

WIP: Developing Career Adaptability Skills Through Teaching: Undergraduate Student Development for Transforming Careers

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Abstract—This work-in-progress (WIP) innovative practice paper focuses on skills developed by student instructional team members working in peer instruction in computing. Research has shown that peer instruction models such as supplemental instruction (SI) support computer science student learning and peer community building while extending the reach of the instructional team. SI participants achieve higher grades and experience greater retention rates in the STEM majors than their non-participating peers, an impact that can extend beyond the initial supplemental instruction semester. While benefits for Supplemental Instruction learners are well documented, the program's effect on the leaders is not well documented. Supplemental Instruction leaders receive training, mentoring, and peer guidance in developing teaching practices that meet students' needs. Unlike lecture-based instruction, supplemental instruction at Kean University involves modeling, guided problem-solving, and interaction with learners in small groups. Students who attend supplemental instruction may arrive with specific questions or academic needs that must be addressed to support further learning of the subject matter, making SI sessions spaces for improvisation and adaptive teaching. The authors contend that leading supplemental instruction sessions for computer science first and second-semester coursework allows leaders to develop flexible communication practices and career adaptability skills, which are vital "soft skills" for career development. Research indicates that career adaptability leads to stronger employment outcomes, such as wages, job satisfaction, and workplace engagement. This work-in-progress paper draws on career development, entrepreneurial mindset research, and social science research on improvisation. The paper makes inferences regarding the apprenticeship and guidance practices that support adaptive thinking and improvisation in SI at Kean University, and develops recommendations for faculty and staff who lead peer instruction efforts in engineering and/or computing departments. Innovations in this paper include considering how SI leaders develop career adaptability in their work, which can support leader recruitment and lead to new mechanisms for improving SI leader performance.

Keywords—peer instruction (7.e.4), problem-based learning (7.e.viii), entrepreneurship (8.j), leadership (8.o), careers (9.a.) (key words)

I. INTRODUCTION

This work-in-progress (WIP) innovative practice paper focuses on skills developed by student instructional team members working in peer instruction in computing. As part of a multi-year project to improve student persistence in introductory

computing classes, students enrolled in the initial sequence of three computer science courses (CS0/CS1/CS2) are offered Supplemental Instruction (SI) Workshops weekly during the academic year to integrate coursework. These enrichment workshops reinforce lectures by providing additional problem-solving experiences and encourage students to discuss their solutions and problem-solving approaches. Led by peer SI Leaders, these SI experiences follow scheduled classroom lab sessions to encourage attendance and easy transition. Supplemental Instruction leaders receive training, mentoring, and peer guidance in developing teaching practices that meet students' needs. The authors contend that leading supplemental instruction sessions for computer science first and second-semester coursework allows leaders to develop flexible communication practices and adaptive thinking skills, which are vital "soft skills" for career development.

II. LITERATURE REVIEW

As computer science (CS) job markets contract, it is more important than ever that CS graduates develop skillsets beyond the technical competencies taught explicitly in the classroom. Adaptability, or the ability to be flexible and adjust to changing factors, conditions or environments[1], [2] is increasingly sought by employers who hope their employees can strategize, make good decisions in uncertainty, and respond to unexpected events [1], [2]. Studies indicate organizations with adaptive, improvisational employees are better poised to handle emergency situations, in which “*knowledge (is) collectively recombined, re-created, and reconstituted in real time.*”[3]”

Workplace studies indicate that employees who can improvise, make plans, and execute those plans concurrently—make difficult decisions in situations of complexity, and try new problem-solving approaches dynamically [4]. Improvisation is a set of behaviors with a research base in music [5], [6], education, and in public sector fields[7], yet investigations regarding how adaptive skills are developed form a gap in the literature—these behaviors relate to the concept of career adaptability which we use in this study to consider how a person “self regulates resources to solve unfamiliar and complex problems arising from vocational tasks” [4]. A related concept, career adaptability, is vital to positive career trajectories [8]. Research indicates students who can respond with flexibility to workplace problems and can navigate volatile situations are valued in the job market [9], [10].

While knowledge about student career adaptability during teaching experiences is relatively unknown, There is evidence that SI leaders gain stronger relationships with faculty, better academic knowledge in their field, greater confidence regarding their knowledge, and appreciation for collaborative learning in their work supporting their peers' learning of their undergraduate course material [11], [12]. The larger study of the Supplemental Instruction program at Kean University investigates these leader benefits in greater detail. This work-in-progress paper explores a theme regarding SI leaders and their development of improvisational practices while serving as peer instructors in CS.

