



M.J. Murdock  
CHARITABLE TRUST

## 2017 Murdock College Science Research Conference Faculty Enrichment Workshop

### CURE

Curricular Undergraduate Research Experience

Convener: Dr. Moses Lee, M.J. Murdock Charitable Trust

#### Organizers

Dr. Frank Caccavo, Whitworth University

Dr. Ben McFarland, Seattle Pacific University

Dr. Aaron Putzke, Whitworth University

Dr. Kamesh Sankaran, Whitworth University

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## Background

Friday, November 10, 2017, brought in science undergraduate students and professors alike from small schools all across the Pacific Northwest to the Spokane Convention Center for the annual Murdock College Science Research Conference (MCSR) hosted this year in conjunction with Whitworth University. Over the course of these two days, more than three hundred students from thirty-three institutions presented the research conducted both at their home universities and elsewhere. The work conducted was proudly and competently displayed in oral and poster presentations. On Friday evening, after a day full of student presentations, the evening was concluded with a dinner banquet at which faculty awards were presented and Dr. Luis Echegoyen gave a lecture on fullerenes. Following the conclusion of the lecture, students were dismissed after a long day, and faculty members were invited to join in a social hour. At this time of mingling, several faculty members from a multitude of institutions presented posters on their work to incorporate research experiences into the undergraduate curriculum. As faculty interacted with one another and conversed about the work they were doing, minds were prepared for the following afternoon's workshop focusing on just such curricular undergraduate research experiences (CUREs). Saturday morning brought more student oral presentations, and the conference officially concluded with a luncheon and student presentation awards.

Although the conference had concluded, the day's events were far from over for nearly forty faculty members. After lunch, these individuals made their way to Whitworth University for the MCSR CURE Workshop. The workshop opened with an introduction from Dr. Moses Lee and was followed by an overview of CUREs given by Dr. Elizabeth Ambos, Executive Officer of the Council on Undergraduate Research (CUR). Following the informative lecture on the value of undergraduate research in the classroom, attendees broke up into groups to discuss various elements, challenges, and approaches for bringing undergraduate research into the classroom. After reconvening and a short summarizing of discussions from the breakout sessions, Dr. Lorna Jarvis, Whitworth University's Chief Diversity Officer and Associate Vice President, shared briefly about her encounters with CURE-like experiences and some tips on how to maximize these opportunities. This was



followed by Dr. Silvia Ronco from the Research Corporation for Science Advancement sharing about the differences in approaches at predominantly undergraduate institutions (PUI) and R1 research institutions. The event concluded with an opportunity to bring comments and questions before the whole group. Attendees were invited to share dinner before leaving the workshop.

## Event Introduction

As faculty members from colleges and universities across the region gathered at Whitworth University, Dr. Moses Lee opened the workshop with a short introduction pertaining to the Murdock Charitable Trust and the intent of the workshop. He shared that the faculty workshop was to not only discuss how work can be done to improve CUREs at an individual level for each faculty member but that attendees were also to be provided with the opportunity to learn from one another. The Murdock Trust was also attempting to discover how they might be able to best assist institutions in putting effective CUREs in place. By attending the workshop, faculty members were provided with the opportunity to not only benefit their own classroom projects but potentially other similar endeavors at their institutions.

## Council for Undergraduate Research (Dr. Elizabeth Ambos)

Following Dr. Lee's welcoming introduction, Dr. Elizabeth Ambos shared about the work done by the Council for Undergraduate Research (CUR), an organization founded forty years ago which has evolved into one of the nation's most valuable resources for undergraduate research. She began her presentation by talking about the nature of undergraduate research, how it is urgent but in a good way, and how we ought to approach it as medical problems are approached. Undergraduate research is an exciting and rapidly developing area, and it should be treated as such. Research experiences for undergraduates in the curriculum involve instructors helping learning to progress and be the most valuable it can be. The student poster session that took place the previous day was an excellent example of how, in some cases, the curricular research experiences can be summarized and disseminated,



accurately simulating how research is conducted at a higher level and overall enhancing the undergraduate learning experience.

Curricular Undergraduate Research Experiences (CUREs) are not new but are currently of high interest. Such in-class experiences are typically offered at small predominately undergraduate institutions (PUIs), as they are more feasible to be carried out on the smaller scale and more likely available at such institutions than at larger R1 institutions. The value of research experiences for undergraduates in general has been studied rather extensively, and education research has now been published to show the high impact practices and positive influences of undergraduate research, demonstrating that this is an invaluable tool for education. Finley and McNair conducted a study in which they found that the three biggest boosts in student perspectives on learning are learning communities, service learning opportunities, and student/faculty research, further supporting research experiences. Federal agencies, like CUR, have also conducted studies about the value of these experiences which agree with outside studies and in result, lead to the supporting of undergraduate research expansion. Such expansion can progress best with specific and structured assistance provided. CUREs became of interest to providing these research experiences, specifically because CUREs were able to provide the lowest cost per student experience. This is important, because finances are a significant hindrance in undergraduate research.

