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# WIP: Leveraging Elements of the Researcher Development Framework Embedded in Entrepreneurial Attributes to Improve Graduate Student Professional Development

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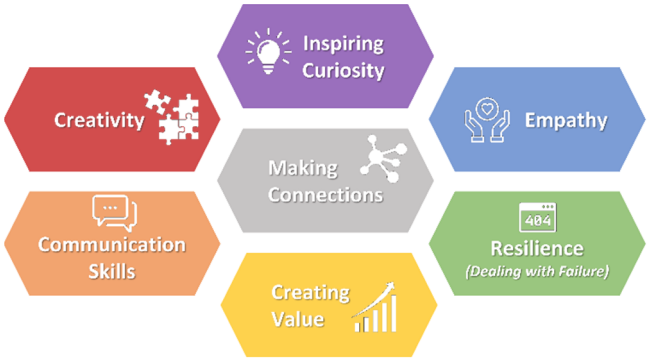
## Introduction and Motivation

Traditionally, faculty members in STEM fields encounter silo-ed approaches to professional development, and this trend extends to their graduate students (future faculty). However, this silo-ed approach often neglects certain facets of faculty life, such as teaching, leadership, service, and mentoring, in favor of spending more time preparing future faculty to conduct research. Acknowledging the insufficiency of the traditional siloed approach to future faculty training, this work-in-progress paper presents an effective strategy to equip graduate students with a common lexicon to more accurately articulate the areas in which they require additional training or mentorship. The work presented in this paper is part of a larger study that explores the impact of framing future faculty professional development more holistically through the lens of entrepreneurial attributes [1]. The larger work expands on extant work to include the seven primary attributes of the Entrepreneurial Mindset (EM) (Fig. 1) [1]–[4].

**Figure 1.** Entrepreneurial Mindset Framework




Promoting EM thinking in engineers has received more recent attention for its appeal to prospective employers, as it enables students to strategically select and exploit opportunities, deal constructively with failure and setbacks to pivot in new directions, and generally persist and succeed in a wide variety of career environments [2]–[6]. It has also been linked to improved self-efficacy outcomes in both undergraduate and graduate students [6], [7]. While these entrepreneurial attributes were used as a framework to organize and theme different professional development activities and reflections, one difficulty experienced by graduate students is that oftentimes, they lack a common language to adequately articulate their skillsets and areas of improvement, especially in aspects of research that they have not received as much exposure to [8]–[10]. This inability to articulate which skills they need assistance in developing can add additional layers of difficulty in mentoring relationships with advisors and supervisors, as it may not be clear where mentors ought to focus their efforts based on mentees' needs and career goals. In short, a common language or professional competency framework was needed to help graduate students map the larger landscape of prominent skillsets that they ought to nurture to excel in a research career in academia, industry, or government.

This is where the current work leveraged the Vitae Researcher Development Framework (RDF)[9], as it is an evidence-based framework that identifies four major domains of skills and characteristics necessary for a researcher's success in a variety of careers in academia, industry, and government (Knowledge & Intellectual Abilities; Personal Effectiveness; Research Governance & Organization; Engagement, Influence & Impact). A total of 63 elements or skills are explicitly identified in the Vitae RDF and classified within the 12 subdomains. Together, the 63 element descriptors seek to encompass the primary behaviors, skills, attributes, and professional standards expected of successful researchers across academic, government, and industrial sectors. These different levels of articulation (domain, subdomain, element) allow graduate students and their mentors to concisely describe their skillsets and areas of improvement with increasingly fine granularity, depending on which level is most appropriate for the professional development conversations at hand. The RDF is a tool that helps its users articulate and reflect on their skillsets, as each of the 63 elements or skills are accompanied by detailed descriptions, representing a continuum of 1-5. This helps users of the RDF more clearly identify where they feel they are currently with a given skill and/or identify a level that they would like to progress to in the future. The RDF has been leveraged by many as a self-assessment tool for graduate students and early career researchers to prompt introspection and reflection to identify strengths and developmental gaps in research portfolios [8], [11], [12].