III. CONTEXT OF THE PROGRAM SUPPORTING STUDENT PROFESSIONAL SKILL DEVELOPMENT

The project by which the Supplemental Instruction Program falls under is the “Building Capacity: Pathway to Success for Students and Faculty in Computing.” The project and its grant began in the 2019-2020 school year and is now in its 5th year. The project's main goals were to increase student retention and success in the preliminary computer science courses (CS0/CS1/CS2). Some methods used to reach these goals include training faculty on growth mindset and revising the curriculum of the preliminary CS courses to encourage more computational thinking. The methods highlighted in this paper are Supplemental Instruction practices and structures that support leader development of improvisation and adaptability.

Supplemental Instruction Workshops are one of the methods by which the project's goals are accomplished. SI workshops are instructional sessions where SI leaders review material the student learned in class. SI leaders are previous students of the CS0, CS1, and CS2 courses who earned good grades and understood the material in detail. In these sessions, students can ask questions as they pertain to what they have learned in class, do bonus problems that will assist with their understanding of homework and test materials, and brush up on concepts they may have struggled to grasp at first pass. Previous research has shown that students who attend SI sessions do better in their classes, stick to the major longer, and understand the material better [13] While the benefits of Supplemental Instruction Workshops are well documented for the students, the benefits for SI leaders have minimal research.

By finding a gap in knowledge about the processes that made SI successful for the project, questions began to arise about what traits make an SI leader effective, and what can be done to make them even more effective, as well as how participating as a leader might influence leader outcomes. At a glance, it is known that teachers of any subject must be able to communicate to students and be knowledgeable in the topic they are teaching. That prompted two debrief sessions with SI leaders, where they were asked questions about the program to discover some of these unknown traits and ways that the SI leader experience could be improved. This work is part of a larger study seeking to improve SI locally and to make broader recommendations regarding SI effective practices.

A theme emerged from the dataset regarding how leading supplemental instruction increased leader adaptive and improvisational skill. This paper addresses the following

question: **RQ:** *In what ways do SI leaders exhibit and describe adaptability in their work with peers?*

IV. METHODS

This paper is part of a larger case study of Kean University use of Supplemental Instruction in the computer science department. The study began in 2020, and has involved the following data sources:

- Longitudinal course outcome data at the individual level, spanning 4 years of course taking including SI attendance documentation and individual demographic variables (this data was deidentified at the time of data analysis)
- Approximately 20 hours of observation data from Supplemental Instruction sessions held at Kean, along with 5 hours of “off schedule” observations of the SI learning space;
- Focus groups with SI instructors at three time points during the grant; participants ranged from 3 to 7 individuals;
- Surveys in fall 2020 and fall 2022 documenting SI student perceived benefits and barriers to participation in supplemental instruction.

This paper builds a case for the development of skills related to career adaptability primarily based on qualitative findings from a focus group of Supplemental Instruction Leaders. Findings are triangulated with an additional data source, formal observations of SI sessions. This paper provides evidence of the SI leaders' perceived development of career adaptability through Supplemental Instruction teaching, and identifies elements of the SI teaching and learning contexts that may lead to opportunity to develop career adaptability in SI at Kean University.

Evidence from formal observations of SI are documented using a supplemental instruction rubric developed based on the tenets of supplemental instruction, specifically: a) SI Sessions are peer facilitated, b) SI leader serves as a model student, c) SI Sessions integrate content and learning skills and d) SI sessions develop small communities of learners. Author four completed the observations and detailed the results in table form. Author four is a learning scientist by training, and has twenty years of experience documenting efficacy of teaching and learning environments in K-20 formal and informal settings. Four sessions in fall 2023 and spring 2024 were observed and documented using the rubric.

A non-formal meeting was arranged with the Supplemental Instructors (SI), during which they were asked a series of pre-written questions concerning their experiences as SIs for the Fall 2023 semester. These questions like “*What did you learn to do better as an SI during your time as an SI Kean?*” and “*What are you currently doing to facilitate student interactions, and how can they be improved?*”. The questionnaire had 17 questions and involved two female and four male participants, with three SIs from CS0 and three from CS1. Participants consented to participate. The 90-minute debriefing had four participants in person and two via Zoom. The questions provided a

comprehensive framework for examining the dynamics of SI leadership and associated success factors, including the benefits students derive from being an SI leader, the impact of institutional support on SI, the role of resources in facilitating SI, strategies for achieving SI goals, and the influence of departmental support on SI outcomes. This paper is part of a broader study on Supplemental Instruction's impact on students, which collects formative data for continuous improvement.

