a goal to increase diversity in the profession. The report stated that efforts to expose women and minorities to wind energy have been very limited, and

that educational materials, as well as strategies to expose these materials to underrepresented groups, must be developed, and implemented. Expanding educational opportunities by developing online delivery of wind energy graduate courses is one of the strategies to increase diversity.

Driven by the need for a graduate-educated workforce in wind energy, the need for universities to establish or enhance wind energy programs but without new resources to do so, and the desire to diversify the wind-energy workforce, the National Science Foundation (NSF) Innovations in Graduate Education division funded the WindU project. Building upon the published literature, the project team is piloting and testing a new, replicable model for rapidly creating an expandable, multi-university, multi-disciplinary consortium in STEM (Science, Technology, Engineering and Math) graduate education. The STEM discipline in which the model is being tested is wind energy graduate education, with the goal that the model can be useful in other fields as well. The results of the pilot are intended to add to the knowledge base concerning establishment of an expandable university consortium in graduate STEM education, strategies for improving diversity of the student population, and for effectively incorporating international experiences. The purpose of this paper is to describe the structure of the consortium and the "*Rapid*" model that is being tested, and to report on the initial findings of the research related to piloting the model.

Previous Literature on University Consortia

For faculty or administrators who have identified the need for new or expanded graduate programs, and that perceive a consortium model as a way to proceed in creating that program, the question that arises is how to establish a consortium quickly and effectively? There are several successful consortia that provide undergraduate and graduate educational opportunities in the U.S. Exemplary programs include the Great Plains IDEA (Interactive Distance Education Alliance); the University Engineering Alliance; NEXUS: the Nursing Education Exchange; and WICHE, the Western Interstate Commission for Higher Education Internet Course Exchange, to name a few. Drawing upon the published literature related to university consortia and upon the experiences of these successful consortia, a new, replicable model for rapidly setting up a consortium in STEM graduate education within the timeframe of one year, and thus designated the *Rapid* model, has been developed.

Multi-university, multi-disciplinary partnerships can be challenging to establish and maintain. The creation of an effective consortium necessitates all collaborating universities enter with a mutual understanding concerning each member university's autonomy. For the WindU consortium proposed here, each member institution will be autonomous in offering its own degrees and graduate certificates, and each university will, as part of the consortium, offer and share high-quality distance learning courses through joint planning and decision-making. Stein

and Short [10], in describing typology of collaborations, characterize this as a "ballerina" collaborative where universities maintain autonomy and seek mutual benefit. Strategies to increase the likelihood of success when establishing collaborative academic programs were identified by Dicenso et al. [11]. Of these, taking the time to create a culture of collaboration by building consensus about roles and responsibilities, negotiating differences and remaining flexible were identified as very important. In their article "Multi-Institution Academic Programs: Dealmakers and Dealbreakers," Anderson et al. [12] , point out that communication is critical to the success of the program, and ensuring the appropriate people from each school are engaged in the process is essential. Drawing upon the experience of six Missouri higher educational institutions in creating a collaborative doctoral degree in Educational Leadership, Short and Stein [13] articulate four challenges in building a successful collaborative curriculum: 1) creating a culture of collaboration; 2) addressing institutional requirements; 3) establishing and meeting high standards; and 4) meeting the needs of educators across organizational types. They further listed several lessons learned. Prominent among these are the importance of communication and a shared vision, and that commitment must come first.

Coombe [14], drawing heavily upon the work of Pohl et al. [15] and Bailey and Koney [16], described the several features of consortia. Key among these is identifying a strategy for collaborating; defining a governance and management structure; addressing critical system features (finances, student information, etc.); and linkages to the external community. These features identify several important characteristics that have been incorporated in the *Rapid* model. An Industrial Advisory Board was created to serve as the primary linkage to the external community, providing feedback and guidance concerning curriculum, programs, webinars, promotion of the program, strategies to recruit students, etc. The board in its inaugural configuration includes 16 members from industry, institutes, and national laboratories.

Much of the literature about creating consortiums describes their features, important characteristics or specific aspects of the consortiums that were successful or problematic. Offerman [17], in his article "Collaborative Degree Programs: A Facilitational Model," directly described the elements of a process to set up a consortium. Offerman conceptualized and tested a 10-element model to guide the faculty and administration at five nursing schools in the Wisconsin university system to design and implement a collaborative degree program. Though Offerman's model was applied within a single state's university system and included activities to foster faculty buy-in, there were components of the model that generally applicable to setting up university consortia. An insightful aspect of Offerman's work was the set of interviews conducted after the consortium was established, interviewing participants involved to ascertain the value of using the model and the usefulness and relative importance of each element. Several model elements were identified as very important, especially the role of an "objective facilitator" to guide the process and arbitrate conflicts, and the need for strong institutional support right from the beginning.

Since Offerman's article in 1997, several successful consortia have been created. Of particular relevance to WindU is the Great Plains IDEA, a consortium of Human Sciences and Agriculture colleges and programs, and the University Engineering Alliance made up of Big 12 institutions sharing Nuclear Engineering courses. Three publications describe these consortia, explaining consortium formation, lessons learned, organizational and technical challenges encountered, and key elements for success [12], [18], [19]. Also described are faculty and administrative activities to plan the curriculum, define the governance, managerial and financial structure, and the role of "functional teams" in creating the agreements and policies required for the consortium to function. With regard to the Great Plains IDEA, Moxley et al. [18] conclude that "inter-institutional online academic programs are a cost-effective means of rapidly increasing access and addressing emerging educational needs."

