

The Undergraduate Research Advantage: The Split Perspective

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Abstract

Undergraduate Research Projects (URP's) are unique opportunities. They can provide students with wonderful learning experiences and faculty with opportunities to mentor bright, young people. This paper provides two authors' descriptions of what can be done to promote successful experiences, ones that benefit both the student and the faculty member. Through their experiences, or what they have learned from their colleagues, this paper offers a qualitative look at how a URP might best be structured. An important element is joint development of the experience, by the faculty member and the student. The goals and objectives of both parties have to be taken into account. The faculty member may need help with a research project while the student may want a foretaste of graduate school or just a chance to earn money. Ideas about how to incorporate leadership, responsibility, independence, networking and growth into a URP are also presented.

1.0 Introduction

Undergraduate research programs (URP) have become a commonplace fixture on most if not all engineering college campuses [7]. At research-based institutions, students can work with faculty and graduate students on sponsored and unsponsored projects [9]. They can also take courses that focus on research-oriented experiences [15]. At predominantly undergraduate educational institutions, they can get involved in one-on-one mentoring with a faculty member [3] and take research-oriented classes [15]. In all these cases, research has been "added" to the undergraduate curriculum and the sense is that these experiences are valuable to both faculty and students [15].

From the perspective of many academics, URP experiences give undergraduates a chance to participate in discovery-based education. Students can see if a research-based career is of interest and if a graduate school is something to pursue. Students can be integrated into a research project and given duties and responsibilities that otherwise might be given to a graduate student; and through this experience, they can assist in advancing the frontier of knowledge. While this description of a URP experience does not fit all cases, it typifies what this faculty member has observed and seems typical of what academics describe [13].

Given this sense of a URP, the authors see issues that should be addressed, especially from the perspective of the student, in devising a successful experience. These issues relate to developing

a shared vision about what the experience should be, reaching a common understanding of what is involved in getting work done, establishing personal goals and objectives and then achieving them, and creating an interpersonal relationship that helps ensure success will be achieved.

These issues are the focus of this paper. These issues are examined from a qualitative perspective considering both the view of a student as well as a faculty member. From what the authors see in the published literature, discussions about the URP experience have rarely been structured this way, juxtaposing a student's perceptions against that of a professor, let alone tying the two together. Yet it is clear, that both the student's and the professor's viewpoint has to be taken into account if the URP experience is going to have its intended outcome.

The remainder of the paper is organized as follows. Section 2 reviews prior thoughts on this subject that have been provided by prior authors. Section 3 provides a point-counterpoint discussion of several topics that seem critically important to a successful URP. Section 4 presents conclusions and recommendations for the features that ought to be included in a URP experience to ensure its success.

2.0 Literature Review

The idea of a "URP experience" can be traced back to about 1980 when the University of Delaware introduced an undergraduate research project option [15, 16]. Of course, undergraduates have always worked with professors on research, but the notion of a "URP" made these experiences a more formal and visible part of the undergraduate educational process (as well as the research environment). In part, this new stature was related to the National Science Foundation's (NSF) decision in the late 1980's to have principal investigators (PI) include an "educational" element in their proposals. NSF also encouraged PI's to apply for REU (Research Experiences for Undergraduates) grants that would allow them to add undergraduates to their research team.

The recent literature on URP experiences tends to focus on one of three topics: program descriptions summarizing different research approaches, URP assessments and evaluations, and guidance for conducting URP's. This paper fits the latter, qualitative category.

The papers that talk about approaches to undergraduate research describe a number of options. Among them are funded projects, unfunded projects, applied studies, theoretical studies, group projects, and individual projects. For example, one department presents students with undergraduate research projects that focus on demonstrating proven concepts [2]. Theoretical contributions may be made as part of the experimental research, but the primary focus is on exposing the students to a positive experience and allowing them to apply new knowledge, while preparing them for their future. Another program focuses on having students be involved in funded research projects [3]. In this latter case, students work on unanswered questions that are crucial elements of research investigations currently underway [3]. In several programs, it is common for the URP student to have a peer advisor. In some instances, the undergraduate may be assisting a graduate student on research and the graduate student acts as the advisor [6].

