

# Chronicling the Development of a Growth Mindset Community of Practice for Computing Faculty: Lessons Learned and Looking Forward

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**Abstract**—This Innovative Practice Full Paper chronicles and reports on the innovative use of a Growth Mindset Faculty Community of Practice (GM-FCoP) to promote student success in a college of computing at a large private university in the northeast United States. Faculty communities of practice bring together faculty as a peer group to engage in learning about a specific topic. The experience is typically a structured approach where members with varying levels of knowledge and expertise about a topic provide encouragement and support to each other as they develop their knowledge and collaboratively generate shared resources. The community members in this GM-FCoP were experienced faculty specializing in computer programming, networking, web technologies, and computing career services, gathering to learn about embracing and developing a growth mindset to apply and promote in the courses they teach and in their interactions with computing students.

Situated in theories of intelligence, growth mindset posits that intelligence is malleable and can be developed over time. A growth mindset views failures as a springboard for future success. This contrasts with a fixed mindset that views intelligence and talent as fixed, or in other words, if you are not good at something you will never be good at it. This encourages the notion that talent alone is responsible for success. While many faculty, including computing faculty, may innately and informally embrace and encourage growth mindset approaches in their classrooms and interactions with students, the integration of growth mindset approaches is not broadly recognized or mindfully applied in day-to-day computing education curriculum. As such, the GM-FCoP provided an innovative opportunity to develop faculty understandings of growth and fixed mindset with a goal of planning for more intentional growth mindset interactions with students. Using communities of practice as a framework for examination, this paper details the innovative practice of a semester-long GM-FCoP, including the planning of weekly meetings and activities. Lessons learned from initial evaluative reporting alongside faculty leadership reflections are examined with an eye toward presenting opportunities for faculty who may also be looking to instill a growth mindset in colleagues and students. This has potential implications for both faculty and student success in numerous domains.

**Keywords**—*growth mindset, fixed mindset, communities of practice, computing education*

## I. INTRODUCTION

In January 2021, a Growth Mindset Faculty Community of Practice (GM-FCoP), consisting of 11 faculty (full-time lecturers, tenured faculty and staff in adjunct roles), met throughout the spring semester to promote student success at a large, private university in northeast United States. Every week, the GM-FCoP met for one hour to plunge into the topic of integrating a growth mindset in post-secondary computing education. Faculty communities of practice bring together faculty as a peer group to engage in learning about a specific topic or domain, in this case growth mindset. The experience is typically a structured approach where members want to have a shared learning experience, provide encouragement and support to each other as they embrace a new subject and reflect on their new knowledge and artifacts created by the community. The faculty in this GM-FCoP were experienced computing and career services faculty specializing in programming, networking, web technologies and computing career development, gathering to learn about embracing and cultivating a growth mindset to apply and promote in the courses they teach and in their interactions with computing students.

The GM-FCoP served as a faculty development opportunity for the community members to enhance their pedagogical skillsets for supporting positive interactions with computing students using a growth mindset. Steinert [1] described faculty development as formal or informal and individual or group-oriented. Formal group settings include workshops/seminars, courses and fellowships, while informal group settings can include communities of practice such as the GM-FCoP which intended to foster engagement and shared learning among the community members.

While many faculty, including computing faculty, innately and informally embrace and encourage growth mindset approaches in their classrooms and interactions with students, the integration of growth mindset approaches is not broadly recognized or mindfully applied in day-to-day computing education curriculum, nor typically addressed in formal individual or group professional development opportunities. The GM-FCoP was designed to provide intentional opportunities for faculty to formally and collaboratively learn and understand growth and fixed mindsets, not only in themselves, but in their students. With this increased understanding, community members would be able to examine

their current course materials and teaching approaches with a mindset lens. They would also be capable of embracing more intentional growth mindset interactions with students.

This paper details the experiences in designing and implementing a Growth Mindset Faculty Community of Practice as a semester-long innovative practice. Weekly planning, activities, challenges and lessons learned from initial evaluative reporting alongside faculty leadership reflections are examined with an eye toward presenting opportunities for faculty who may also be looking to instill a growth mindset in colleagues and students. This has potential implications for both faculty and student success in numerous domains.

## II. RELATED WORK

### A. Communities of Practice

In their seminal work, Lave and Wenger [2] developed the theory of communities of practice which proposed learning as a collaborative, social experience where people come together with a shared goal of learning about or enhancing their knowledge around a particular topic. While originally focused on learning via apprenticeships, Lave and Wenger [2] recognized the strong social aspect, which included situated learning, whereby community members learn from one another through legitimate peripheral participation, allowing novices on the periphery of the community to gain knowledge, skills and expertise, moving them toward the center of the community. The theory of communities of practice and the concept of legitimate peripheral participation posited that the social aspect of learning extended beyond an individual activity as participants move toward mastery of knowledge and skills. Wenger and Snyder [3] extended this by promoting that the synergy between learners, regardless of existing knowledge or competency in the respective domain, can result in new knowledge discovery for the community.

To this end, the characteristics of the community are critical in moving toward mastery of knowledge and skills. Wenger and Snyder [3] distinguished communities of practice from other types of groups such as workgroups, project teams, and informal networks based on the answers to questions of purpose, membership, cohesion, and duration. Specifically, communities of practice have the distinction of advancing and exchanging individual and group knowledge by members who choose to participate, focused on a shared domain, collaboration among community members and shared practice [4]. One outcome of practice within a community can be a “communal memory that allows individuals to do their work without needing to know everything” [5, p. 46]. This collaborative generation of community resources results in artifacts that memorialize the knowledge developed by the community to become an historical representation of the evolution and new knowledge generated by the community. Membership is integral to the community and the domain is integral to the membership. Without a voice in the community and a clear connection to members’ interests, goals or expertise, members may not persist in the community [3].