Using these entrepreneurial attributes combined with the Vitae Researcher Development Framework (RDF) as a binding framework, future faculty professional development modules were designed and embedded into three engineering and engineering education graduate courses at two major R1 institutions in the eastern United States over multiple semesters. Feedback gathered from students and instructors were used to iteratively revise and re-design aspects of the professional development modules over the course of multiple semesters. A subset of students was invited to participate in post-course interviews to explore their perceptions of using the RDF as a tool in the course, as well as their perceptions of using the entrepreneurial attribute framing for the professional development modules. Using this feedback and data provided from the RDF reflections in each module, this paper will explore preliminary trends seen in the data as well as suggest best practices for future implementation of these modules.

**Methods**

The population studied in this work involved several semesters of graduate-level engineering and engineering and science education graduate courses at two major R1 universities: Clemson University (CU) and The Pennsylvania State University (PSU). The courses were conducted in a variety of modalities, including online asynchronous, online synchronous, and hybrid partially synchronous. A total of 24 unique students (50% women, 50% men) were engaged at various times in the professional development modules in the courses, although some courses did not deploy all modules (Table 1). The reason for this is that the modules were intentionally designed so that they could be easily adapted to meet the needs of the students within a given graduate course and its objectives. Institutional review board approval was obtained from both participating universities to protect the students involved in the research. Students were explicitly instructed that the RDF scoring activities were based on completion and were invited to submit their RDF score documents anonymously.

In this study, all 63 elements of the Vitae RDF were sorted into the professional development modules according to which entrepreneurial attributes they were most closely

associated with. In each of the seven professional development modules spaced throughout the semester, students were asked to engage in reflection exercises, among other activities that were themed around the entrepreneurial attribute but did not explicitly involve the RDF. Over the course of the semester, students were asked to maintain a tracking document (provided by the instructors) as they encountered each of the 63 RDF elements over the course of the seven modules. In every module, students used the Vitae RDF element descriptors to self-identify their current skill level (from 1-5), as well as to reflect on where they would like to see themselves in each skill by the time they graduated from their program. This is important to note, as students' varying career aspirations would result in different prioritizations and desired skill levels of various elements. It was also explained to students that a perfect "5" was not necessary (or even feasible) to attain over the course of a few short years, in many cases. In several of the modules, students then engaged with the RDF descriptors and elements further by prioritizing areas of improvement based on their personal career aspirations and/or practicing articulating evidence of their proficiency in the elements that they perceived as being most relevant to their career goals.

**Table 1.** Details of RDF module deployment and data collection

| Course | RDF Modules | Data Collected |
|---|---|---|
| *STEM Online Pedagogy (CU)* | Empathy, Inspiring Curiosity, Resilience | RDF scores, end-of-course surveys |
| *STEM Professional Communication (CU)* | Communication Skills, Making Connections, and Creativity/ Creating Value | RDF scores, end-of-course surveys |
| *Engineering Graduate Teaching Assistant (PSU)* | All seven attributes | RDF scores, end-of-course surveys and student interviews |

**Results and Discussion**

When analyzing the data, high self-evaluation scores were interpreted to indicate either a high self-perception of skill in an element (for the current ranking prompt), or a high perceived value of scoring well in an element by the time they graduate their degree programs (for the future ranking prompt). For example, if a student scored an element high for the "future" prompt, this would indicate that they perceived this skill was relevant, necessary, and important for success and graduation from their program. The difference between the self-evaluation scores (of where they saw themselves now versus by the time they graduate) was interpreted as a proxy for priority and magnitude of developmental gaps. For instance, if the difference between current and future scores for a given element was high, this was interpreted as the student recognizing a large gap between where they are now versus where they see themselves as needing to be by the time they graduate. Looking at combined data, the following RDF elements were identified as the either being the highest or lowest scoring with regards to student perceptions of their current skill level in that element, or their future desired skill level by the time they graduate (Table 2).