In setting up a collaborative regional training center for nursing, Dicenso et al. [11], reported that "perhaps the most important lesson learned by the training centers is the amount of time required to set up and maintain a collaborative program across universities," and recommended that similar initiatives should plan sufficient time to create a culture of collaboration, plan the curriculum and secure academic approval. They further recommended substantial time be devoted to regular meetings of the management team and principal faculty. The importance of sufficient planning time was also reported by Halada [20] in describing a multi-campus collaborative set-up as part of an NSF TUES grant. The faculty team behind setting up the WindU consortium have worked to capitalize upon the culture of collaboration existing among the faculty and to secure the administrative support needed to pursue creation of the consortium.

The Rapid Model

Based upon the published literature and existing consortia, the *Rapid* model was created as a facilitation model describing a process for the rapid development and deployment of an expandable, multi-institutional collaborative educational program in STEM graduate education. The name of the model refers to the goal of deploying a consortium within one year. The model is being piloted and tested in the formation of the wind energy graduate education consortium. The elements of the model are described below and represented in the flowchart presented in Figure 1.

The list below explains each block represented in the figure in terms of the following 10 elements:

1. *Agreement to collaborate* – Create a memorandum of understanding that firmly establishes the consortium member's intent to collaborate. The one-year clock on consortium initiation via the *Rapid* model can start once this agreement is in place and planning activities begin in earnest.
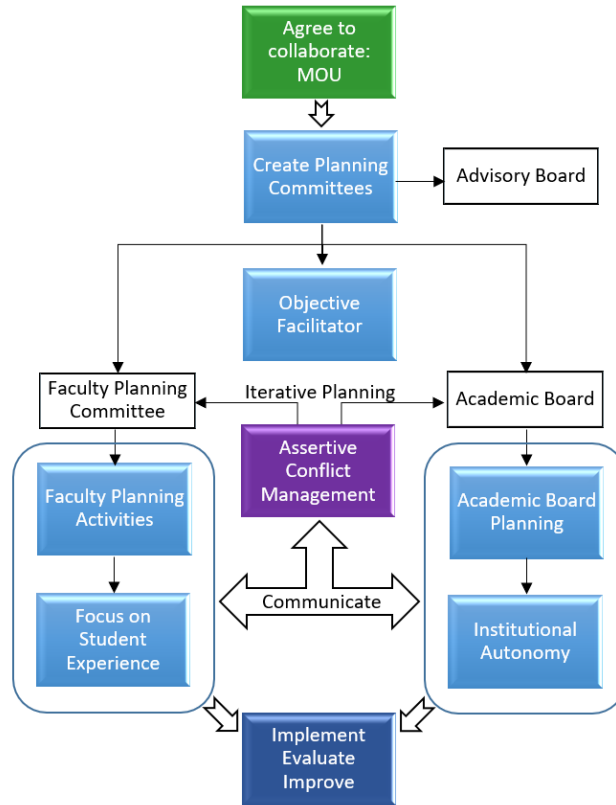
Figure 1: Flowchart showing the elements of the Rapid model.

2. ***Create planning committees*** – Establish high-level principles/objectives/organization of consortium: i) convene the Graduate Deans at the earliest possible time to agree upon "principles of collaboration;" ii) form "Functional Teams" to address specific aspects of consortium setup and establish an Academic Board; iii) form a Faculty Committee for planning the curriculum; and iv) form an Industrial Advisory Board to advise and guide the consortium.

3. ***Objective facilitator*** – Identify and hire a facilitator that is perceived as objective and outside the discipline, with experience in setting up university consortia. The facilitator serves in a supervisory/advisory role for all elements of creating the consortium, assisted by one or more faculty "champions" that have a clear vision of the consortium goals. A champion on each campus is required.

4. ***Faculty planning activities*** – Faculty are best able to conceptualize the actual collaboration related to a practical, shared curriculum, course delivery including timing frequency and content, and academic programs. Planning activities include development of the curriculum, a course offering plan, online learning strategies, and course requirements, etc. [18].

5. ***Academic Board planning*** –Agree to principles of collaboration, provide administrative oversight to the program and its sponsors.

- Define governance structure and responsible people/positions/committees
- Oversee action of functional teams: 1) graduate deans; 2) university chief financial officers (CFOs); 3) registrars; 4) online learning deans; 5) university marketing; and 6) disability resources.
  - Define management structure of consortium.

6. *Iterative planning* – Faculty on the Planning Committee and administrators on the Academic Board work on their tasks in parallel, but actively communicate with one another and share decisions.

7. *Focus on student experience* – The curriculum and mechanisms to enroll in consortium courses must be as seamless as possible and serve the needs of the students, first and foremost, but within the constraints of the faculty and administration.

8. *Institutional autonomy* – The planning process and eventual consortium must assure institutional autonomy, respect academic freedom and differences between universities and programs.

9. *Assertive conflict management* – Assure all important issues are addressed by the planning groups and handled with respect. The Objective Facilitator will ensure this during formation of the consortium, and then the Academic Board during operation of the consortium.

10. *Implement, evaluate, improve*: Enroll students, share, and deliver courses/programs, evaluate performance, and implement improvements. Create a sustainability plan and experiment with improved processes, courses, course delivery methods, and transform educational processes and paradigms.