### B. Growth Mindset

Carol Dweck’s [6] seminal book on mindset proposes two mindsets: a growth mindset and a fixed mindset. A growth

mindset posits that intelligence is malleable and can be developed over time and that challenges or failures encountered can be used as a springboard for future successes. Alternatively, a fixed mindset views intelligence and talent as fixed, or in other words, if you are not good at something you will never be good at it, fostering the belief that talent alone is responsible for success. Critical to understanding these concepts are the ideas that mindsets are malleable and that a combination of fixed and growth mindsets can reside within an individual. For example, a person might have a fixed mindset around art with the belief that they are not a good artist and could never be a good artist because they weren’t born with artistic talent. Yet, this same individual might exhibit a growth mindset when it comes to a sport where they see value in practice to enhance and evolve their skills.

Mindset has been researched in the context of STEM disciplines within higher education. Growth mindset research has focused on STEM as a whole [7]–[14] and within a specific area of STEM, such as science [15]–[19], engineering [20]–[22], and technology [23]. Growth mindset has also been considered from multiple perspectives including the student’s mindset [7], [10], [17]–[19], [21], [23], the instructor’s mindset [11]–[13], [16], [20], [22], both the student and instructor’s mindsets [14], and the student’s perception of the instructor’s mindset [8], [9], [15]. Mindset has also been studied in relation to minoritized groups in STEM including women [13] and underserved racial groups [7], [10], [12], [14]. Mindset interventions have largely focused on encouraging a growth mindset in students with the hopes of positively impacting retention, perceptions, and/or performance [10], [17], [18], [23]. Although instructor mindset has been nominally considered, faculty-oriented mindset interventions, particularly in STEM higher education, appear to be lacking. This leaves a gap in developing faculty mindsets with the end goal of defining strategies that faculty can mindfully use to promote a growth mindset in courses and through interactions with students.

## III. GM-FCoP STRUCTURE

### A. Institutional Context and Participants

This innovative practice was conducted in the College of Computing at a four-year private technical university (PTU) in the northeast United States. PTU is a Carnegie-classified Doctoral University and prides itself on undergraduate education, career preparation and research experiences for students. Cooperative education experiences are required for all undergraduate computing students, and research experiences are commonly available. Over 5,100 undergraduate and graduate computing students are enrolled [24]. The 11-member GM-FCoP was composed of seven full-time faculty members from the College of Computing faculty (including tenured and lecturer faculty), one faculty administrator and three adjunct faculty who also serve in staff roles in the college and in the Office of Career Services and Cooperative Education at the university. Two of the full-time faculty members from the College of Computing served as coordinators for the GM-FCoP. Teaching experience ranged from four years to 24 years. The

GM-FCoP served as an important component in an overarching NSF S-STEM project promoting a holistic growth mindset approach for computing students that includes mentoring and augmentations to programming and career development courses. Each GM-FCoP member was instrumental to the overarching project in a role as programming course instructor, co-op/career development instructor, mentor or grant leadership team. The GM-FCoP was designed as a closed, invitation-only community. While Wenger and Snyder [3] promoted that individuals self-select into a CoP, they also acknowledged that it is appropriate to invite individuals to join the community based on the perceived alignment of the individual to the community. The decision for a closed community was made such that participants would be predisposed to an open-minded curriculum revision approach and because the focus of the GM-FCoP needed to serve the college programming I and II courses, the co-op prep courses and mentoring students as part of the overarching grant project. Thus, the community composition aligned with CoP literature emphasizing the advancement and exchange of individual and group knowledge by members who choose to participate, based on a shared domain, collaboration among community members and shared practices [4]. While discussion of curricular augmentations to computing areas outside of these defined courses, as well as outside of the computing domain, would be worthwhile for the college, university, faculty and students, it would likely have detracted focus from the areas defined as part of the overarching project. As such, this study utilized a purposeful sampling approach. In addition to participating in the GM-FCoP to further their growth mindset knowledge and support students, all members of the GM-FCoP agreed to participate in the study via informed consent. Opening the community more broadly to additional domains or establishing a GM-FCoP in a differing university/college such as a small liberal arts college would likely broaden the dialogue, particularly around the individual classroom and student examples presented and discussed. However, as outlined in Section B, meeting plans were “general” in nature and could easily be adapted to any academic area with additional domain specific examples presented based on faculty/community interest, experiences and expertise.

### B. Meeting Plans

To prepare for the semester of GM-FCoP meetings, a high-level vision was developed by the authors who also served as the GM-FCoP coordinators. The plan, seen in Figure 1, emphasized the evolution from learning about the mindsets to considering student perspectives to shifting mindsets to considering the faculty role for the use and creation of tools and then finally to considering course augmentations to integrate growth mindset. This vision informed the GM-FCoP weekly meetings, while allowing for flexibility around community interests.



Fig 1. High-level GM-FCoP Semester-long Plan

The GM-FCoP met via Zoom for one hour every week during the spring 2021 semester. Remote meeting was required during the height of the COVID-19 pandemic, and provided an opportunity for equitable discussion and sharing materials. Community members completed pre-reads from Carol Dweck’s book, *Mindset: The New Psychology of Success* [6] and two growth mindset workbooks by Brock and Hundley [25-26]. Brock and Hundley [25-26] applied concepts from Dweck [6] to provide resources and strategies for educators to not only examine their own mindset, but also to offer opportunities for educators to infuse growth mindset into their pedagogical practices and encourage and foster a growth mindset in their classrooms with their students. Areas of focus include teaching students about fixed and growth mindsets, metacognition, building relationships, types of praise (person and process) and effective feedback, normalizing mistakes, and growth mindset communication and community building with various stakeholders (i.e. students, parents, colleagues, and school leaders). Again, each of these topics was presented in a general manner with examples specific to the computing domain drawn from the expertise of the community members, and is easily adaptable to additional domains and interest areas.