Due to the results that solidify the value of research experiences, the federal government decided to invest by way of a statement by the publishing from the President's Council of Advisors on Science and Technology (PCAST). This statement called for federal agencies and academic institutions to advocate and provide support for replacing standard laboratory courses with discovery-based research courses. Essentially, CUREs were declared a right to students. This was an important advancement for CURE-growth, but how is this change implemented all across the country? This is the challenge.

Because implementation of research experiences has proved to be such a difficult task, the National Science Foundation sponsored a multi-field study conducted by the National Academies of Sciences-Engineering-Medicine. There were two main published results from this, the 2015 *Integrating Discovery-Based Research into*



*Curriculum: Report of a Convocation and the 2017 Undergraduate Research Experiences for STEM students: Successes, Challenges, Opportunities.* These findings have been used, but despite the vast number of specialty practitioners and science education communities that came together to determine causality, the reason for the value of CUREs specifically is still in question. Nonetheless, it has been determined that CUREs should be conducted, and even though CUR is not the be-all end-all of CUREs, many do stem from the organization. Thus, it should be viewed as an invaluable tool for conducting CUREs.

In 2012, CUR compiled *Characteristics for Excellence in Undergraduate Research (COEUR)* to assist in the implementation process of CUREs. This document can act as a blueprint for institutions looking to start CUREs, and it has 12 characteristics outlined ranging from administrative support to external funding. The complete publication can be found online at CUR's website under resources at: [https://www.cur.org/publications/publication\\_listings/COEUR/](https://www.cur.org/publications/publication_listings/COEUR/).

CUR is now aiming to continue to provide opportunities to begin and transform CUREs to make them the most valuable experiences possible. This is occurring by developing sustainable faculty leadership structures, partnering between faculty, students, and administration, expanding student participation, scaffolding curricular elements, and partnering with students to change the process. It is important to remember that true curricular reform takes time and effort, and different disciplines have different cultures which cause this implementation to vary. Additionally, faculty workloads often affect how effective CUREs can be. CUREs can take on two major frameworks, a business framework which makes jobs using undergraduate students for start-up companies, or a social framework which makes the experiences personal and emphasizes the social side of science. In conclusion, community and environment are what tie the top three most valuable learning practices, learning communities, service learning opportunities, and student/faculty research together.



## Breakout Sessions

### *Challenges*

Dr. Kamesh Sankaran led a discussion on the challenges of doing CUREs. He outlined challenges being found at an individual level, with specific challenges of internal and external incentives, at an institutional level, with specific challenges of resources and structure, and at a disciplinary level, with specific challenges of access to equipment and “content gap”. Unintentionally, institutional and disciplinary challenges became the focus of the discussion. Institutionally, challenges stem from tenure processes, departmental goals varying from institutional goals, and lack of good communication between departments and institutions. Disciplinarily, challenges stem from determining ways to address “content gap” between the academic canon and the background needed for research and determining if the goal is to obtain publishable data or to teach the research process, thus requiring a consistent definition for research at the undergraduate level. As Dr. Sankaran sought input from his fellow faculty members, he found two extremes pertaining to CUREs. The first is an attitude of defensiveness, thinking that CUREs take too much time, money, and effort and are not feasible for all content; therefore, there is no point in attempting to have them. The other extreme is looking down on those who are not already doing CUREs, creating an environment of opposition rather than invitation.

After the topic of challenges was outlined, the floor was open for discussion and many individuals had insightful input. A significant challenge, especially found in the fields of botany and ecology, is not being able to allow student ownership of CURE projects when the timespan of projects are too long. This makes it harder to gain administrative support to even begin such projects which already requires much effort and patience and also makes it more challenging to accurately replicate the research process. Similarly, in fields like biochemistry, it is a challenge to provide supplies that pertain to each student’s research area of interest, which again limits student ownerships of projects. For a field such as mathematics, challenges arise from high-impact learning efforts involving active and discovery-based learning techniques not receiving recognition as research or CUREs. Thus, maybe the word “research” ought to be redefined for such scenarios. On an administrative level, challenges arise from not recognizing that many problems surrounding CUREs



overlap, and structuring the problems together allows one to overcome them more successfully. Communication between departments and institutions concerning expectations for topics like tenure and department goals also play into these challenges. While these and other challenges exist and can cause many hardships for CUREs, individuals have found creative ways to overcome these, demonstrating the possibility for success.