The published materials on assessment and evaluation of URP experiences primarily focus on the benefits from such programs. Rueckert [10] talks about two types of assessment. One focuses on

finding areas which can be improved. The other seeks to find things to replicate, ideas to expand and enhance, etc. so that greater student satisfaction can be achieved.

These papers generally survey faculty and students to capture feedback about the experience. Typically the surveys are focused on the goals and expectations of the faculty member, not the students. In one of the few that focus on students, Alexander, Foertsch, and Daffinrud [1] asked for feedback that would help identify why URP programs are successful, so they could be replicated. In the case of this minority-focused program, the attributes identified by Alexander *et al.* are interactions with the program director, being in the company of other minority students, and interacting with other minority students in the program. Lopatto [4] surveyed students and faculty regarding their perceptions of the benefits from URP experiences. An interesting insight from Lopatto's survey is that the benefits perceived by the faculty are different from those seen by the students. The students emphasize good student/ mentor relationships while the faculty talk about enhanced oral and written skills. Seymour, Hunter, Laursen, and DeAntoni [12] found from their interviews of URP participants that students' personal/ professional gains and improved thinking ability were the two major benefits. While not yet complete, NSF is sponsoring a survey of thousands of undergraduate student researchers and faculty, post-doc, and graduate student mentors about their experiences with undergraduate research in order to learn more about how to ensure success [14].

The literature on conducting URP's addresses things to do and not to do to help ensure success. For example, the URP website at Stanford University [13] provides advice for mentors about establishing short and long term goals, devising a plan for the work to be done, and being clear about student interaction expectations. It also talks about breaking down large tasks into smaller ones that the student can understand and manage. It encourages students to keep a log book so that deadlines aren't missed, thoughts aren't lost, etc. It suggests the professor is admonished to temper his or her criticism of the student work to help ensure that discouragement does not take over.

These guidelines are clearly important. Counsel needs to be provided, but in a positive, non-threatening way. Students need to know how to pick a topic in which they have an interest, explore faculty availability, and ensure that communication with the professor is workable.

It is interesting, though, that the student-related issues/ benefits identified by Lopatto [4] or Seymour *et al.* [12] do not seem to receive much attention. They don't figure significantly in developing the URP experience. The emphasis is more on establishing a mechanism to ensure successful research results, not student growth.

Schultz [11], however, addresses some of these issues in talking about mentoring. His argument is that the mentoring should be personalized for each student. There should be regular one-to-one meetings to assess progress and get feedback from the student. The faculty member needs to be available, for example to provide help with analysis and data interpretation. The student needs to be encouraged to explore ideas, develop new theories, and look for new ways to do what needs to be done. He or she also has to bolster the student's morale when things are going awry, when experiments aren't going as planned. The professor also needs to be prepared to help keep the student focused, to redirect or steer their course, so a sense of accomplishment does not falter. It

involves organization and planning, so that the student always perceives that the way ahead is known. The professor also has to ensure that the student understands the questions being addressed.

A fairly conservative viewpoint is espoused by Fromwalt, *et al.* [2]. They argue that URPs should be structured around “discovering” proven concepts. They should not be focused on doing real research, i.e., making new discoveries. Such experiences will still prepare the students for graduate study. The students will still learn discovery tools and techniques. They will still learn what “research” is about. Moreover, these experiences are investigations for which the professor already knows the outcome. The students can always be given quality guidance. The results that will be obtained are already known. The students can also learn how to apply this “newly learned knowledge” to additional situations, which are also about proven concepts. The students learn none-the-less, and the professor is assured that the guidance provided will lead to a quality discovery, because the ultimate findings are already known. Fromwalt *et al.* [2] also argue that there should be activities that result in a physical product. They say that this increases motivation and the desire to see an end result.