The element #7, "focus on student experience", relates to the objective that the experience of a student enrolling in and taking a consortium course to be as "normal" as possible. Figure 2 shows an illustration of the process for a typical student. A student, shown on the left side of the illustration, enrolls in and completes a consortium course just like any other course available at the university. Thus, courses offered through the consortium are listed in each universities catalog as one of their courses, but with the course taught online from a faculty at any of the consortium universities. The courses are transcripted as courses at the home institution and not as transfer courses. The cost to take a consortium course will be transparent to the student; either it will be no different than any other course the student pays tuition for, or there will be some evident course fee or scholarship if different than the normal tuition rate. Behind the scenes, as represented by the box in the middle of Figure 2, is the action of the consortium. Student registration and grade information is exchanged between universities via a secure platform that complies with all federal, state, and university regulations. The WindU consortium uses the

"Expansis" software available through the Institute of Academic Alliances. A staff at each university, called a "campus coordinator," is responsible for exchanging information between their university and the other consortium universities, such that their students are enrolled in courses at other consortium universities and that students from consortium universities are entered into their learning management system (LMS) and enrolled into their courses. The instructor, represented by the person on the right side of the figure, gets course enrollment information like any other course, and teaches the course like any other online course. As is evident, two very important planning activities that need to occur in setting up the consortium are 1) devising a method to enroll students and exchange information (a task taken on by the "Registrar Functional Team"), and 2) defining a financial model to exchange tuition dollars between the universities (a task taken on by the "CFO Functional Team"). Identifying the courses to be shared (in other consortia this could extend to shared programs or certificates, etc.), is the responsibility of the "Faculty Planning Committee" identified in Figure 1. Establishing the agreements necessary to establish and operate the consortium is the responsibility of the "Academic Planning Board" and the "Functional Teams" identified in element 2 of the *Rapid* model.
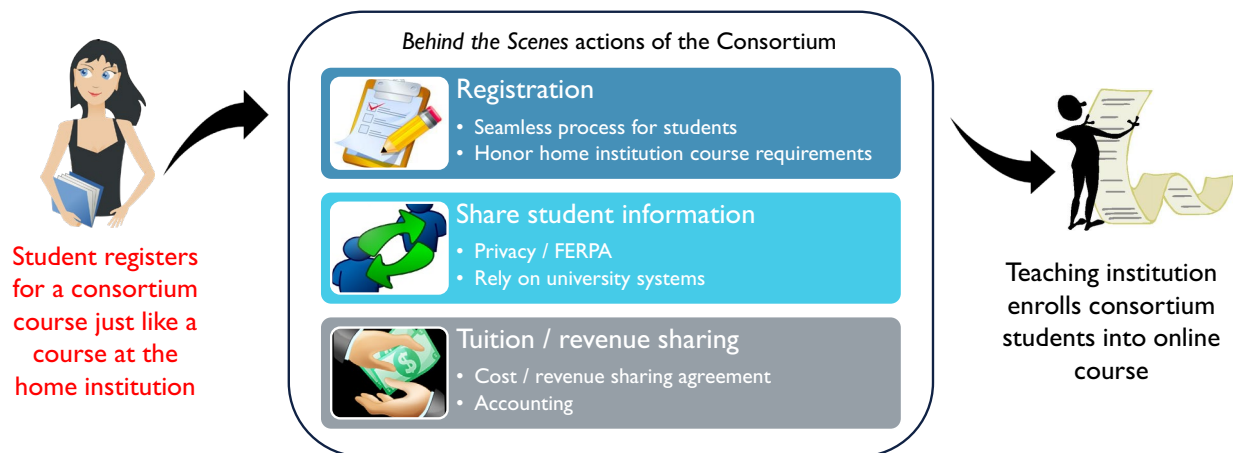

Figure 2: Illustration depicting the "everyday" roles of the student, teaching faculty, and the consortium.

The WindU consortium began sharing courses in the Fall 2020 semester, fulfilling the goal of starting within a year. The purpose of this paper is to report on the effectiveness of the *Rapid* model in facilitating creation and start-up of the consortium. The next section will describe the research questions, the methods employed in evaluating the effectiveness of the model, followed by the initial results of the research, followed by discussion, and conclusions.

Research questions

The project team endeavored to study the process of setting up the consortium and thus provide a workable model for the development of future consortia in STEM education. The primary

research question is: Was the *Rapid* model effective for consortium development? To answer this primary question, these questions guided the study:

1. What elements of the *Rapid* model were essential for consortium development? What elements were not essential?
2. What were strengths and challenges in the consortium development process?
3. How can the *Rapid* model be refined to support consortium development more effectively?

Methods

Researchers used a design and development research process to provide real-time evidence for model pilot-testing during consortia development. Design-based research [21] supports the development and continuous improvement of education innovations in complex systems, such as the WindU consortium, by engaging the program team in iterative cycles of design, implementation, analysis, and redesign.

Data collection

The data collected to answer the research questions were: 1. Evidence of course implementation through student enrollment information. 2. Semi-structured interviews with individuals involved with consortium development, and 3. Evidence of implementation of *Rapid* model elements from observations at team meetings and interview responses. Each of these are described below.

Student enrollment information
Student enrollment numbers were provided by the campus coordinator at each consortium university. This person was also in charge of exchanging student information with each partner university, enrolling students, keeping track of enrollment numbers, and tabulating the tuition exchange that should occur.

Interviews
The interview protocol was modified from Offerman [17]. Some interview questions were emphasized, and others deleted, depending upon the roles and responsibilities of the interview participant in the project. Interviews were conducted with three North American universities who were leading the development of the consortium for wind energy education. One university each was in the Northeast, Great Plains and Southwestern regions of the United States. Twenty-one individuals from the three institutions were recruited to participate in interviews. Recruitment was conducted through email introductions by the program PI and then follow-up emails by the primary researcher. Individuals represented members of functional teams developed for the consortium who had already completed their primary responsibilities for consortium development (disability support services, graduate deans, registrars, and online learning), faculty

from each university leading or involved in consortium development at their institution, two external facilitators hired by the program, and campus coordinators at each institution. Sixteen individuals consented to participate. Two other individuals responded that they recently had title changes and suggested others to take part in the interviews. Because these individuals had not participated in the consortium development, it was determined that these individuals would be interviewed at a later date, after consortium implementation. A total of sixteen interviews were conducted (Table 1).