### **Assessment**

Dr. Ben McFarland led a discussion about assessment of CUREs. He started his group discussion by first explaining a CURE he has been conducting and how he has worked in conjunction with education professors to find the best way to assess this CURE. In CUREs, one must administer the CURE, allow for authentic research, assess the CURE, and adapt based on the assessment. His specific CURE pertains to using an online database called GENI ([geni-science.org/](http://geni-science.org/)) in which students are allowed to publish some of their results into this online database. He, in conjunction with his institution's education department, attempted to assess student attitudes, knowledge of the content, and website functionality. Student attitudes and website functionality were assessed positively, showing that CUREs significantly increase student enthusiasm for and ownership of scientific projects. Assessments of specific content such as found on standardized tests were not increased as much as general attitudes toward science, showing that CUREs do not "teach to the test" but rather teach practical skills by providing the students with an apprenticeship experience integrated into the curriculum. The educational assessment is complex and ongoing to further distinguish the unique contributions CUREs can make to education.

As discussion began, it became clear the assessment needs to be defined: what is the purpose of the assessment, and what is being assessed? A few potential areas to be assessed are student attitude, knowledge, skills, data, and grades. It is also important to define what gives validity to the CURE, and what makes the research authentic. Many potential answers were provided for the latter question, from the requirement of new discovery, to the requirement of student ownership, to the requirement of students asking unanswered and open-ended questions, to many more. Overall, there is value in using the resources available such as collaboration



with other departments like an education department to make the most of an assessment, and therefore, maximizing a student's CURE is critical to being a successful CURE facilitator.

### *Learning Outcomes*

Dr. Cecilia Toro led a discussion pertaining to the learning objectives of CUREs. The most prominent question that needs to be asked when determining learning objectives is to first determine the goal of a CURE. Is it a pedagogical exercise, or is its purpose to get the most publishable data and progress in a research project? Dr. Toro suggested that the purpose of CUREs is to develop the pedagogical aspect of science and research, fostering an environment to allow for a student to grow in skills, in confidence, and in the very real emotional aspect of science. In order to make learning objectives useful both to the faculty member and students, what is to be assessed should be put on the syllabus while other learning outcomes should be discussed with the students.

During the discussions that ensued following this introduction, a significant statement was emphasized. Science has a social aspect to it, and it needs to be recognized as important to develop. Students need to be validated as scientists, and CUREs can offer an opportunity to do this. Because of their more pedagogical nature, CUREs do not need to be an entire course. It is also important to remember that CUREs may work better with program-oriented learning objectives. This can allow inclusion of some CUREs in lower division classes, in which the value is normally overlooked, developing skills so that in upper division classes more intensive CUREs can be enacted. CUREs are opportunities to show students that they can be successful in their field of studies.

### *CURE and Collaborative Learning*

Dr. Frank Caccavo led a discussion about collaborative learning in CUREs. He shared his own experience of conducting a CURE in an upper division class. In this class, he has, over time, developed a fairly extensive process students must go through,



requiring a high degree of student ownership in their projects. Students write a detailed proposal that must be approved before lab work can begin. This process is both challenging for the students and time-consuming as an instructor, but by replacing the lab that would usually coincide with this course with this project, students work together to have a real-world research experience simulated.

Discussion led to talking about the challenges that go along with such an extensive project. A major concern with a project that requires so much background research from students is the lack of ability to read literature to acquire the necessary knowledge. Without such skills, students may not be able to fully understand their projects enough to conduct meaningful research. After the background research has been conducted, the problem then turns to safety in the lab. If multiple groups are working each on their own separate projects, often using unfamiliar techniques and materials, it becomes much more challenging to maintain a safe lab space. In conclusion, such CUREs require a delicate balance of student freedom and faculty supervision to make the project a valuable and safe learning experience that can amount to some sort success or more accurate exposure to scientific research.

### ***Collecting Publishable Data***

Dr. Aaron Putzke led a discussion about how to collect publishable data through CUREs. It is often difficult to find ways to allow for undergraduate students to have project ownership yet still be able to collect data for a project that can be published. Dr. Putzke explained how he has done this in a genomics course he has taught. The first item on the agenda for starting any CURE is to determine what kind of questions you are asking and if they are for science research or simply pedagogical means. It is important to determine if the data students collect will be meaningful to the research community, especially because many of the students will have no experience in the research area. In the genomics class, students had to be trained how to analyze data to get meaningful results, something that was very foreign to many of them. Dr. Putzke concluded his introduction to the topic by sharing that although not all of the students will be authors, they feel the satisfaction of knowing they contributed to a project that will get published



During the discussion following the introduction, the conversation turned to the challenges involved with conducting CUREs that achieve publishable data. Challenges such as how to scale up your own research and how to make CUREs practical were discussed. Also, how to be resourceful, how to get institutional support, and how to ensure quality control among the data being obtained by the students are valid were additional challenges brought up. Determining what level of a course such a research class should be was also discussed. Overall, there seems to be a consensus that conducting CUREs in such a manner is doable, but is very challenging and requires the ability to adapt as a project continues.