Fromwalt, *et al.* [2] also say there can be a negative effect from the URP experience. Students can neglect their other coursework. They can be captivated by the URP that other things are ignored. They may overestimate the accomplishable workload. In this regard, Fromwalt *et al.* argue that “the mentor should provide some guidance to prevent unnecessary waste, while at the same time, should allow the student to make minor mistakes, giving them advice when the student expresses or the mentor observes a need for help.”

Greendyke argues for the opposite position: that a real research project should be the venue [3]. He says undergraduates can be used to discover new knowledge. Of course, he comes from a predominantly undergraduate institution, so his principle research resource is undergraduates. Such faculty members have to use undergraduates in their research projects, otherwise the work does not get done. Greendyke argues that success can be assured if a few key ideas are taken into account. The faculty member must gear the tasks for the limited experience or knowledge base of student. Tasks should be divided into their simplest components. The student-faculty interaction should be high. The faculty member must be accessible. Greendyke also argues that faculty should exhibit self-discipline and follow a schedule. From the students who worked with Greendyke, four things can be discerned. First, the URP confirmed the students’ career goals. It didn’t alter their decision about either going to graduate school or getting a job but it did reinforce their perception that they had made the right choice, whatever that choice was. Second, the students who worked in groups felt they had a better experience; third, the URP helped the students understand what real engineering was likely to be about; and fourth, the URP significantly improved the students’ confidence in being able to do engineering work.

More insight into the student experience comes from the University of Michigan [8]. Their Rackham School of Graduate Studies has produced a document entitled “How to Get the Mentoring You Want”. This reference offers advice for both mentors and students about how to manage the apprenticeship experience. For undergraduates, it talks about how to be a good protégé; how to work effectively with a professor. It describes the expectations that most professors have, especially things that may not occur to students when they begin their URP. For

faculty members, it stresses the fact that they need to advise, support, and tutor the students. They need to be a master, a sponsor, and a model to follow. It gives guidance on how faculty members can help ensure success in all these aspects of a URP.

Nagda *et al.* [6] talk about how student research teams can affect student morale and student retention. They highlight the value of having students to work with students, to become professional peers. For example, they report how students begin to realize that even during social events, they can talk about research related issues, a behavior phenomenon that is so common within the research community. A bridge is created between their social and intellectual lives, as is the case for almost all faculty members.

An article prepared by the Reinvention Center at the State University of New York, Stonybrook, talks about what it takes to make a URP program a success [15]. The spotlight is on four schools: Princeton University, Stanford University, the University of California at Berkeley, and the University of Delaware. The student quotes from Princeton are particularly interesting:

- "For the first time in my life, I felt passionate about an issue.... I wanted to dig deeper into the...questions; I wanted to search for my own answers."
- "I am a hands-on person, and I felt as though I was finally applying the book knowledge I'd gained in my classes."
- "One of the most exciting aspects of the senior thesis for me was being responsible for original research, rather than merely summarizing the work of others."
- "I feel an immense sense of satisfaction at having produced a truly new piece of work."
- "One of the highlights of the thesis experience, aside from generating original research, is working closely with a faculty member who has vast experience and knowledge in your area of interest."
- "The most rewarding thing about writing a thesis is the skill set that you walk away with. I am now able to manage my time effectively and efficiently, organize my responsibilities, and utilize the resources I have around me. The thesis-writing process itself empowered me with a confidence that I can succeed in all that I do."

The comments by the Princeton faculty members are also revealing:

- "The opportunity to engage in collaborative research with a Princeton undergraduate is one of the most rewarding aspects of life as a Princeton professor. Like most professors on this campus, I suppose, I find the world and activity of research thrilling. Watching the first steps of an eager student into this world is always exciting. Walking into the research world together, which happens when the student chooses to join me in my own research, combines the best of these experiences."
- "The collaborative nature of the advising experience is what I typically find most rewarding.... Having a student become passionate about...issues [you

care about] and become expert enough to work as a true colleague on a project is perhaps the most fulfilling thing a researcher can ask for."