Table 1: Source and number of interviews

Role	Institution 1	Institution 2	Institution 3	Unaffiliated
Faculty		1	2	
Campus coordinator	1	1	1	
Disability support functional team	1	1	1	
Graduate dean functional team	1	1		
Registrar functional team	1	1	1	
External facilitator				2

Interviews lasted approximately 30-45 minutes and were conducted on a rolling basis, from summer 2020 to winter 2021, depending upon the timing of the primary roles and responsibilities of the interview participant during the consortium development process. Interview participants were asked about the importance of different aspects of the *Rapid* model that related to their role in the consortium development process, as well as strengths and challenges of the consortium development process, and potential impact of the consortium. Interviews were recorded and transcribed. Transcriptions were sent back to the participant for member-checking and identifying any errors in transcription.

Monthly meeting observations
To garner evidence of *Rapid* model implementation, the primary researcher participated in monthly meetings with the consortium development team, which included primary faculty involved at each institution, the program evaluator, and two external facilitators, and took notes that were later analyzed. Interview responses supplemented these data.

Data analysis

Data included interviews with key involved individuals (Table 1), course implementation and student enrollment numbers (Table 2), and observations at team meetings. Interviews were coded following thematic analysis [22] using a combined deductive and inductive approach. Initial codes were derived from the research questions and the elements of the *Rapid* model. As coding commenced, further codes were identified. Codes were grouped by the following categories that emerged: *human resources, policies and procedures, strengths,* or *barriers/challenges.* Themes emerged from the codes (Table 3). The implementation of each of the *Rapid* model elements was coded as *completed*, *in progress*, *not started*, or *not applicable* (Table 4). To validate the accuracy of research findings, the researcher employed several strategies recommended by Creswell [23]: peer debriefing (discussions with the research and program team during data collection and analysis), and triangulation using both multiple and different sources of information. The data was continually reexamined during analysis as patterns and themes emerged [24].

Results

Four universities initially were involved in the development of the consortium. Three institutions ultimately engaged in the consortium and exchanged courses. Students enrolled in courses starting in Fall 2020. Six courses have been offered to-date, with 49 students enrolled (Table 2). Each course typically had student enrollment from the university teaching the course (identified as "the teaching university") as well as student enrollment from the universities that were not teaching the course (identified as "the non-teaching university"). To-date, overall enrollment numbers are modest, and are composed entirely of students that attended as traditional on-campus students at each of the three universities. Thus, the enrollment is typical of a graduate-level engineering course at a mid-sized state university, in a specialized field like wind energy.

In interviewing faculty, administrators and staff that participated in formation of the consortium about the *Rapid* model, several prominent themes emerged. The themes were identified from the coded data presented in Table 3 and are described below, organized by category and theme.

Interview participants identified key components that supported consortium development.

Human resources

Participants identified human resources as critical to the consortium development process. In particular, objective facilitators, faculty with vision, some key individuals on functional teams, and supportive administrators with buy-in, were identified as most important.

Table 2: Student enrollment numbers

	Number of students enrolled from the teaching university	Number of students enrolled from non-teaching university	Total number of students
Fall 2020 Wind Energy Engineering	6	4	10
Fall 2020 Wind Energy Law, Policy, and Regulation	0	4	4
Spring 2021 Wind Turbine Design	13	2	15
Spring 2021 Advanced Wind Energy Technology II	4	1	5
Spring 2021 Wind Energy Finance, Economics and Policy	3	6	9
Spring 2021 Advanced Wind Power Conversion	5	1	6
Total	**31**	**18**	**49***

*Six students took two courses each in spring 2021, therefore the number of unique students is 43.

Experienced and effective facilitation

Two external facilitators who had experience developing a similar consortium with a number of universities (including with one of the current participating institutions) were deemed critical to the process, both due to their experience with the logistics of setting up the consortium and for their knowledge of pitfalls in the process. Facilitators described that they were very purposeful to not act as decision makers for the process, but rather as guides. At the start of the program, they made campus visits with key administrators, and members of each of the functional teams. Faculty deemed these visits as essential to getting buy-in from key campus leaders. As described by one dean about the importance of facilitators, "*They have learned a lot from their own experiences, and they have learned more from what did not work, in some cases. It has been great having them on this project. They are very adept facilitators.*" The facilitators also provided quick access to critical documents from previous consortium development efforts and

Table 3: Codes and themes emerging from interviews

Category	Code	Theme
Human Resources	External facilitators	Experienced and effective facilitation
	Faculty board	Experts with a vision
	Administrators	Accessible and supportive campus leadership
	Academic Board	Academic board steers decision making
	Industry Advisory Board	Involvement of leaders in the field
	Functional teams/others	Other committed university key players
	Campus coordinators	Campus coordinators are a critical role for successful student experiences
Policies and Procedures	MOU/ Principles of Collaboration	Signing initial documents confirmed commitment
	Expansis	Common platform critical for course sharing
	Online learning best practices	Online learning best practices for ensuring positive student learning experiences
	Other tools	Campus and consortium-specific guides for training and sustaining practices
	Curricular tools	Facilitation of faculty planning and communication
Other strengths that supported consortium development	Prior experience	Prior experience developing a consortium facilitated development
	Content and curricula	Strong need for broadening curricula through course sharing
Barriers/ Challenges	Financial model	Financial model does not account for tuition waivers
	Marketing	No budget for website/marketing
	Faculty as consortium leads	Limited time for administrative tasks
	Identified future issues	Addressing emerging issues, future growth, and sustainability

had knowledge of a network of key players who could be problem solvers at each institution. A number of interview participants commented that this knowledge and resource sharing sped up the consortium development process.

