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GIFTS: Making Research Experiences Meaningful through Critical Self-Reflection

Peter DeCrescenzo, University of Maryland Baltimore County

Author is a doctoral student in the Student Affairs program at a public research university in the Mid-Atlantic. He serves as an Assistant Director to an NSF-funded project in order to increase the number of racial and ethnic minorities who matriculate into and successfully complete high-quality degree programs in science, technology, engineering and mathematics (STEM) disciplines in order to diversify the STEM workforce. His research interests are centered around understanding how racism operationalizes on college campuses to develop action steps to address structural barriers. He has presented at regional conferences on STEM undergraduate success and persistence through graduate school.

Sunji Jangha

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Introduction

In this Great Ideas for Teaching Students (GIFTS) paper, we offer learning outcomes that we are identifying from our eight-week Research Experience for Undergraduates (REU). There are four characteristics that have been found to be essential to success in Science, Technology, Engineering, and Mathematics (STEM) fields: a strong sense of STEM identity [1],[2], scientific self-efficacy [3], a sense of belonging [4], and a psychological sense of community [5]. This is especially true for first year and transfer students pursuing STEM undergraduate degrees. A variety of studies have been published that go into detail about why these characteristics have such a significant effect on student performance and retention [1], [2], [3], [4], [5]. This paper builds on past research focused on the intersections between reflection, metacognition, and STEM professional skills [6]. We present Critical Self-Reflection [7] to integrate development of these characteristics into student research experiences to foster experiential learning. STEM students are not often trained to critically self-reflect on their experiences in classroom and research settings. An inability for undergraduates to reflect intentionally on their experiences creates greater risk for attrition from STEM disciplines. Further, undergraduates who persist beyond college can find it difficult to adapt to a constantly changing STEM workforce without reflection and metacognition skills [6].

Driven by the purpose of facilitating deep learning and understanding of self, classroom content, and experiential learning, the University of Maryland, Baltimore County Louis Stokes Alliance for Minority Participation (UMBC LSAMP) Undergraduate Research Fellows Program (URFP) engaged STEM majors (primarily rising second year and transfer students) in a series of critical reflection activities. Fellows are paired with faculty mentors over eight weeks to engage in undergraduate research. Guided by Coulson and Harvey's [7] framework for scaffolding reflection for learning through experience, activities are curated for undergraduate researchers to learn to reflect, reflect for action, reflect in action, and reflect on action. Subsequently, undergraduate researchers strengthen metacognitive learning and ability to make sense of the learning process.

UMBC LSAMP is a member of the University System of Maryland (USM) LSAMP, a National Science Foundation (NSF) funded project, which takes a comprehensive approach to student development and retention. Emphasis is placed on transforming undergraduate STEM education through innovative, evidence-based recruitment and retention strategies and relevant educational experiences supporting racial and ethnic groups historically underrepresented in STEM disciplines [8]. UMBC LSAMP supports its Fellows through individualized advising, graduate school preparation, professional development, and funded research opportunities. Critical self-reflection activities are a pedagogical tool used to supplement the undergraduate research experience. Through reflection, Fellows can hone their understanding, confidence, skill, and agency to make meaning of their experience [6], [7]. Fellows can then develop a strong sense of STEM identity [1],[2], scientific self-efficacy [3], a sense of belonging [4], and a psychological sense of community [5] that creates a pathway from their undergraduate experience to graduate school enrollment and ultimately graduate degree attainment [9], [10], and the STEM workforce

[11], [12]. These areas of growth are often not the focus of STEM curricula but can have a lasting impact on positive workplace outcomes [13].

Further, the URFP partners with the university career center to align its objectives with the National Association of Colleges and Employers (NACE) Career Readiness Competencies to provide opportunities for growth in STEM professional skills [14]. Fellows engage in activities to improve in the following areas: communication; critical thinking; equity & inclusion; leadership; professionalism; teamwork; and technology.