- "Most satisfying...is the partial reversal of the usual roles of teacher and student. The idea, or the hunch, is the student's to start with; she has to think through its implications and the proper way of articulating its skeleton; and she finally has to put flesh on the bones during those late-night/early morning sessions at the keyboard. I'm here to help out along the way, to question and probe and make suggestions, but the student is the leader, the person on whom the enterprise really depends."
- "The relation between adviser and advisee, asymmetrical to begin with, began to change, as I began to learn from the fruit of her work. This is the single most rewarding part of advising seniors: the fundamental reciprocity of the learning-teaching experience."
- "[My advisee] addressed...topics that I had considered, taught, and written about before. But our year of cooperation gave me ideas I had not had before - and by that I mean not only that I had new thoughts; I also mean that I found myself correcting errors I had made, changing my mind, realizing that issues I had not thought significant actually counted, and questions I had thought important might be well left aside."
- "Because her angle on the material was so fresh, [her] thesis taught me a great deal about two authors I had already known rather well."
- "Truth be told, the most satisfying moments of thesis advising are, simultaneously, the most humbling. They can best be summed up under the simple heading: 'Hey, why didn't I think of that?'"

Monte [5] talks about mentor expectations and student responsibilities in URP's. He says that URP's can teach students what research is about. The experiences can provide students with guidance about career decisions and help them improve their skills. He talks about establishing clear expectations for the student relative to professor's workload and the need for a written student research proposal to ensure the student understands he or she is trying to accomplish.

3.0 Point - Counterpoint

So what does this faculty member and this student think? What do they believe is involved in a successful URP? This section addresses four topical areas in that regard: developing productive faculty-student relationships, managing faculty and student expectations, helping the student gain a perspective on the research, and getting things done. The commentary is based on the experience of this faculty member in dealing with numerous students over a 20 year academic career and the experience of the former undergraduate co-author who participated in URP experiences and also observed the experiences of many peers.

3.1 Developing Productive Faculty-Student Relationships

As was said before, a URP experience is intended to give a young student an opportunity to see what research is about, perhaps for the first time. Most likely, the student's expectations are high and so are the professor's.

Yet neither person is likely to know the other well enough to ensure success. This is not a situation where the student is a member of a class and is simply doing homework, taking tests, etc. The student needs to be integrated into a research project with real goals, real objectives, real deliverables, etc.

Both of the authors of this paper argue that undergraduates participating in research generally enter into the project without actually understanding what they are signing up to do. From the students' perspective, they may "know" what skills they have but not know what is required for the project. They may need growth in those skills to complete project tasks. Most likely, this student author thinks the students will not understand the growth required and the professor may not either, because the student doesn't necessarily identify what he or she doesn't know and the professor can't always tell just by asking. The faculty member author has seen some students who are overconfident and overestimate what they actually know and others who lack confidence in their abilities and think their ability to contribute will be limited. So correctly assessing what the student does and doesn't know can be a challenge.

Both of the authors agree that the student and faculty member need to get to know one another. For example, the professor needs to get to know the student's background, skills, capabilities, talents, interests, work habits, personality, course workload, other responsibilities, and maybe even vacation plans, as in a job interview, so that the professor knows how to motivate, guide and nurture the student. Similarly, the student needs to learn about the professor: work habits, standards for quality of workmanship, expectations for interactions, etc. so that he or she can most productively interact and make contributions. Moreover, both authors agree that making this exchange of information a high priority is very important. Unlike a graduate student, there is little time in which to develop the working relationship.

To a limited degree, the two even need to get to know one another on a personal basis. This student author thinks the URP participant needs to understand why he or she doesn't always get the guidance and attention desired. This lack of attention can be taken as a sign that the work he or she is doing is insignificant or unimportant. Students may have trouble finding their dedication and motivation for the project if it is unclear whether the professor is also dedicated to the work. Consequently, the student needs to understand what the professor's world is about. This includes the roles and responsibilities that the professor has in the project; other teaching and service commitments; and professional societal roles. It is also important that the student understands that the project on which they are working may be one of many that the professor is managing.