Experts with a vision
As identified by several interview participants, the consortium was faculty-driven. The consortium in this study was developed to respond to the challenge that individually, universities lack sufficient breadth of coursework, which is a critical problem in STEM fields preparing experts in a rapidly changing technical field. Thus, faculty with a clear vision of the importance of providing access to broader content and curriculum through course sharing across institutions were identified as critical for participation. A strong history of faculty working together, and trust was important for initial implementation. Overall, the faculty involved shared this larger vision, though at times they disagreed on details, such as which courses to share. According to one interview participant, in other consortium efforts, administrators have led the efforts, which may reduce logistical and other implementation challenges. However, they felt that in this consortium, because the purpose was to improve graduate education, it was critical that curriculum and the faculty vision, rather than revenue stream or profits, were at the forefront. Because the core faculty were leading the efforts at their individual institution, it became clear that they needed to maintain strong involvement with the functional teams and be aware of all major decisions that were made, which required significant time investment.

Accessible and supportive campus leadership
In addition to faculty leading the vision, it was important to have key administrative leaders who shared this vision and were accessible to faculty. This particularly was the case for the graduate deans, who were identified as instrumental in supporting the faculty efforts at the three institutions. Implementing required policy and procedural changes for consortium development had to happen at a high level within the institution, so garnering this support was critical. The importance of buy-in by these graduate education leaders was made even more evident when one institution involved in initial planning ultimately did not join the consortium, because the lead administrators would not provide the needed support.

Academic Board steers decision-making
Although a number of interview participants identified an Academic Board as a critical group to steer current and future decisions about curriculum, this board was just in the initial stages of developing. One challenge was identifying who were the appropriate individuals at each campus to form this board.

Involvement of leaders in the field
The Industry Advisory Board, comprised of leaders in the wind energy field, had met twice. This group was identified as crucial for identifying industry needs, sustaining the consortium beyond

funding, and possibly providing networks for recruiting future graduate students into the consortium.

Other committed university key players

In addition to faculty and campus leaders, the individuals who came together to develop the consortium were identified as a strength of the consortium. These included individuals on the recognized functional teams of graduate deans, chief financial officers (CFOs), disability support services, marketing, and registrars (who frequently acted as operations coordinators), who worked across the campuses to develop the consortium. They were identified as willing to commit time, share resources, and take on leadership roles within the team to implement the consortium on time and within the available financial resources. For instance, one campus had less developed resources for textbook accessibility, and the other campuses offered to step in and take the lead. Another example was the helpfulness of a staff member familiar with campus operations who was "*key to cut through a lot of the red tape.*" Beyond the core faculty who had previous collaborations, individuals on functional teams had not worked together previously. As one individual commented, "*Those involved are very cooperative, willing to cooperate, and supportive. Even where I thought there would probably be disagreement, people have come together and been willing to collaborate.*"

Campus coordinators are a critical role for successful student experiences

In addition to functional teams, other key human resources emerged, including information technology specialists, and others on campus who had to be involved with the processes. Some of these roles were not identified in the original *Rapid* model. For instance, campus coordinators were required to implement the logistics of student registration and campus invoicing. Identifying and hiring an appropriate campus coordinator at the early stages of consortium development, to provide training in the campus systems as well as the consortium systems, proved critical. When turnover in these roles happened, students at times had challenges enrolling in classes on time.

Policies and procedures

The importance of specific policies and procedures were identified as critical to the development of the consortium.

Signing initial documents confirmed commitment

The *Memorandum of Understanding* [MOU] and *Principles of Collaboration* were the first documents that campus leadership saw about the emerging consortium. Signing the initial documents, which were modified from a similar consortium, were the first indications that the campus leadership were supportive of the consortium, willing to engage in the collaborative work, and committed to the processes. As one participant commented,

> *Without the MOU, if you just go and start talking to administrators and other people about the project, they don't really understand what it is you're trying to do. The MOU lays out what it is we're trying to accomplish and gives others an understanding in a concise and uniform method, so everybody gets told the same thing.*

Although the MOU was identified as important, one participant thought it could further define expectations,

> *I would recommend that the MOU be in place as quickly as possible. But we need to be sure that the university is fully committed to the collaboration and probably agree a little more on what that collaboration means, and how we will work together.*

Common platform critical for course sharing

Expansis, the common platform for exchanging student information between campuses, already in use by another consortium, was viewed as a critical tool for rapidly and efficiently implementing course sharing in the consortium. As one participant commented,

> *Expansis really helped the registrars do their job in a timely manner- how they would exchange courses, information, enrollments and drops. If we hadn't had that tool, I think we would still be figuring out how to exchange that information legally and safely.*

Online learning best practices for ensuring positive student learning experiences

Using different national models for online learning such as *Principles of Good Practice* provided each institution in the consortium autonomy to implement courses aligned with institutional policies, but also confirmed that best practices were in place. Participants identified a range of support they received from their respective online learning groups. Typical support provided by these groups was identified as potentially limited in spring 2020 by the emerging pandemic, and the campus shift to online learning that was concurrent with the development of the initial courses.