Project Approach

This project builds on past research that has identified the practice of self-reflection as a facilitator for deep learning [6], [7], [15], [16]. Through curated reflection activities, we offer undergraduates the opportunity to consider their agency in the learning process. The URFP integrates the framework for scaffolding reflection for learning through experience and comprises four phases: (1) learn to reflect, (2) reflect for action, (3) reflect in action, and (4) reflect on action [7]. Each phase builds off the others. For students to learn to reflect, they must be exposed to reflective tools, provided opportunities to reflect, and receive feedback. In the reflect for action phase, learners begin to reflect in the context of the experience. Students continue to receive feedback to strengthen their reflection skills. Reflection in action focuses on the sense-making of the experience and allows learners to navigate issues that arise. Reflection on action provides students with space to process their emotions and connect discipline concepts to practical experiences [7]. Critical self-reflection allows Fellows to bring their whole selves to their experience. Within the program, critical self-reflection is embodied in three activities where Fellows describe their perceptions: creating a legacy statement, participating in facilitated dialogue sessions, and writing curated journal entries.

Description of Innovations

Legacy Statement Exercise
In orientation, we ask the Fellows to introduce themselves, including their background information, optional pronouns, and academic and professional goals. UMBC LSAMP staff follow by introducing the legacy of Congressman Louis Stokes, the program's namesake. Then, Fellows reflect and create their legacy statement using guiding prompts [see Appendix A.].

Following five-minutes of individual reflection and writing, Fellows are placed in small groups to share their legacy statement draft and receive feedback to refine it into one or two focused sentences. Fellows are encouraged to think about how life is not always linear. To help illustrate that point, Fellows reexamine their legacy statement at the end of the program and can make changes based on their experiences.

Facilitated Dialogue Sessions
Fellows engage in six weekly 75-minute dialogue sessions where they are placed in discipline-based groups to limit size, account for cultural differences within disciplines, and facilitate community building. Each session is co-facilitated by two-three Fellows. Before each session,

facilitators identify and share a short article, video, quote, song, or set of discussion questions relevant to the topic for the week.

In the initial dialogue session, we introduce Fellows to the NACE Career Readiness Competencies focusing on verbal and written communication [10]. Then, following active listening tips and a guide to ask meaningful questions, Fellows are prompted to create a 30-second elevator speech introducing their education, experience, skills, and goals. A series of dyads follows this activity, where Fellows practice their active listening skills [see Appendix A.].

We then introduce Fellows to their groups and dialogue topics. Groups work together to assign facilitator roles and finalize any outstanding group details. The dialogue topics include:

1. Ambition & Initiative
2. Mentoring & Advising
3. Communication & Conflict
4. Engaging & Belonging
5. Post-Graduation Planning
6. Emergent Theme (selected by each group during week three). Past emergent themes included mental health strategies and adapting to online learning.

Curated Journal Entries

Every two weeks, Fellows submit curated journal entries to facilitate reflection on the research experience. We focused on two overarching themes to deepen the participants' understanding of their experience: 1) perception of experience and 2) application of new knowledge. From those themes, the six reflection prompts were designed to facilitate higher-order cognitive processes [1]. Each prompt captured an aspect of the associated theme [see Appendix A.]. Fellows were allowed to select the one that best fits their experience for that week. Prompts can be selected no more than twice. This flexibility allowed for contextualized growth and personalized meaning-making. Questions varied from self-analysis of daily tasks and recognizing the benefits of struggling with a task to highlighting the differences between knowledge garnered in the classroom versus in the research environment. Table 1 places each LSAMP activity within the critical self-reflection framework.