Community members discussed the readings and participated in activities to learn about growth and fixed mindset. Active learning exercises included an icebreaker activity to illustrate mindset, community members reflecting on their own experiences, community members analyzing a pre-recorded faculty-student office hours role play and community members presenting their own views on all content. Readings were selected to provide a balance between learning about key aspects of growth and fixed mindsets and to be considerate of heavy faculty loads, particularly during the height of the pandemic. Most of the 12 sessions were planned and led by the project leadership team serving as coordinators of the community, and after some foundational knowledge around the mindsets was gained by the group, two GM-FCoP members were asked to lead sessions. This invitation for community members to lead sessions further added to the sense of voice in the community as well as connection to the members’ interests and goals. Additionally, while a topic or activity was presented at each meeting, most meeting time was allocated for discussion among the group, further enabling community voice and sharing of interests. The specific topics and readings for the 12 meetings are outlined below. At the end of each meeting the community members were provided with a reflective prompt for their individual Reflective Journal, setup as a private Google Doc that the researchers also had access to, to encourage continued thought and internal integration of session topic. Prompts included questions around student behavior exhibiting fixed and growth mindset, perspectives about changing and influencing mindsets, and using a growth mindset when conversing with others. Meeting notes around key discussion points were recorded by the leadership team in a Google Doc for the entire community and ultimately became artifacts of the knowledge generation and discovery of the community.

*Meeting 1:* After an overview of the GM-FCoP logistics, and high-level plan, the GM-FCoP started with community members watching a video on how to draw an eyeball. Presented as an icebreaker, this active learning exercise was expected to be unfamiliar and uncomfortable for computing and career educators, lending to the growth mindset notion of skill development in contrast with innate skills (fixed mindset). The community facilitators (project leadership) encouraged community members to share their drawing and thoughts, presenting an opportunity to connect their experiences, ideas and emotions to growth and fixed mindset ideas.

*Meeting 2:* The second meeting focused on distinguishing aspects of a growth and fixed mindset. Discussion centered on the consequences of thinking that intelligence and personality is a fixed, deep-seated trait versus something that can be developed.

*Meeting 3:* Upon invitation from the facilitators, this session was led by a community member and presented a series of examples around the growth and fixed mindset concepts of “risk versus effort”. Anecdotes from athletics and other professions, such as a chef, were discussed from Chapter 2 in Dweck [6].

*Meeting 4:* This meeting was led by another GM-FCoP member and focused on malleable mindsets and discussion on the idea that while we may have some fixed mindset attributes, such as seeing other’s success as threatening rather than inspiring and motivating, we can foster a growth mindset over time.

*Meeting 5:* In response to community members’ questions regarding mindset research, facilitators designed this session to present two research papers [12], [23]. The first paper [12], was presented because of its strong citation count, its currency and because it addressed growth and fixed mindset at the intersection of race, stereotype threat and faculty mindset. The second paper [23] was selected again because of a strong citation count, and its focus on computer programming courses. After the study design and key findings were presented to the group, discussion followed with a healthy and robust dialogue around the studies’ contexts and results.

*Meeting 6:* In this meeting, the GM-FCoP examined the students’ perceptions of feedback in the context of a fixed and a growth mindset. The coordinators also introduced a role play video where they portrayed a professor meeting with a student during office hours with fixed and growth mindsets integrated into the dialogue. Prior to the meeting, the role play was recorded and facilitators set specific pause points where GM-FCoP members analyzed the video/office hours session to identify mindset phrases and actions. The community members discussed how the conversation might be redirected toward a more growth mindset approach and in some cases found additional examples of fixed and growth mindset that were not planned by the facilitators.

*Meeting 7:* This meeting focused on promoting a growth mindset with students through a faculty member’s self-talk, feedback, responses to mistakes, metacognition and distinguishing between empathy and shaming. Members considered their own course assignments alongside interactions with students during office hours, hallway talk, academic alerts,

classroom talk and crisis planning. Viewing and dialogue on the faculty-student office hours role play also continued.

*Meeting 8:* This meeting introduced a growth mindset “toolkit” approach (developed by project leadership) for cataloging mindset phrases from student and faculty perspectives. Setup as a spreadsheet, facilitators intended for this “toolkit” to serve as a reference of recorded list of fixed mindset scenarios with growth mindset approaches that faculty could use to address future instructional and mentoring situations. While the facilitators provided the framework and initial examples for the toolkit, the full set of scenarios was developed by the community members.

*Meetings 9 - 11:* These meetings continued with the community members building the toolkit and faculty preparing to put into practice what they learned. Community members’ entries to the toolkit included shaming (fixed mindset) versus empathy (growth mindset), person praise (fixed mindset) versus process praise (growth mindset), and valuing and normalizing mistakes (growth mindset) to name a few, and were categorized as teaching, career instruction or mentoring.

*Meeting 12:* This meeting served as a wrap up; participants completed a final review of the toolkit and discussed future plans for enacting a growth mindset with students in the future.

#### IV. DATA COLLECTION AND METHODS

The innovative GM-FCoP was evaluated using qualitative methods. The qualitative data collected provided formative and summative evaluative inferences. Four community members were interviewed at the end of the semester by external evaluators at the Center for Professional Development and Education Reform at the University of Rochester. Interviewees were purposefully selected because of their instrumental roles in the overarching project. Each confidential and audio-recorded interview was transcribed verbatim. The interview protocol, developed in collaboration with project leadership, asked participants about their understandings of growth mindset and applications of growth mindset in their work. The interviews were analyzed using a modified grounded theory approach [27] to qualitative analysis, applying both existing theoretical frames (communities of practice [2], theories of intelligence [28]–[30], growth mindset [6]) as outlined in Section II, as well as emergent categories and codes using the constant comparative method [31]–[33]. The constant comparative method was appropriate given the established theoretical frames that were considered during the development of the community of practice and which provided an initial lens of theoretical attributes, while also allowing space for additional attributes and themes to emerge.