Campus and consortium-specific guides for training and sustaining practices

Interview participants identified the process of registering students from other campuses into courses at the teaching campus as a very involved process. One campus coordinator identified that they were in the process of creating a manual documenting procedural steps specific to their campus, to support future training of campus coordinators, and to support sustained efforts in the event of staff turnover. One of the external facilitators also was in the process of expanding an existing guidebook, in order to detail common procedures across campuses, such as the use of *Expansis*. Others suggested expanding this manual to include topics to be aware of, FAQs, and "sticky" issues in the consortium development process.

Facilitation of faculty planning and communication
Syllabus briefs and course matrix were important resources that the faculty used to communicate course content, prerequisites, and course expectations to students. The course matrix was used to determine curricular alignment and create a schedule for the consortium courses.

Other strengths that supported consortium development

Interview participants identified several other strengths that supported consortium development.

Prior experience developing a consortium facilitated development
Two of the three institutions already had consortia in other disciplines at their campuses. Having this experience facilitated the consortium development because some processes and procedures were already in place. As one interview participant commented about the consortium, "*People on this campus understood it. Everybody from the dean to the registrars, to the finance people, etc. So when we went to these various groups, they were familiar with the processes that were involved to make the consortium work.*" The facilitators' experience with a prior consortium and provision of pre-developed resources available for modification also facilitated timely implementation.

Strong need for broadening curricula through course sharing
Graduate education leaders on campus as well as faculty identified broadening the curriculum and content in wind energy as a critical need, therefore there was strong buy-in for course sharing. As one individual commented,

> *Each of these universities really does need a consortium in this area, each of them only has one or two faculty. And so there is the synergism of bringing three universities together to do something they couldn't do alone. And so I think that is a huge strength, that's the starting point for a consortium and that is really good.*

A number of interview participants identified that a consortium model will be useful for many STEM fields and technologies and is aligned to address future changes in higher education. As one commented about the benefit of this consortium, "*I think that the ability of these institutions to provide quality graduate education online is going to be enhanced.*"

Barriers/Challenges

Interview participants identified several challenges and potential barriers to the development and implementation of the consortium.

Financial model did not account for tuition waivers
One of the most commonly mentioned challenges was the financial model and finding a common price point for shared courses between the universities. Because of regional and other differences, there was a significant tuition difference at the three universities. Finding a common price that was high enough that CFOs would not balk at, but low enough that students would not resist, took considerable effort. An issue that no one expected was the challenge of tuition waivers. Since doctoral students (and some master's students) in STEM fields frequently receive tuition waivers through graduate assistantships, there is no revenue to exchange, therefore no financial incentive for course sharing. The consortium has piloted a financial model in order to implement the program this year, but institutions are still grappling with this challenge. Another challenge was communication between the CFOs and operation experts on campus, to make sure that financial decisions made were able to be implemented through current systems.

No budget for website/marketing
Because no budget was initially set aside for the development of a consortium website, a website was not a marketing priority at the campuses and was delayed. This resulted in a number of challenges, including not having a platform to advertise the program to students already at the institutions, nor having a place for students to get information about the broader curriculum or the courses. This also resulted in a delay in expanding advertising outside the universities, to other graduate students or professionals interested in graduate coursework in wind energy.

Limited time for administrative tasks
Interview participants mentioned the extensive work to date involved in developing a consortium, which was challenging for full-time faculty. A solution would have been to hire consortium manager early on in the process, who could oversee the functional teams, coordinate the Industry Advisory and Academic Boards, and schedule meetings. Several interview participants commented on the eventual need for a consortium Executive Director in order to sustain efforts.

Addressing emerging issues, future growth, and sustainability
Participants identified several topics that the consortium developers will need to work through in the future. For instance, several faculty members questioned how to determine whether students from other universities had the necessary content background to take a course, and they suggested either a placement test or defined prerequisites. Several interview participants mentioned that identifying who counts as a consortium student, which has financial implications, still needs to be confirmed by all partners. A number of interview participants identified that criteria for future growth and direction of the consortium should be determined in the near future, such as what criteria should be used to add new courses, certificates, or partners, and how to confirm course rigor and quality. Sustaining the consortium beyond grant funding was also mentioned by several as a future issue.

Status of implementation of Rapid model elements
Ten elements of the *Rapid* model were identified previously (Figure 1). Table 4 presents the extent to which these elements have been completed.

Table 4: Status of implementation of Rapid model elements

Rapid model elements	Status
1. Agreement to collaborate	Completed
2. Create planning committees	In progress
3. Objective facilitator	Completed
4. Faculty planning activities	Completed
5. Academic Board planning	In progress
6. Iterative planning	In progress
7. Focus on student experience	In progress
8. Institutional autonomy	N/A (This was deemed an agreed upon basic principle of the consortium)
9. Assertive conflict management	In progress
10. Implement, evaluate, improve	Not started

Discussion

The discussion presented below is drawn from the interviews, observations of the principal investigator and the lead researcher (i.e., the two authors), and input from the objective facilitators. Several lessons and key themes emerged regarding the *Rapid* model, summarized below.