Transcripts were developed using Otter.ai and Rev.com online services, reviewed, and then merged into a unified document, segmented to map questions to their corresponding responses. The segments were then organized into distinct categories.

TABLE I. CODES 1 AND 4 ADDRESS SI LEADER BEHAVIORS

Code		P01	P02	P03	P04	P05	P06
1	Benefits of being an SI	5	2	3	2	3	4
4	Strategies for SIs	21	18	10	8	7	2

This paper focuses on the inductive coding[14] elements of adaptability and improvisation evident in the data from Codes 1 - *Benefits of being an SI*, and 4 - *Strategies* (Table I). Darker cell shades in the table signify a higher frequency of responses from the indicated participants (P01-P06). In the case of the “benefits of being an SI” code, participants described how the experience served as a professional learning experience for them, and in the case of “strategies for SIs,” the leaders indicated the actions they performed in service of SI sessions. We viewed both types of responses as vital for building a case for career adaptability, as the former indicates the leaders perceive the experience as improving their professional capabilities, and the latter provide examples of leaders’ career adaptability within the SI sessions.

V. INITIAL RESULTS

The table below summarizes observational data related to SI sessions observed by an external member of the writing team. Scores range from 0-2, with 0 indicating the theme was not evident, 1 indicating some evidence, 2 indicating good evidence of the theme. Themes are based on the major tenets of SI as it was developed in the early 1990s in the midwest United States.

Element of SI	Rating across four observations (0-2)	Summary of observable behaviors related to the element
Sessions are Peer Facilitated	2,2,2,2	Leaders bring materials and lesson plans in written and digital forms; leaders directly request participant interaction with one another and with the leader; leaders facilitate based on feedback from participants regarding current progress in course curriculum, and improvise based on student stated needs.
Leaders serve as model students	2,1,2,1	Leaders describe interactions with shared faculty, describe struggles and successes in departmental courses and activities, leaders model problem solving approaches on the white board—for example, they may

		complete the first exercise aloud with participants observing their work.
Integrate content and learning skills	1,2,1,2	As leaders solve problems in front of their participants, they “think aloud,” demonstrating a key skill for metacognition. Leaders also request that participants complete activities such as building consensus with a partner, explaining steps required to complete a coding problem or translation, and creating their own “KWL” reflection based on their experience of the SI session.
Leaders build a sense of community	2,2,na,2	When more than one participant attended the SI session, leaders would ensure that each person knew one another’s name. The leaders intentionally paired students so that they would interact with each person in the group at some point. Leaders utilized names in sessions, and spoke of students who typically attended to see if the group was aware of missing students’ whereabouts. Leaders used positive language regarding student development.

A. Evidence of Career Adaptability, SI instructor perceptions

Based on our understanding of educational contexts, we hypothesized that educational settings would provide opportunities for adaptation and improvisation as SI leaders continuously improved their efforts with peers. To address the research question, the authors reviewed strategies described by supplemental instruction leaders that included flexibility, dynamism, and change elements.

Some adaptability-related responses involved SI leaders reflecting on their improvement over time as a leader, and how they work differently now with students than they did in their first weeks in the role. Jorge* mentioned how he improved in his engagement with peers in SI sessions by shifting the representation of problems.

“I got better at breaking stuff down. If people don't understand visual concepts or something, we break it down to smaller pieces... I kind of learned that, just breaking down a problem slowly and then just building up to it helps a lot, instead of just getting right into it.”

Matthew* noted he developed patience in his role as an SI leader—this patience manifested in continuous and evolving explanations of concepts to students.

“What I learned from both those semesters is mainly patience. I think I developed a lot of patience because sometimes students come in with a lot of questions they might not know. They do not completely understand it properly, so just having to deal with that, and explain better to make sure these students end up walking out of the room with somewhat of an understanding.”

In other instances, SI leaders described situational adaptability and improvisation. For example, as Mirabel* transitioned to leading sessions online, she needed to adapt her engagement strategy to the online environment. She chose to add a new practice, screen sharing during problem-solving, to increase student interactivity as well as accountability.