#### V. RESULTS

During interviews, faculty were able to clearly describe their understandings of growth mindset concepts. In addition to specifically articulating the key ideas and concepts of growth and fixed mindset, faculty were able to describe those ideas and concepts within the context of their own experiences and actions with their classes and students as well as how they were planning to enact more growth mindset actions in the future.

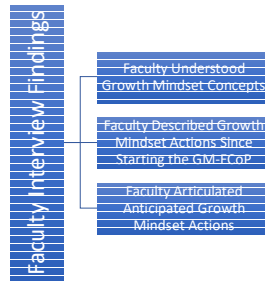


Figure 2. Research Findings Summary

These summary results are highlighted in Figure 2 and examples of each are exemplified in the following sections.

#### A. Faculty Understood Growth Mindset Concepts

Community members were able to accurately describe the ideas around growth mindset using their own words. For example, one member described, “I guess for me I would say that it's a way of approaching learning where we look at what makes somebody good at the thing that they're trying to learn, and sort of defining what, what does success in this area, look like for you. And then what is the effort, or the frame of mind, or the perspective that that person is going to use to get there.” They continued on to offer, “... it's very evident in the way that people deal with challenges [that they] have a fixed mindset or a growth mindset and so what are the, you know, the characteristics of somebody with a growth mindset? In terms of how they deal with challenges, [they] would be somebody who looks at failure as an opportunity to get better, to see progress towards their goals and then to realize their goals.”

#### B. Faculty Described Growth Mindset Actions Since Starting the GM-FCoP

Community members also exhibited their understandings of mindset by identifying current and past experiences they'd had with students who demonstrated both growth and fixed mindsets as well as steps they took to try to shift students to more of a growth mindset. These actions included providing more encouraging feedback to students, providing opportunities to resubmit work, reframing failure, and teaching that mistakes are learning experiences. Faculty specifically described how they had shifted their conversations and practices in working with students since starting the GM-FCoP. In describing a student who regularly visits during office hours, a community member offered, “I suddenly became aware that he is just absolutely terrified of failure. He doesn't ever want to be wrong. And so I said, ‘Okay, this assignment is really low stakes it doesn't have a big impact on your grade. So I'm going to do an example and now you have to go back and this is this process you'd have to go through. You have to do it on your own. I'm not going to step you through every problem...’” They continued on to describe this as preparation for the workforce where the student would have to be working on their own, “I had to teach him, I think, something different, which was not to be so terrified of making a mistake... the idea is to practice and learn from your mistakes; but to not make them at all [and] to stop the minute you don't understand something means you didn't even try.”

One member described shifting their instructional approach to allow for assignment resubmission. They described a student's office hour visit that revealed the true source of a problem with an assignment, “I realized in my interaction with her that it wasn't so much the assignment that gave her difficulty but you didn't know how to troubleshoot the problem. And so what I did was I spent some time going over ... early questions in the assignment and explaining to her how she could interpret the error messages she was getting. ... I then told her, I said, ‘Now, I want you to take the rest of the assignment, and I want you to fix it and turn it back in again, no regrets.’” In an effort to normalize failure, another community member described, “one thing I do in my class is, I have a student panel, and I'm very specific about the students that I asked to be on the panel, ... I always ask students who struggled with the job search to be on the panel.”

#### C. Faculty Articulated Anticipated Growth Mindset Actions

Some faculty related their current and past growth mindset interactions with students with their plans for augmenting growth mindset in the future. When describing how they discuss assignments with students, one GM-FCoP member articulated, “I always put [out that] if somebody didn't do well so you know please see me. Right. But I think they're taking that as criticism rather than I want to help you. So I'm trying to figure out another way to word that so that it doesn't come across as ‘I'm out to get you’, right, and rather it's ‘I'd like to help you understand why you didn't do this well’”. All members spoke about what they planned to do as a result of the GM-FCoP. These anticipated actions centered around interactions with students or revising or planning instructional strategies that foster a growth mindset in students. One community member described that rather than simply deducting points for mistakes, they planned on giving more detailed feedback by writing things like, “interesting that you chose that; I might have chosen this.” They also suggested that in the future when students are presenting on their projects, they would have students include “what did they learn [and] what [they] would do different[ly] - that type of stuff.”

## VI. DISCUSSION

Wenger, McDermott, and Snyder [34] specified seven principles for cultivating communities of practice: 1) design for evolution, 2) open a dialogue between inside and outside perspectives, 3) invite different levels of participation, 4) develop both public and private community spaces, 5) focus on value, 6) combine familiarity and excitement, and 7) create a rhythm for the community. These points provide a framework for examining the GM-FCoP data findings and are contextualized alongside researcher reflections.