Overall, aggregated data showed that 'time management' was the largest developmental gap perceived by graduate student participants in this study, with an average difference of 2.00. This suggests that additional professional development in time management could be beneficial to closing this developmental gap for engineering and engineering education graduate students. Trends found in the data de-aggregated by institution are summarized in Table 3. In future work, this data could be used to explore more deeply into what factors influenced the high or low perceptions of these skills by students.

**Table 2.** Summary of highest and lowest scoring RDF elements

| **Where Students See Themselves Now** | | **Students' Perceptions of Relevance/Importance in Future** | |
|---|---|---|---|
| **Highest scoring** ***(most proficient)*** | **Lowest scoring** ***(least proficient)*** | **Highest scoring** | **Lowest scoring** |
| 3.37 – Self-confidence | 1.68 – Policy | 4.64 – Research methods (theoretical knowledge) | 2.92 – Policy |
| 3.23 – Preparation and prioritization | 1.87 – Publication | 4.59 – Perseverance | 3.03 – Global citizenship |
| 3.23 – Integrity | 1.91 – Legal requirements | 4.50 – Problem-solving | 3.03 – Society and culture |
| 3.19 – Inquiring minds | 2.00 – Intellectual property rights and copyright | 4.46 – Self-confidence | 3.32 – Public engagement |
| 3.18 - Perseverance | 2.00 – Public engagement | 4.41 – Research methods (practical application) | 3.39 - Enterprise |

**Table 3.** Summary of trends of RDF scores, de-aggregated by university

| **CU student RDF scores** | **PSU student RDF scores** |
|---|---|
| ▪ Strong consensus that 'people management' and 'mentoring' are two skills in which high achievement is necessary by time of graduation.<br>▪ Gaining more experience in mentoring was largest developmental gap.<br>▪ Smallest perceived developmental gap was 'society & culture' skillset. | ▪ Strong consensus that high achievement in 'research methods (theoretical knowledge building)' is needed by time of graduation.<br>▪ Building a publication record was perceived as a higher priority developmental gap.<br>▪ Smallest perceived developmental gap was 'intellectual risk' |

When assessing future professional development needs by the RDF competencies holistically, only the data from students who self-assessed in all modules (all 63 elements) was included (*i.e.,* PSU students only). The "Knowledge and Intellectual Abilities" domain of competencies was identified as the highest-scoring domain both currently and in the future with the highest degree of consensus (lowest standard deviations) – indicating a perception of both current high proficiency in that element, as well as an even higher degree proficiency expected by graduation. However, the largest developmental gap was identified as the "Research Governance and Organization" domain, which also had the lowest average current perceived proficiency, suggesting that graduate students may benefit from more exposure to professional development opportunities that build research governance skills, such as grant fund-seeking, grant-writing, budget management, and other related skills. Lastly, the researchers found it interesting that the lowest degree of consensus across all competency domains was the scoring of "Engagement, Influence, and Impact" elements. The large standard deviations observed for elements in this domain suggests that students held strongly divergent beliefs about the importance and relevance of these skills to their future professional career goals.

**Recommendations for Practice and Limitations**

In general, students indicated favorable perceptions of the use of RDF as a tool for reflection and individual goal setting for developing their professional skills in a targeted manner. In fact, a majority of the students indicated that they felt the engagement with RDF was insufficient in the course, and that they would have liked to have seen deeper engagement and discussion surrounding the RDF during the synchronous and in-person sessions. For example,