### **Dr. Lorna Jarvis**

Dr. Lorna Jarvis shared some of her knowledge and experience in assessing undergraduate research. Summer research by undergraduates has proven time and time again to be a powerful high impact practice for many students. However, it is very costly and only a minimal number of students get such experiences. CUREs are excellent ways to allow for this to be available for many more students. However, it is important to proceed using the right resources and to think about CUREs at a more programmatic level rather than only in a specific course. A couple examples she gave of using resources wisely were to work across disciplines at an institution and to use what is available outside of an institution, like Cornell's free CURE assessment program. By taking such steps, a CURE can be well supported, highly impactful, and sustainable over long periods of time, benefiting the most students possible.

### **Dr. Silvia Ronco**

Dr. Silvia Ronco was the last speaker of the afternoon who brought her expertise about optimizing CUREs at PUIs. In order to have a successful CURE, faculty members must be excited about the CURE they are conducting. To maximize such excitement in an institution, hiring should be an intensive process that looks for young faculty eager to organize CUREs. Conferences that bring together Ivy League or R1 faculty members and PUI faculty members are currently being hosted by the



Research Corporation and allow for such institutions to learn from one another. Networking is a huge aspect of finding the proper resources to have successful CUREs, and such conferences are able to provide an environment for this networking. The Research Corporation has many resources available to faculty from all institutions trying to start successful CUREs and is in the process of developing even more resources (**CURE.net**). Organizations such as the Research Corporation are continually working to bring a multitude of resources to faculty members, enabling them to start and sustain successful CUREs and have the highest impact on students from a variety of institutions.

## Closing Discussion

At the closing of the workshop before everyone was dismissed to attend dinner, Dr. Lee opened the floor up to comments and questions, allowing for attendees to voice their concerns to the Trust. This provided an opportunity to evaluate not only the workshop but to clarify the next step for Murdock to best support the PUIs from across the Northwest. There was an overall theme in the ensuing discussion. Many individuals greatly appreciated the work done at the workshop and inspiration it brought. However, they hoped to continue the conversation. The support they desire from Murdock is to continue to bring forth networking opportunities. Especially in fields, such as theoretical physics, where CUREs can be very challenging to develop and departments are frequently very small at PUIs, having access to other institutions and being able to work with one another on a more regular basis would allow for involved institutions to grow these high impact practices. Having a platform on which specifics of currently conducted or developing CUREs can be shared would allow for more collaboration. By working with other institutions on these projects, CUREs could be collaborative and approached from many different angles.

Several attendees also offered encouragement to those aiming to start CUREs. One such piece of advice is to start small and make the CURE an obtainable goal. CUREs in and of themselves require great amounts of time and dedication, but by just implementing a small portion at a time, these can be achievable. As had been repeated throughout the afternoon, the group was again reminded to collaborate



within colleges and universities. An advantage to being at PUIs is that they are often small enough that faculty are acquainted with one another across departments. This makes interdisciplinary work more feasible. Overall, everyone seemed to leave the workshop feeling as if it had been a good use of their time with hopes of communications to be continued in the near future.

## Conclusion

The 2017 Murdock College Science Research Conference proved to be a successful event, and the faculty enrichment workshop that followed was no different. Faculty members from a multitude of institutions were able to use the workshop as an opportunity to learn from one another and create more networking opportunities to connect in the future. Dr. Beth Ambos shared insightful information pertaining to the value of CUREs and opportunities for those conducting CUREs from the Council of Undergraduate Research. Dr. Silvia Ronco shared of the networking opportunities and informative material available from the Research Corporation to faculty who are attempting to start or sustain CUREs at their institutions. Valuable thoughts pertaining to the challenges involved in CUREs were exchanged, from determining proper assessment and learning objectives, to allowing for collaborative work, to obtaining real and publishable data. Important questions were brought up, and suggestions for next steps were made. After a day and a half of student presentations demonstrating the value of CUREs, the workshop was an excellent way to conclude the event as it allowed for the excitement of the conference to be carried over into future planning. An excellent platform for the future of Murdock's work in CUREs for the PUIs of the Pacific Northwest had been established.