#### A. Design for Evolution

Aligned with Lave and Wenger's [2] concept of legitimate peripheral participation the “leaders” of the GM-CoP focused on advancing the “apprentices” knowledge about growth and fixed mindsets and as their knowledge grew, it appeared to the coordinators that members learned from each other through discussions and generating artifacts like the “toolkit” as legitimate peripheral participation. Leadership encouraged the

GM-CoP members to utilize many of the activities proposed by Etienne and Beverly Wenger-Trayner [4] including problem solving, seeking feedback about past experiences, growing confidence, and discussing new ideas, which work towards advancing the shared knowledge of the community. As the semester progressed, the coordinators' roles shifted from educating to facilitating learning. The semester plan in Figure 1 allowed for this evolution that was exemplified with the addition of reviewing growth mindset research and several sessions devoted to the role play analysis, with extended discussion driven by the community members. It was also seen in the participant interviews after the conclusion of the GM-FCoP, where members indicated future actions they would put into place. This demonstrated a significant shift from the beginning of the semester, where community members indicated their tendency to embrace a growth mindset during initial conversations with project leadership regarding their participation (and hence the reason for their invitation to the GM-FCoP) but were not able to articulate specific attributes or actions or dialogue to enact a growth mindset in the classroom or with students. Indeed, by the end of the semester faculty were able to express their ideas and plans for this. One member specifically indicated that since they were part of the GM-FCoP, they had shifted toward working through identifying the source of a problem area with students. They indicated understanding and emphasis of "process praise" as part of enacting a growth mindset when they offered that they had "been trying to ask more guiding types of questions, and really trying to understand where [students'] difficulty is and making sure that I'm doing the appropriate problem, what I call problem source identification. No, it's not just explaining this concept to them. But, oh, you mean you don't understand how to convert from binary to decimal; oh that's the problem, okay so let's go, let's step back to that. ... and they think, 'I just can't do this.' Well, no, let's go back and so, trying to identify what the source of the problem is and then guiding them forward from there."

### *B. Dialogue Between Perspectives*

Maintaining an open dialog between perspectives was respected and valued. The coordinators understood that the GM-FCoP members were at different levels of experience and understanding around mindsets. Facilitating a safe space for community members to share and reflect on their own mindsets was critical and aligns with Preece's [35] discussion of etiquette, empathy, and trust within CoPs. In fact, many members openly disclosed examples of their own struggles and challenges with having a fixed mindset along with ideas on how to shift their actions toward a more growth-mindset approach. For example, in their Reflective Journal, one member described a memorable and shocking grade-school failure at a spelling bee when a higher accomplishment was expected. They disclosed that this fixed mindset experience where skill-level was considered innate rather than developed, impacted their outlook on learning through high school.

During every meeting, the facilitators invited open dialogue among the community members, intentionally allowing space for each member to contribute without single members dominating the conversation. Often a presentation or a Google

Doc was presented with blank spaces for community members to add their own thoughts or for facilitators to add notes from the discussion, reflecting the community members' ideas, examples and key points. By encouraging dialogue between perspectives, the facilitators enabled space for differing viewpoints and skepticism. For example, some community members expressed initial skepticism around the mindset work described in Dweck [6] because the writing was not presented according to traditional scholarly conventions. The coordinators attempted to address this skepticism by presenting scholarly research [12], [23] while maintaining a focus on the overarching aspects of enacting a growth mindset with students.

### *C. Differing Levels of Participation*

Wenger, McDermott, and Snyder [34] identified differing participation levels including coordinator, core, active, and peripheral, and each was observed in the GM-FCoP. The coordinators were responsible for organizing meetings, delivering content and leading and moderating most discussions. Member's participation levels varied based on work responsibilities with some members more active and engaged than others. Two community members led sessions, which proved extremely valuable as they guided a discussion from their own lens, perspectives and interpretations of the readings. Most community members engaged as core or active members and regularly attended meetings, prepared readings and expressed their interest and appreciation for the thoughtful and engaging dialogue, while a few members remained on the periphery due to schedule constraints. Ultimately, it was left to each individual member to determine their level of participation within the community. Indeed, most meetings ran until the very end of the allotted hour because community members were so enthusiastic to share their insights and perspectives on the discussion points. The faculty role-play analysis, which was intended for one meeting, spanned across two meetings and easily could have continued into a third. While time was planned for community members to write in their Reflective Journals at the end of every meeting, this time was often sacrificed to continue the rich and enthusiastic discussion among the group. As a result, while the quantity of the reflections was limited, the quality of the reflections indicated evolving and deepening understandings around mindsets.

### *D. Community Spaces*

In order to facilitate shared learning and personal reflection, the coordinators included both public and private community spaces as part of the GM-FCoP. Weekly meetings were open to all community members to encourage discussions and open sharing of ideas. A personal Reflection Journal, setup as a Google Doc, provided each community member a private space to share their reflections and responses to the prompts at the end of each meeting. Notes and meeting recordings were made available to participants for review, as needed. All artifacts generated by the group were also made available to community members for future reference.

### *E. Value*

The GM-FCoP value centered on providing a collaborative learning and development experience for community members to advance their knowledge and application of growth mindset. Doing this as a CoP, with colleagues in a safe environment,

allowed faculty to engage in a way they were comfortable with, co-create artifacts that memorialized the knowledge of the group, and consider how they could apply and promote growth mindset in their courses and in their interactions with students. More specifically, faculty focused on augmenting programming and career courses as well as strengthening growth mindset approaches used in student mentoring. This aligns with the characteristics of a community of practice [4] that focus on a shared domain, in this case growth mindset, and where regular collaboration results in shared learning and practice alongside the developing shared resources and artifacts. To this end, the collaborative generation of community resources, such as the Catalog of Growth Mindset Approaches (toolkit), resulted in artifacts that memorialized the knowledge developed by the community. Twenty-seven distinct ideas were recorded in the toolkit by nine of the 11 community members. This shared resource served as a means for GM-FCoP members to articulate their understandings of growth mindset, and it continues to serve as a resource for members to reference after the conclusion of the community. As outlined by Wenger, this collaborative resource creation became a communal memory [5].