one student interviewee remarked that although he liked the RDF as a tool, the interspersed self-evaluations in the course "feel kind of out of context, and we have to do just do it as a task instead of more like a study [of ourselves]". Several end-of-course survey respondents also felt it would be valuable to see how their faculty would rate themselves based on the 63 element descriptors to help them visualize what "reasonable" self-scores might look like for a recent graduate and early-, mid-, and late-career researchers. Feedback from instructors primarily centered around the timing of the modules and ensuring that the level of work required for the modules was commensurate with the course credit hours, especially as the class in which all seven modules were implemented was only a one-credit hour course. Students would not get to reflect on certain critical skills until much later in the semester in some cases, which instructors felt could be better leveraged if students encountered them earlier in the semester. However, students had mixed opinions of whether it would be preferred to continue reflecting on small subsets of the RDF elements embedded throughout the modules, or instead conduct one larger self-evaluation on all 63 elements at the same time at the beginning of the course. The primary concern by both students and instructors would be the time burden of conducting a thoughtful, authentic self-evaluation of all 63 elements at one time.

Despite the detailed descriptors provided by Vitae that accompany each of the 63 RDF elements, it should be noted that inherent limitations are present in this study because of the ambiguity of certain descriptors. For example, in several elements, it is difficult to delineate what distinguishes a '3' from a '5', as both scores might share the same description, yet are displayed on a continuum. This contributed to the somewhat arbitrary nature of using a scale of 1-5 for each element. However, based on student feedback, the scores were still able to help students indicate skills' relevance to their career goals and perceived proficiencies, so while direct student-to-student comparison of scores may not be as meaningful, looking at the average scores for a group of students may still hold value from a professional development planning standpoint. This is especially true if there are elements or groups of skills in which students consistently rank themselves as low values. These areas of perceived low mastery or proficiency by students can then be targeted with tailored professional development interventions. Based on feedback from students and instructors, it is suggested that most students felt encouraged to engage authentically with the RDF self-evaluations based on the way in which it was framed by the instructors, that "the more [effort] you put into it, the more you get out of it [as a reflection and goal-setting tool]". Lastly, researchers were only able to capture students' RDF scores at one point in time due to the course structures. That is, researchers were unable to longitudinally track the progression of how students self-evaluated themselves over a longer period of time.

**Conclusions**

Findings from this WIP study indicate that using professional competency framework self-evaluations such as the Vitae RDF can help students begin to recognize and prioritize both research strengths and developmental gaps. Results also suggest this approach could be used to plan targeted professional development opportunities to guide the collective growth of small groups of graduate students, such as those within a shared research group. It could also be used as a basis for discussion to explore the factors that influence a high or low perception of a given skillset by students. Future plans include a longitudinal study to see how students might apply the knowledge and insights realized through use of an initial RDF self-evaluation to assist in their development and goal setting in a more targeted manner over a longer period of time.

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**Abstract**

There currently exists a substantial gap in preparation between traditionally trained graduate students and the multi-faceted demands required of them by a typical faculty career. Acknowledging the insufficiency of the traditional siloed approach to future faculty training, this work-in-progress paper presents an effective strategy to equip graduate students with a common lexicon to more accurately articulate the areas in which they require additional training or mentorship. In this holistic approach, researchers designed professional development modules that were framed using an entrepreneurial mindset framework and embedded these modules into three engineering and engineering education graduate courses at two major R1 institutions in the eastern United States over multiple semesters. Relevant elements of the Vitae Researcher Development Framework (RDF) were embedded into these modules with accompanying reflection activities. Together, the 63 element descriptors in the RDF describe four domains that are meant to encompass the primary behaviors, skills, attributes, and professional standards expected of successful researchers across academic, government, and industrial sectors. Spaced throughout the semester, these RDF activities prompted graduate students to reflect on their current skills and abilities and clearly articulate their future mentoring and training needs in those areas. This paper details how this holistic approach was implemented and its synergistic activities to promote student reflection. This paper provides preliminary results in the form of student feedback about the use of the RDF in the courses from end-of-semester surveys and student interviews and suggestions for improvements based on instructors' experiences.