The authors think there is a need for the professor and student to determine how they will communicate with each other. They need to develop protocols for making appointments, emailing, and phone calls. This is important because professor needs to understand when the student can be contacted, by what means (e.g., email, cell phone), the responsiveness that is likely to be provided, the degree to which plans can be juggled, and the availability that can be expected. The student needs to understand the same kinds of things for the professor, like the way he or she wants to be contacted, the extent to which their personal life can be disrupted, the responsiveness he or she can provide, and availability to postpone what they were doing and help out the student.

Therefore, it is in the professor's interest to develop a working relationship with the student. To get the highest productivity from the student, the student has to be happy about what he or she is doing. The student needs to feel appreciated. This is really only possible if the student feels as though the professor realizes that he or she is a person whose feelings, condition, and situation are understood. Treating the student as a mechanical resource to be tasked with work isn't likely to produce an endearing experience for the student.

For research professors that don't teach undergraduate classes, URP experiences are opportunities for those faculty members to interact and work with students that they otherwise would not have a way to see or mentor.

The professor needs to understand that the world of an undergraduate is very different from that of a graduate student. The undergraduate lives in a world that includes class assignments, social activities, etc. His or her life does not revolve around the research project, its day-to-day activities, deadlines, deliverables, and desired results.

Moreover, each student is unique. The professor has to determine the kind of interpersonal relationship the student wants to have. Some students seem to want the URP experience to be like a job. Others want it to be a partnership, where the student works side-by-side with the professor, sharing in doing the work and making the decisions related to the project. The sooner the professor ascertains the kind of interpersonal relationship the student wants to have, the better.

The faculty member needs to realize that peer pressure plays a role. The student may be doing something that few of his or her peers are doing. The student may not be comfortable carrying on technical discussions with a professor in the presence of his or her peers. The student may not want to be bothered away from the office setting. The student may be more friendly and engaging when he or she is interacting directly with the research team than when in a social setting. The faculty member needs to be sensitive to this fact, to realize it is normal, and to not expect the student to behave differently. The faculty member needs to be careful not to push too hard or be too controlling.

Even though the professor does these things, however, he or she should also look for ways to help the students to grow professionally. If the students are willing, they should be asked to handle responsibilities and perform tasks that allow them to become more comfortable with their chosen career path. This type of growth could result in greater receptivity to risk, an improved ability to be creative, and more open discussions.

3.2 Meeting Faculty and Student Expectations

From the published literature, it seems that the goals and objectives that are often set for a URP experience are generally related to conducting some portion of the research. The goals are to conduct some type of experiment; conduct an analysis; create or validate models; prove that something is true; or produce a specific deliverable. The goals of the student are typically not explicitly recognized.

The authors of this paper think there is a potential shortfall in defining the URP's goals and objectives if the student's perspective is overlooked. The project's needs may be met but the student may have a "disappointing" or "unfulfilling" experience.

One might assume, naively, that the student's goals and objectives are the same as the project's (or the faculty member's), but these authors believe such is not likely to be the case. While both the student and the faculty member may be interested in seeing the project succeed, the faculty member is likely to be far more interested in that goal. Of course, it is possible to focus only on the faculty member's goals and ignore the student's. But these authors believe that is likely to result in an unrewarding experience from the student's perspective.

The implication is that it is important, as soon as possible, for the faculty member and the student to list their goals and objectives and devise a work plan that ensures they are met. An "unfortunate" part of this thought is that this student author thinks the URP participant may not be able to articulate his or her goals and objectives in a clear manner. This student author thinks the student's objectives are likely to be far broader and less well defined than the professor's. The student is likely to have expectations such as: gaining experience in research, seeing how the material they learn in class is applied, working on a project, making money, etc. It is unlikely that the project's success will be the student's main goal. The student is more likely to be using the project to build a network of professional contacts, find a job, and get recommendations for graduate school or a job. That means that when the student thinks about participating in the URP, the success of the project is not something that immediately comes to mind. That's the professor's problem, not the student's. The project's goals may actually have a relatively low importance on the list of goals for the student.