Community members also indicated value when expressing their developed understandings of growth mindset as well as their evolved classroom practices. One member accurately described growth mindset using their own words as “the opportunity to influence students to have greater belief in their capability to learn.” Another community member described growth mindset as, “kind of like trying to remove that negative self-defeating attitude, where I can't do this, I'll never learn this, to become more of something like, hey, I'd like to try this.” When describing their plans for allowing assignment revisions, the faculty member who recognized the true source of a problem area during an office hour visit with one student, later opened the resubmission opportunity to other students in the class. The faculty/community member reported that two of four eligible students corrected and resubmitted the assignment; “And so, I felt that was a great learning experience for them rather than just walking away in defeat, saying, ‘I blew that assignment.’”

#### *F. Familiarity and Excitement*

The design of the GM-FCoP combined familiarity and excitement. Many of the community members knew each other, thus creating a sense of comfort and familiarity. Excitement was woven into the meetings through thought-provoking discussion questions and activities that took the members out of their comfort-zone (eyeball drawing). The office hours role-playing video analysis appeared to be particularly engaging for the community, generating extensive dialogue along with ideas to promote stronger growth mindset interactions with students. All of this enabled the community members to apply in real-time what they were learning throughout the semester.

#### *G. Rhythm*

Rhythm for the community was established with weekly meetings and consistent structure that included an activity or reading, discussion and a reflection prompt to foster deep internalization of the topics. Community members embraced this approach and arrived prepared and ready to engage in respectful and open dialogue.

## VII. LESSONS LEARNED AND LOOKING FORWARD - VIEWS FROM THE COMMUNITY LEADERS

The GM-FCoP was effective in enhancing faculty understandings of growth mindset as well as supporting them in identifying future actions for augmenting their classes and interactions with students. Accomplishing this through a community of practice served as an innovative practice as faculty were able to develop their understandings and future actions while part of a community that embraced the seven community principles as outlined by Wenger, McDermott, and Snyder [34]. Yet, despite this positive result from the community, leader reflections yield a series of lessons learned and thoughts on moving forward that may provide others with insights in considering their own communities of practice.

### *A. Lessons Learned*

*Extend Weekly Meetings/Times.* The weekly meetings were structured around readings and served as an effective means to learn about growth mindset. Community members were engaged and reflected on both their personal life and professional academic experiences in the context of mindset. They shared stories about their childhood, relationships and experiences in their classes that demonstrated deep understandings of the content. This sharing was exceptionally positive as it enabled community members space to process the topics and learn some of the nuanced aspects around growth and fixed mindset, such as the idea that not all praise is effective when striving for progress. In fact, the community members were so eager to share their thoughts and experiences, that it was sometimes challenging to ensure everyone had an equal space during the meeting times. In this same sense, this energy and passion led to limited writings in the Reflective Journals. While the facilitators intentionally invited open dialogue during meetings, it often meant that some topics were left underdiscussed. Additional meetings or extending topics to multiple meetings could be considered for the future planning, especially if reflective journaling is considered a priority.

*Extend the Role Play Activity.* Some of the most lively discussion centered on the faculty-student role play that was recorded by the GM-FCoP leaders. In this role play, one leader portrayed a student visiting a faculty member's office hours. The second leader played the faculty member. Using a script that emphasized growth and fixed mindset statements from both the student and the professor, the role play focused on approaches toward improving exam grades, and could be applied to any domain. The community members were exceptionally enthusiastic about the role play and eager to continue discussion beyond the allotted time. Community members also discovered and called out fixed mindset dialogue that was unplanned in the role play, further emphasizing their understandings and learning among all members of the community, including the leaders. Upon reflection, this activity was exceptionally worthwhile for and well-received by the community. Community members were actively engaged in listening to and reframing the dialogue from a fixed mindset toward a growth mindset and extending the attention on the role play would have been time well spent. Additional activities around role play could include the

community members writing and enacting their own role plays while taking on differing roles among the group and focusing on specific fixed and growth mindset characteristics.

**Address Skepticism.** One meeting was structured to address skepticism about growth mindset. Presenting research on the topic and demonstrating the effectiveness of integrating a growth mindset into curriculum and classroom work appeared to be worthwhile and effective for most members.

**Recognize the Importance of the Toolkit.** Actively engaging community members in developing the “toolkit” was critical to understanding ways in which growth mindset could be enacted in academia. Providing the community with a space to write down their ideas categorized by course activities, projects, classroom dialogue and mentoring conversations with students. Using the toolkit as a meeting activity provided the focus that was needed to think about each of these areas and for each community member to present ideas through their own lens. This type of activity where community members took ownership of the artifact being produced as well as providing something tangible that could later be referred back to was an important component of the community, and a similar artifact or outcome should be considered for future communities.

**Use Coordination to Enable Momentum.** Although traditional CoPs may not include a coordinator, it was helpful to the GM-FCoP. The planning and development performed by the coordinators allowed the community to gain momentum faster than if the group self-organized, and the coordinators were able to focus the group until community members gained core growth mindset knowledge and competencies.

### *B. Looking Forward*

The concept of a GM-FCoP can be applied across many contexts and settings to promote personal and professional development, including mental and physical health, sports, interpersonal relationships, as well as career performance and advancement. In fact, the approach outlined through this GM-FCoP was general in nature and could be applied to a multitude of domains. Discussions, rather than meeting topics, focused on the computing domain and could easily be modified to address other domains. Etienne and Beverly Wenger-Trayner [4] report communities of practice appearing within various settings including organizations, associations, government, and online.