To respond expeditiously to national or regional needs for new graduate programs, universities need to be agile and creative. New academic programs require faculty and physical resources (e.g., laboratories, computing resources, etc.), and the institutional capacity to create the programs (e.g., administrators with the time and ability to set-up a new program). The most difficult of these resources to acquire is typically the faculty; hiring faculty with the expertise and capacity to deliver a new program often takes years to put in place and significant investment of university resources. Given the annual timing of many university processes, e.g.,

budgeting, curriculum approval, etc., setting-up a new program inside the space of a year is challenging, even for a university that already has the faculty and physical resources in place. Thus, at universities where the faculty resources do not exist, inter-institutional collaboration is a possible solution, in which the combined effort of faculty from multiple universities can create an excellent graduate program. Depending upon the nature of the graduate program and the availability of new resources, inter-institutional collaboration may offer the only feasible path forward. However, the challenges in setting-up a new program are multiplied when creating an inter-institutional program. Different universities have different priorities, processes, institutional cultures, and time frames for considering and approving new programs.

A goal of the *Rapid* model is to start a consortium inside the space of one year. Successful creation of a consortium within this short timeframe requires a good "road map" outlining what activities need to occur, and commitment on behalf of each university to work through the issues that will arise in a timely fashion. Such a roadmap is one of the anticipated results of the NSF support for this project. Regarding commitment, each university intending to participate must understand the purpose of the consortium, its potential benefits, that its creation will take substantial time and effort on behalf of faculty and administrators and to acknowledge that there are no known roadblocks prohibiting their participation (e.g., state laws, university policy, etc.). With this level of commitment, each interested university signs an MOU indicating that it commits to jointly plan and create a consortium. Exploratory discussions should be completed, and each university that signs the MOU should do so with the intent to participate. That said, this level of agreement only obligates the universities to work in earnest to create the consortium. The actual agreement to participate is not signed until the functions and processes that define the consortium are agreed upon and documented. In the case of the *Rapid* model, these functions and processes of the consortium are created over the course of a year. The clock starts on this year of planning when the MOU has been signed, and the universities initiate their planning activities. Related to "the clock starting" for the WindU consortium, the first lesson learned in creating this consortium started with the MOU. All four of the institutions signed an MOU; however, at one of the universities the intent to participate was not cleared with other university officials required to approve the consortium, and ultimately that university decided not to participate. That lack of commitment delayed several of the planning activities, all of which could have been avoided. Thus, the first lesson in implementing this consortium is to ensure that the person signing the MOU on behalf of a university should not only have the authority to commit the university to the planning process, but that person should seek consent from other university authorities able to derail the planning process by delaying or disagreeing with the consortium. The university administrators who should be contacted concerning creating the consortium include the dean(s) of the college(s) that will participate, the graduate dean (if the consortium includes graduate education), the provost (chief academic officer), the chief financial officer, and the university President. Without the consent of the people filling these roles, firm commitment to participation by the university should be considered questionable.

Having a signed MOU in place when starting consortium planning was very important. Committed leadership on each campus to ensure the right people are engaged in the planning process is crucial. Universities have a lot of institutional inertia, and often do not adapt quickly to changes; having committed individuals at each university able to involve and motivate the necessary parties is vital.

In addition to the MOU, a "campus champion" is essential to moving the planning process forward. This person can be a faculty or an administrator and should be aware of the processes and agreements that are required, as well as the schedule to be followed to move the process forward. The campus champion should be involved in the meetings of the various functional teams, serving as the glue that binds the various teams and planning activities, and is often the most expedient communications pathway between the functional teams. Setting up a consortium involves many people that will have many questions, and answering those questions is one of the important roles of the campus champion. That said, the campus champion is unlikely to know the answer to many questions and should be willing to find answers when needed. In this regard, the objective facilitator can be extremely helpful, bringing a wealth of experience derived from other consortia.

With a signed MOU, a campus champion, and an objective facilitator, the planning can commence. Two foundational activities launched the planning processes at each university. First the graduate deans met and collaborated on creating a "principles of collaboration" document. An exemplar document was adopted from another consortium, the Great Plains IDEA, modified, and then signed by the graduate deans. This agreement establishes the general principles upon which an agreement will be formed and identifies the goal of creating the consortium (i.e., course sharing only, joint degree program, etc.). The second activity was a set of guided meetings on each campus, arranged by the campus champion, where the campus champion and objective facilitator visited all the key personnel involved in planning including the functional team members. During these meetings, the goals and benefits of the consortium were shared along with the activities needed to setup the consortium, and questions were answered. Each meeting was tailored with information specific to each person and their role in setting up the consortium. Each campus visit included meetings with the people in the following positions (or their representatives):
- ✓ Chief academic officer (Provost, etc.) and/or college dean
- ✓ Chief financial officer
- ✓ Graduate and undergraduate academic officers (e.g., graduate dean) or other appropriate administrators
- ✓ Registrar
- ✓ Dean of online learning (i.e., distance education dean, etc.)

If possible, meetings were also set with people in the following positions:
- ✓ Marketing director for outreach programs
- ✓ Disability support services administrator

✓ Assessment/evaluation administrator or campus liaison to the university's accrediting organization
✓ Department chair
✓ Faculty teaching in program (if needed)

The campus champion was responsible for organizing and running these meetings, involving the objective facilitator, and leaving each person with a realistic expectation of what needs to be accomplished, the timing, and their role. The main constraint in setting-up these meetings was coordinating the calendars of very busy administrators. Anyone listed above and not met with during the campus visit was contacted by the campus champion at a different time. These campus visits were considered essential in starting the active planning processes at each university.