Another issue is work product expectations. Both authors agree that there is a potential for "trouble" in this regard. The professor can have problems if he or she forgets that the student is learning how to shift from "student quality" work to efforts that are of a professional quality and useable for journal publications. The professor has to realize that it will take time to explain what has to be done, it will take the student time to internalize what has been learned, the professor will have to teach the student how to do the work, and the student will have to "practice" how to do it so that quality results can be ensured. The student, on the other hand, may be in a wide range of "perception places." At one extreme, the perception may be that he or she already knows how to produce "professional quality" work and doesn't need to "learn" what is involved, which produces an interesting challenge for the professor. At the other extreme, the student may feel that he or she is incapable of producing such high-quality work without more experience and maturity, which presents a different mentoring challenge.

Both authors agree that the professor needs to explain how the student fits into the project team. Otherwise the student will be confused, uncertain of the role they are to play and how they fit into the group. The professor has to realize that these may be new concepts from the perspective of the students. The students may not have been involved in a project where multiple people are working on inter-related tasks, and on a project where the main objective is to make new discoveries; which means that outcomes are unknown, the path to those outcomes is not completely clear, and the end results may not be what was anticipated. There are risks involved, with twists and turns that are unforeseen, and unexpected outcomes.

The authors also agree that the faculty member needs to explain what the deliverables are. This may sound silly, but the thought relates to ensuring that the students understand what quality the deliverables have to have to be suitable for journal publication, as well as client acceptance. The students may not understand what the sponsor's expectations are, how those expectations relate to the publishable results, the quality of workmanship the professor expects, and the importance of keeping the project on track. These are all important objectives for the professor. The students need to understand how and why they are important and what has to be done to ensure that success is achieved.

Some ways to deal with these issues include: creating "bite size" tasks that are clearly worded, laying out what needs to be done as well as how, seeing how students "wishes" can be incorporated into the tasks (sort of assessing the value of the task from the student perspective), being organized, and making room for flexibility.

3.3 Gaining Perspectives on the Research

The authors agree that it is difficult for the students to understand what the research is all about. This means the project's significance, its relationship to other research efforts, both on-going and preceding, the hypotheses that are being tested, the contributions that are being sought, the manner in which those contributions are striving to be made, and the way in which those contributions are expected to affect future research. The authors also agree that this is something that the professor can find difficult to convey since he or she has a personal interest in the work being done.

The authors think one way to meet this need is to bring the students in contact with the community of researchers worldwide who are working in the field. This includes getting the students to know other researchers on the university campus who have similar interests as well as researchers at other universities on an international scale. This thought is particularly "out of the box" from a student perspective, because students are unaccustomed to thinking about people they know having colleagues on an international level, or that the person with whom they are working might have only a handful of peers in the world.

The professor author of the paper thinks faculty members sometimes see URP students as highly effective low-cost labor. They are very intelligent, highly motivated people, and capable of doing very good work if carefully guided. Professors have to guard against this perspective. The URP participants need to have experiences that "inspire" them to take an interest in research work, to consider graduate school, and to contemplate a career in research. "Gopher" treatment will not make that happen.

It is important for the student to understand what the project is about: what outcomes are expected, and what character they will have. The student needs to understand the project's goals and deliverables, the milestone dates, and the role the students have to play.

It is important to recognize that undergraduate may perceive that even though they may complete the task(s) assigned, the results are likely to be of little value or significance. The authors think students need to understand how their efforts will be valuable. It is the student author's opinion,

if they can think of the significance in terms of worldwide advances, their motivation and dedication will be greater. As a new undergraduate research student, there is often a feeling of, “You expect me to do what? How?” Students are easily overwhelmed by the overarching statements professors often present in research descriptions. If the topic or title is daunting, thinking of tasks and responsibilities can be even more stressful. Concepts of understanding what they are actually responsible for, their level of involvement and how to actually accomplish the project goals can produce huge questions, insecurities, and lack of confidence for some students.