Creating a GM-FCoP as an ongoing, university-wide community of educators has exciting possibilities and some challenges. Using an open membership, as promoted by Wenger and Snyder [3], would potentially allow for a diverse group related to growth mindset knowledge and experience, which could result in rich discussions and knowledge generation across domains and experiences. Allowing fluid participation within the community would help to ensure that members are present because they want to be, which could in turn increase involvement and engagement allowing a core group to form, while also allowing peripheral participation. In contrast, fluid participation could create a challenge in continually having to bring new community members up to speed on growth mindset and community activities. How this “onboarding” of new members is done would be critical to creating a welcoming and non-intimidating environment for new members. Thus,

promoting a culture of shared learning is critical and at the core of a community of practice.

Regardless of the domain, the content and structure designed and developed for this GM-FCoP is adaptable. For example, the content and structure could be utilized as a starting point for communities of practice focused on differing audiences including students, administrators, advisors, mentors, and teaching assistants. The content could also be adapted for more discrete experiences such as workshops or training sessions, allowing for more punctuated learning experiences. In this grant project, the GM-FCoP served as a foundation for faculty to be mentors for incoming students who are part of a scholarship program, thus members’ roles shifted from community member to student mentor. As such, the mentors continued to meet throughout the following year and the GM-FCoP evolved to a growth mindset mentoring community of practice. Additional faculty were added to the community as more mentors were needed and as roles shifted. Data collection also continued and evolved to better understand mentors’ perceptions of the community as well as students’ understandings and experiences of being mentored with a growth mindset framework. Findings from these data collections and analyses will be forthcoming with expectations that growth mindset best practices may be developed and applied for both new and experienced computing faculty who serve as formal and informal mentors to students.

## VIII. CONCLUSION

In many ways the innovative integration of growth mindset in computing to form the GM-FCoP exceeded the expectations of the coordinators. The design and implementation of the community fostered shared learning that deepened faculty understandings of fixed and growth mindset. This was demonstrated in community members’ interviews and descriptions of growth mindset understandings and plans for future actions. The collaboration in knowledge generation resulted in artifacts that remain available to community members for future reference. Members shared their perspectives and opinions while moving through the learning process together. The approaches and experiences shared by the community members offered encouragement and support for others to explore how they can foster a growth mindset in the courses they teach and in their interactions with students.

A limitation of the GM-FCoP is that it was not an open community. However, this enabled a focus on the computing domain that served the goals of the overarching project. Future efforts could include a university-wide GM-FCoP open to a broad spectrum of individuals and domains, yielding a more diverse group in terms of mindset. Regardless, this innovative practice of a semi-structured growth mindset community of practice can serve as a model for faculty in any domain, yielding positive results in deepening mindset understandings, planned activities, mentoring and faculty-student interactions.