Table 1: LSAMP activities in critical self-reflection framework

	Legacy Statement	**Dialogue Sessions**	**Journal Entries**
Learning to reflect	Initial Legacy Statement	Dialogue Zero	Journal Prompt 1
Reflection for action			Journal Prompt 1
Reflection in action		Dialogue Sessions 1-4	Journal Prompt 2-4
Reflection on action	Final Legacy Statement	Dialogue Sessions 5-6	Final Journal Prompt

Results and Discussion

Fellows have begun to show a deep understanding of the impact they can make as a STEM professional. For some undergraduates, it was their first opportunity to consider how their pursuit of a STEM degree related to their overall life goals. Through the legacy statement exercise, the research fellows are provided space to imagine a future for themselves and community members. Here is a quote taken from a computer science major that expressed a common sentiment:

"I want to be a champion for my community and utilize the intersection between ethics and computing technology to bring about equity for them. I would want to begin a cycle of giving and inspire others to use their power and influence to bring about change too."

Fellows provided very positive feedback on the dialogue sessions. Here is a quote taken directly from a Fellow that expressed a common sentiment:

"The small group discussions (dialogue sessions) were always engaging and relatable."

Additionally, the curated journal entries have offered us insight into student growth over the course of the undergraduate research experience. In student journal entries, we have witnessed undergraduates reflect on an obstacle and overcome them by the end of the research experience. We pulled a series of quotes from one Fellow's curated journal entries that were representative of the larger group and expressed the following themes: (1) personal and professional growth; (2) increased sense of STEM identity; (3) increased predisposition to graduate study.

"I am beyond excited to work on my project with... lab this summer. I am excited to work on a project that is driven by my interests and an opportunity to learn new techniques." - Journal Entry 1

"Growing up, I felt like all the questions I would ask were wrong and it made me feel like asking questions was a bad thing…. In a lab, asking questions is what fuels the need and want for discovering different answers, additional questions, and curiosity. …I still struggle with asking questions, but now I get my idea out in the open for people to comment on." - Journal Entry 3

"This summer has been one of my most stressful yet rewarding summers I've had…. Before I transferred... I thought that applying to graduate programs was near impossible, but thanks to all the support and direction from the LSAMP program and MARC U* Star program, I feel confident applying to graduate school! Watch out world, future Dr. . . . is coming for ya!" - Final Journal Entry

Critical self-reflection is a pedagogical tool that can benefit staff and undergraduate researchers. Through reflection, undergraduate researchers can compose and express their thoughts and feelings about their experience while acknowledging potential areas of improvement and their dedication to their overall academic and professional goals.

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Appendix A.

USM LSAMP Research Fellowship Facilitation Guide

Legacy Statement Exercise Prompts

1. What do I want to be remembered for?
2. What higher purpose do I want my life to contribute to?
3. What do I want the end result of my life to be?
4. How might your loved ones or group of supporters be included in your legacy?
5. What is the purpose of my life and what will be my life's work?

Facilitated Dialogue Orientation Prompts

1. Describe the neighborhood you grew up in or what are some familiar smells you remember from childhood?
2. Why did you choose to attend your home university? If you could go back in time, would you choose to attend that university again?
3. How did you know that you wanted to pursue your major?
4. If you could visit one place in the world, where would it be and why?
5. If someone gave you a million dollars, but you had to give it away (no family or friends allowed), who would you give it to and why?
6. If you were President of your university for one day, what is one thing you would change?

Curated Journal Entries Prompts

1. Consider your day-to-day tasks, what tasks do you find come easy to you/you do well at, and what tasks do you struggle with? Of those tasks you do well, do you enjoy them? If there are tasks you struggle with, are these areas where you want to challenge yourself to learn more and improve?
2. What are you learning about yourself–your strengths and weaknesses–through engaging in a research experience? How do you plan to use this knowledge in navigating future endeavors?
3. What are the differences between what you thought this research experience would be like and what it is actually like?
4. How does what you are learning in class compare to what you need to know to be effective in your research project? What has surprised you?
5. What are you learning about the field that you didn't know before? How does this new knowledge impact your opinion of the work and motivation to further engage in research in the discipline?
6. Is this a subject you see yourself continuing to study? Is this research you would like to build on?