The authors also think that the students need to realize that even small steps are steps. They need to have a sense of achievement. They need to realize that even minor advances can produce huge advances in knowledge. There needs to be some sensitivity for the student’s sense of accomplishment. If they feel they are moving forward, they may become more and more interested in their work.

The student author perceives that undergraduates don’t necessarily see or understand the big picture. This means the undergraduates may form the opinion that the professor is making the problem more complicated than it should be. Although that may not be true, it seems that many undergraduates share these feelings. Student comments and actions suggest that they think there must be a simpler way to approach the problem. The students do not necessarily understand the context of the research and they may not have enough background in the project area to understand the developments that have led to the current state of the research.

3.4 Getting Things Done

Getting things done is always a challenge. These authors feel this is especially challenging because in research, the tasks being done have never been done before. Outcomes are not really known, how long it will take to obtain them is somewhat unpredictable, intermediate findings may alter the path taken, and the research sponsor may refocus the effort. Getting graduate students to understand these ideas is difficult enough, let alone explaining it to undergraduates. At least the graduate students have some idea what research is about and the importance of keeping the project on track. Undergraduates have no experience. They may be accustomed to “giving up” when things become difficult or finding ways to skirt around roadblocks.

One thing that helps ensure success is commitment to the project. It is the experience of the faculty author that this is a rare condition for undergraduates. They are not likely to take significant ownership of the project or its results. The student author agrees with this comment, but feels as though that it doesn’t necessarily need to be the case and argues that there should be a way to ensure that the student takes partial ownership for the project. Undergraduates are more likely to be nonchalant about whether the intended results are obtained or a significant contribution to knowledge is made. A part of the “problem” here is the fact that the duration of time that the undergraduates are involved in the project is likely to be too short for them to take ownership. Another “problem” is the differences in time scales associated with the project and the student’s involvement. Often, the student participates for only a semester, or up to a year. Most projects are longer than a year in duration, which means the student does not see the project through from beginning to end. This means that either the student participates in the project at its inception, but doesn’t stay involved until it concludes (which means ownership has “no”

meaning or they become involved midway through, which means they did not share in either delineating what the project is to be about or setting the initial course for the effort. The student author feels that the more involved students become in the project and the more critical they perceive they are to the success of the project, the more they will try to take a portion of the ownership. Of course with projects that are unsponsored and have no deadlines or contractually defined workscope, this problem is not as significant as it is for sponsored ones. The unsponsored projects can be defined and redefined so that they fit within the scope of the time available and the student's capabilities.

The authors note that there is also an issue here about who contributed what. Naturally, people often take ownership of a project when it is clear to them that their personal efforts are contributing to the effort's success. This thought applies to the undergraduates just like it does to everyone else, with the understandable implication that it may not be that often that they make contributions that enable them to clearly see that they have truly contributed to the project findings or outcomes in some substantive way.

The authors also agree that undergraduates don't necessarily deal well with "dead ends" very well, conditions that routinely arise in research projects where an idea being pursued proves to lead nowhere. Students may complete tasks that end up being "useless", and it is hard for them to understand, when that happens, why they were asked to do what they did. The notion that the professor didn't know if the effort would succeed or not, seems like "stupidity" on the professor's part. The students are reluctant to accept the idea that tasks can be worthwhile even when the outcome is unknown or the results are "useless".

All of this implies that the professor has to be clear about certain project-related details. Deadlines have to be set for getting things done. The process to be followed has to be specified, and then understood, to ensure that the desired outcomes are achieved. When results don't emerge as intended, the students also have to learn how to spot the fact that things are off track, be confident about bringing that result to the attention of the professor, and possibly, being able to suggest corrective actions that will get the project back on track.