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## REFERENCES

- [1] Y. Steinert, "Faculty development: From workshops to communities of practice," *Med. Teach.*, vol. 32, no. 5, pp. 425–428, May 2010, doi: 10.3109/01421591003677897.
- [2] J. Lave and E. Wenger, "Situated learning: Legitimate peripheral participation." Cambridge university press, 1991.
- [3] E. C. Wenger and W. M. Snyder, "Communities of Practice: The Organizational Frontier," *Harvard Business Review*, Jan. 01, 2000. Accessed: Mar. 10, 2022. [Online]. Available: <https://hbr.org/2000/01/communities-of-practice-the-organizational-frontier>
- [4] E. Wenger-Trayner and B. Wenger-Trayner, "Introduction to communities of practice," 2015. <https://wenger-trayner.com/introduction-to-communities-of-practice/> (accessed Mar. 17, 2022).
- [5] E. Wenger, *Communities of Practice: Learning, Meaning, and Identity*, 1st edition. Cambridge: Cambridge University Press, 1999.
- [6] C. S. Dweck, "Mindset: The new psychology of success." Random House Digital, Inc., 2008.
- [7] C. Wang *et al.*, "A Framework of College Student Buy-in to Evidence-Based Teaching Practices in STEM: The Roles of Trust and Growth Mindset," *CBE—Life Sci. Educ.*, vol. 20, no. 4, p. ar54, Dec. 2021, doi: 10.1187/cbe.20-08-0185.
- [8] K. Muenks *et al.*, "Does my professor think my ability can change? Students' perceptions of their STEM professors' mindset beliefs predict their psychological vulnerability, engagement, and performance in class," *J. Exp. Psychol. Gen.*, vol. 149, no. 11, pp. 2119–2144, Nov. 2020, doi: <http://dx.doi.org.ezproxy.rit.edu/10.1037/xge0000763>.
- [9] M. A. Fuesting, A. B. Diekmann, K. L. Boucher, M. C. Murphy, D. L. Manson, and B. L. Safer, "Growing STEM: Perceived faculty mindset as an indicator of communal affordances in STEM," *J. Pers. Soc. Psychol.*, vol. 117, no. 2, pp. 260–281, Aug. 2019, doi: <http://dx.doi.org.ezproxy.rit.edu/10.1037/pspa0000154>.
- [10] A. Lisberg and B. Woods, "Mentorship, Mindset and Learning Strategies: An Integrative Approach to Increasing Underrepresented Minority Student Retention in a Stem Undergraduate Program," *J. STEM Educ. Innov. Res.*, vol. 19, no. 3, pp. 14–20, Aug. 2018.
- [11] D. S. Richardson, R. S. Bledsoe, and Z. Cortez, "Mindset, Motivation, and Teaching Practice: Psychology Applied to Understanding Teaching and Learning in STEM Disciplines," *CBE—Life Sci. Educ.*, vol. 19, no. 3, p. ar46, Sep. 2020, doi: 10.1187/cbe.19-11-0238.
- [12] E. A. Canning, K. Muenks, D. J. Green, and M. C. Murphy, "STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes," *Science advances*, vol. 5, no. 2, p. eaau4734, 2019.
- [13] J. LaCrosse, M. C. Murphy, J. A. Garcia, and S. Zirkel, "The role of STEM professors' mindset beliefs on students' anticipated psychological experiences and course interest," *J. Educ. Psychol.*, vol. 113, no. 5, pp. 949–971, Jul. 2021, doi: <http://dx.doi.org.ezproxy.rit.edu/10.1037/edu0000620>.
- [14] A. Rattan, K. Savani, M. Komaraju, M. M. Morrison, C. Boggs, and N. Ambady, "Meta-lay theories of scientific potential drive underrepresented students' sense of belonging to science, technology, engineering, and mathematics (STEM)," *J. Pers. Soc. Psychol.*, vol. 115, no. 1, pp. 54–75, Jul. 2018, doi: <http://dx.doi.org/10.1037/pspi0000130>.
- [15] K. Muenks, V. X. Yan, N. R. Woodward, and S. E. Frey, "Elaborative learning practices are associated with perceived faculty growth mindset in undergraduate science classrooms," *Learn. Individ. Differ.*, vol. 92, p. 102088, Dec. 2021, doi: 10.1016/j.lindif.2021.102088.
- [16] R. E. Scherr, "Fixed and growth mindsets in physics graduate admissions," *Phys. Rev. Phys. Educ. Res.*, vol. 13, no. 2, Dec. 2017, doi: <http://dx.doi.org.ezproxy.rit.edu/10.1103/PhysRevPhysEducRes.13.020133>.
- [17] H. B. Miller and M. C. Srougi, "Growth mindset interventions improve academic performance but not mindset in biochemistry," *Biochem. Mol. Biol. Educ.*, vol. 49, no. 5, pp. 748–757, Sep. 2021, doi: 10.1002/bmb.21556.
- [18] Y. Wang, G. A. Rocabado, J. E. Lewis, and S. E. Lewis, "Prompts to Promote Success: Evaluating Utility Value and Growth Mindset Interventions on General Chemistry Students' Attitude and Academic Performance," *J. Chem. Educ.*, vol. 98, no. 5, pp. 1476–1488, May 2021, doi: 10.1021/acs.jchemed.0c01497.
- [19] A. J. Cavanagh, X. Chen, M. Bathgate, J. Frederick, D. I. Hanauer, and M. J. Graham, "Trust, Growth Mindset, and Student Commitment to Active Learning in a College Science Course," *CBE Life Sci. Educ.*, vol. 17, no. 1, p. ar10, 2018, doi: 10.1187/cbe.17-06-0107.
- [20] F. Brown and K. Cross, "Engineering Faculty's Mindset and The Impact on Instructional Practices," in *2020 IEEE Frontiers in Education Conference (FIE)*, Oct. 2020, pp. 1–5. doi: 10.1109/FIE44824.2020.9274185.
- [21] G. S. Stump, J. Husman, and M. Corby, "Engineering Students' Intelligence Beliefs and Learning," *J. Eng. Educ.*, vol. 103, no. 3, pp. 369–387, Jul. 2014.
- [22] F. Brown and K. Cross, "Engineering Faculty's Mindset: An Analysis of Instructional Practice, Learning Environment, and Teacher Authenticity," in *2019 IEEE Frontiers in Education Conference (FIE)*, Oct. 2019, pp. 1–4. doi: 10.1109/FIE43999.2019.9028524.
- [23] Q. Cutts, E. Cutts, S. Draper, P. O'Donnell, and P. Saffrey, "Manipulating mindset to positively influence introductory programming performance," *Proceedings of the 41st ACM technical symposium on Computer science education*. pp. 431–435.
- [24] Rochester Institute of Technology, "Overview | Golisano College of Computing and Information Sciences | RIT." <https://www.rit.edu/computing/overview> (accessed Mar. 24, 2022).
- [25] A. Brock and H. Hundley, *The Growth Mindset Playbook: A Teacher's Guide to Promoting Student Success*. Berkeley, CA: Ulysses Press, 2017.
- [26] A. Brock and H. Hundley, *In Other Words: Phrases for Growth Mindset: A Teacher's Guide to Empowering Students through Effective Praise and Feedback*, Teachers Guide edition. Berkeley, CA: Ulysses Press, 2018.
- [27] B. G. Glaser and A. L. Strauss, "Discovery of grounded theory: Strategies for qualitative research." Routledge, 2017.
- [28] L. S. Blackwell, K. H. Trzesniewski, and C. S. Dweck, "Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention," *Child development*, vol. 78, no. 1, pp. 246–263, 2007.
- [29] C. S. Dweck and E. L. Leggett, "A social-cognitive approach to motivation and personality," *Psychological review*, vol. 95, no. 2, p. 256, 1988.
- [30] K. De Castella and D. Byrne, "My intelligence may be more malleable than yours: The revised implicit theories of intelligence (self-theory) scale is a better predictor of achievement, motivation, and student disengagement," *European Journal of Psychology of Education*, vol. 30, no. 3, pp. 245–267, 2015.
- [31] J. B. Bavelas, C. Kenwood, and B. Phillips, "Discourse analysis," *Handbook of interpersonal communication*, vol. 3, pp. 102–129, 2002.
- [32] J. Creswell, "W.(1998)," *Qualitative inquiry and research design: Choosing among five traditions*, vol. 2. 1998.
- [33] B. G. Glaser and J. Holton, "Remodeling grounded theory," *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, vol. 5.
- [34] E. Wenger, R. McDermott, and W. M. Snyder, *Cultivating Communities of Practice*, 1st edition. Boston, Mass: Harvard Business Review Press, 2002.
- [35] J. Preece, "Etiquette, Empathy and Trust in Communities of Practice: Stepping-Stones to Social Capital," *J. Univers. Comput. Sci.*, vol. 10, no. 3, pp. 294–302, doi: 10.3217/JUCS-010-03-0294.