During the set-up of the consortium, all functional teams met at least once, and the consortium was successfully initiated. In retrospect, the following "pinch" points in the consortium creation process were identified:

o The CFOs coming to an understanding of the cost/benefit implications of participation in the consortium, and then devising a suitable financial model for sharing tuition revenues.
o The Registrars understanding how to securely exchange information, and then how to adapt their enrollment and grading procedures to include students from the partner universities.
o "Getting the word out." With no marketing budget built into consortium initiation, it was difficult to inform students about the new courses that were available. Because COVID-19 vacated campuses, the normal routine of posting flyers and making class announcements did not work. Having an effective web presence is needed.
o Finding, hiring, and training a "campus coordinator" at each university with the appropriate skill set was challenging. The campus coordinator is at the heart of the machinery that makes the consortium work, enrolling students, exchanging information, invoicing for tuition sharing, etc.

The help of an experienced objective facilitator was crucial. In the case of the WindU consortium, two people filled the role of the objective facilitator. Their knowledge of the processes, agreements, potential for impact, and ability to ease the worries of and help university administrators find solutions to potential problems was essential in starting the consortium within one year.

While the faculty and some administrators understood the various tasks required to create the consortium and to start sharing classes, few understood the actual mechanics required to set-up the consortium. For example, when a tuition sharing model was agreed upon in year 1, problems were discovered in the mechanics of implementing the agreement. This led to the year 2 process

of revising the agreement such that it can be more easily implemented. The effort required to lead the consortium (which occurs outside of the NSF support which is focused on this research) is substantial. Setting aside resources to support this effort during consortium start-up should be considered mandatory (about one-third of a full-time equivalent [FTE] was needed for the lead PI, and about one-tenth to one-sixth of an FTE for each campus champion). Having a lead PI in-charge of coordinating the consortium planning process at all of the participating universities was found to be very effective, so ensuring that person has adequate time available to lead the effort is important. Once up and running, the financial model of the consortium includes funding for consortium leadership via an Executive Director position; however, the funding is derived from student enrollment in the courses, enrollment that will materialize only after the first couple years of the consortium. Thus, seeding the planning process with leadership support for a couple years is important. Concerning governance structure, creating the consortium policies and procedures documents is a significant effort, even with similar documentation from other consortia available.

The discussion above represents some of the most important lessons learned during the first year of creating the consortium. Comments about and potential modification to the *Rapid* model elements based upon the interviews have been identified and are summarized in Table 5.

Table 5: Comments on and potential modifications to the Rapid model elements.

Rapid model elements	Potential modifications
1. Agreement to collaborate	This element is essential and should remain in the model.
2. Create planning committees	• Graduate deans and CFO functional teams are essential; The CFOs should meet immediately once the process to establish the consortium begins, and staff required to implement the financial agreement should be included. • The Registrar functional team should include representatives within their operations to identify potential implementation problems and solutions. • Marketing functions are needed, but this may not need to be a functional team. • Disability support is a necessary functional team but may only be needed during consortium start-up. • Academic planning committees are essential and should remain in the model.
3. Objective facilitator	This element is essential and should remain in the model.
4. Faculty planning	This element is essential and should remain in the model.

activities	Syllabus briefs and the course matrix are important.
5. Academic Board planning	The Academic Board has been renamed the Governing Board. This group just met for the first time (at 1.5 years into the process), but it is recommended that the board start interacting during the first six months.
6. Iterative planning	This element is essential and should remain in the model.
7. Focus on student experience	This element is essential and should remain in the model.
8. Institutional autonomy	Autonomy is important and more easily enables willingness to collaborate in a course sharing consortium. However, it is a foundational principle of working together as opposed to an element of the model.
9. Assertive conflict management	This element is essential and should remain in the model. The objective facilitators should implement this step as needed.
10. Implement, evaluate, improve	This element will be essential and should remain in the model.
11. Consortium structure and staff	This element should be added as a first step in the model.

A limitation of the study thus far is that not all administrators, faculty or staff engaged in the consortium development process have provided their feedback. Two of the functional teams are still completing their tasks, and therefore have not been interviewed. Also, course implementation has just begun, so student feedback and student outcomes have not yet been considered. This will be conducted in future work.

Conclusion

The goal of this paper was to report on progress in implementing the *Rapid* model for developing a consortium of universities sharing graduate level courses in wind energy, and to make modifications to the model for future use in STEM graduate education. Consortium development, course sharing, student enrollment and feedback from faculty, staff and administrators suggest that the *Rapid* model was a useful framework for the development of a new consortium. Other strengths and barriers were identified for refining program elements for effective consortium implementation and sustaining efforts. A number of *Rapid* model modifications are suggested.

The findings of this study suggest that universities with a shared vision and need for broadening graduate education curriculum in STEM fields can use a model such as this to develop a consortium to create a distance learning program to share courses successfully and rapidly. This will benefit students already enrolled in the programs, as well as individuals from industry or other fields who want to reskill but are unable to be on site. Future work for this project is to market and share courses more broadly to provide opportunities for these individuals, including women and other underserved students who are critical to diversifying wind energy fields and expanding the workforce. As the consortium is implemented more broadly, student outcomes including enrollment numbers, demographics, and student perceptions of their experience, will be examined to determine the success of the wind energy consortium.

Taking a broader perspective, the *Rapid* model has proven to be effective in establishing a course-sharing consortium in graduate education. The model is not specific to the universities involved nor the topical theme of the course sharing, and consequently is applicable to other universities and any graduate topics that are amenable to online delivery. Challenges may arise in devising a financial model for universities with widely different tuition rates, but this can be overcome if there is sufficient will to do so. To facilitate future consortium development, not only will the *Rapid* model be revised with lessons learned in this effort, but a set of exemplar documents from the WindU consortium will be provided (e.g., the Principles of Collaboration document, the Policies and Procedures manual, etc.) along with recommendations for resource allocations needed to successfully launch a consortium.

Acknowledgements

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