This student author believes students can get frustrated if things appear to be inefficient. It is hard for undergrads to balance research and course work, so when they get stuck in a research problem and stop moving "forward" they can get stressed out, especially if the value of the project has become very important to them.

This faculty author also observes that one has to be careful to make sure that "student standards" are not set for work products, either by the faculty member or by the research sponsor. Final deliverable qualities must always be maintained. The students have to comprehend these standards for workmanship and, in many cases, understand how those standards are far about those related to coursework or even co-op or internship expectations where publication of the results in an archival journal is not the intended end outcome.

This relates to expectations of creativity on the professor's part, especially for finding creative ways to work past roadblocks that emerge as the work progresses; as opposed to what might be

hand-holding expectations on the student's part. The students perceive that the professor leaves them hanging and lost.

The professor and student both become impatient. The professor gets "tired" of waiting for the student to get things done and gets "tired" of answering questions that he or she thinks ought to have "obvious" answers if the student only "thought" about the problem "creatively." The student on the other hand perceives that the professor is not providing enough guidance and is being unreasonable in his or her expectations for what the student can do by himself or herself. They get annoyed because the professor does not seem to provide enough guidance, seems to be too vague, leaves too much decision making responsibility in the hands of the student, and expects too much in terms of project leadership.

In some ways, the URP experience puts the undergraduates in a setting that they are likely to enjoy. Some kind of hands-on activity is likely to be involved. The work involved is not perceived as "classwork" even though it may be similar to laboratory exercises or term papers. There is a perception that they have more latitude to exploit their creativity in finding ways to accomplish the project tasks.

URP's often help the professors with their sponsors, who want to see that the research work is being connected to the educational mission of the university. The sponsors want to have a sense that the new students entering the profession are benefiting from the new discoveries being made as a result of the research findings.

The students gain lots of benefits from the URP experience. One is the opportunity to be involved in research. Another is the chance to learn how to make new discoveries and advance the frontier of knowledge. They get to network with other professors at other schools, to find out what the graduate programs are like at other universities, worldwide, to network with people at consulting firms and governmental agencies who might hire them once they graduate. The students get to know one or more professors well enough to be able to get quality recommendations for graduate school (or for jobs they want to take). They get to see how what they are learning relates to the discovery of new knowledge. They get to see what professors are really like and what the world is like in which they live. They get to see the educational process through the professor's eyes, which gives them a "completely different" perspective on the educational process through which they are passing. They get exposed to undergraduate programs at other schools, through the interactions with the other researchers in the field and they get to learn about other graduate programs.

4.0 Conclusions and Prognosis

This paper focuses on qualitative perspectives regarding URP's. A student and a faculty member talk about a variety of URP-related topics ranging from "getting things done" to developing interpersonal relationships. The paper's main contribution to knowledge is its emphasis on the undergraduate perspective and relating that perspective to the way in which a faculty member often sees the situation. As might be expected, there are similarities and differences in the perspectives, with the differences relating to such important aspects as the goals and objectives the each brings to the effort, the degrees of commitment that exist, the understandings of the

significance of the project and the way it fits into the research landscape, and the extent to which the project is a “real” effort with “new” results that have not been discovered before.

The authors present ways in which these issues can be addressed including giving the students specific responsibilities so they know what they're supposed to do, taking the students to conferences where they can see first-hand the way in which the progress of the frontier of knowledge is being portrayed, involving them in project meetings and teleconferences where they can hear and see the leading researchers discussing project progress. Older students can also be used to mentor younger ones.

The authors also observe that to sustain a URP program requires continuing involvement of the undergraduates. It involves establishing and protecting continuity in the involvement of the students, having “older” students” mentor and “indoctrinate” the younger ones, having the graduate students take responsibility for the effort as well, getting students to understand the frailty of the program in which they are involved, so that they help sustain it, making sure there are clear incentives for students to do URP’s, getting the students to see that what they are doing is important, getting them to perceive that they have joined a “team” or a “family” that is engaged in a collaborative effort to make contributions.

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