“So like for my online sessions, since we can’t see the students and vice versa, I found it hard to encourage student participation and engagement... we’re not face to face so they feel like they can get away with not talking. So I started like regularly sharing screens... Like I make them share screens so I know that they’re actually attempting the problems and make them explain themselves.”

Interpersonal adaptability is something that SI leaders negotiated in their work—for example, Vanessa* said that her friends often attend her SI sessions. As a leader of the sessions, she needs to manage her dual roles in these social engagements, that of friend, and of leader—she stated:

“People that are friends in the SI session... they get kind of loud and get off topic. I would try to bring everyone back to the SI material. I also didn’t want to be rude because then those are my friends...(in the end) I was able to bring it back into focus.”

Throughout the focus group, participants were encouraged to describe the strengths of their peers as well as themselves. A veteran SI leader, Ben*, noticed an adaptive practice that other leaders utilized in the sessions—*“So I walked in one day and Jorge had one student, but he was teaching the student in Spanish, and I feel like that makes it a lot more accessible.”* Two SI leaders, Jorge and Mirabel, who had Spanish language skills, noted they used those skills when appropriate—the group discussed the possibility of communicating which languages the leaders spoke on the sign-up forms to promote and signal bilingual computer science support in SI.

In another instance of describing others’ practices, Mirabel, who had participated as a student in an SI session from Ben, said that students with differing classroom expectations were handled with improvised breakout rooms during online SI.

“If they were in chapter five, but the other students came for chapter seven, he could create rooms and then kind of go between the rooms and do (parallel activities and discussions) in breakout rooms.”

SI adaptability and improvisation skills were evident from the SI leader descriptions of adapting to student needs by decomposing problems into smaller parts to increase comprehension, practicing patience, actively engaging students through screen sharing, mindful classroom management, and realizing a native language would be best for the learner. These methods varied, depending on the student context and the adaptation needed. This initial analysis shows a range of adaptive behaviors SIs exhibited as they led their peers in learning experiences. The SI leaders improvised, through pedagogy, use of technology, or bilingual skills, as needed in the context which best met the needs of the students seeking learning assistance. Career adaptability research indicates that individuals with the ability to adapt to changing situations, problem solve, and utilize their human, social, and cultural capital in inventive ways have more positive work-related outcomes. Ensuring that SI leaders are supported to develop these skills and to recognize the value of adaptability may support their school to work transitions. In the following sections,

B. Programmatic Elements Facilitating Leader Adaptability and Improvisation

Research indicates that having a sense of trust supports individuals’ readiness for adapting to dynamic situations. Becoming a supplemental instructor (SI) offers a multitude of academic and pedagogical benefits while also nurturing a profound sense of community among participants. The department recently shifted the location of the SI sessions to the computer science building, rather than the centralized library location. This shift means that the SI room, located on the same floor as the research labs, faculty offices, and computer science classrooms, has become a place for leaders to study, interact with one another, and discuss their work as SI leaders. Informal observation by external observer Hug indicates when SI sessions are not occurring, the room remains occupied with leaders engaging with one another. We posit that this change in location may lead to a sense of community, as Mathew indicated in the quote below:

“I noticed that, throughout the semester, my peers... I would say it’s more like I like the sense of community I have especially with my team, and the SI COURSE # team, we’re all kind of like a family to each other, and I think that the leadership and the community we kind of built up with each other is a good social aspect.”

Classroom practices of some professors supported SI adaptability through providing student feedback about their learning needs. Without knowledge of student needs, SI leaders might script out lessons and activities based specifically on the book or the lecture notes from class, creating static, reusable lessons that may or may not benefit students. Ben describes a formative feedback strategy his instructor used, KWL forms, that led to adaptation in SI activity planning. Ben would access the forms that described what students “Know, Want to Know, and Learned”—these sheets supported adaptation of lessons ideas that were relevant for CS learners.

“(KWLs) helped me plan my sessions, because I knew if everyone was struggling with one topic and not another, I wouldn’t bother with the other stuff. I mean I would focus-in on the more challenging concepts.”

Access to course assessment, without the responsibility to grade or assess students summatively, supported SI leaders in adapting plans to best suit the needs of student attendees. Ben was able to view the KWL assessments his target students completed to tailor activities based on their reflections. Similarly, Mirabel described accessing midterm grades so that her activities addressed common misconceptions or sticking points in the curriculum. Because she could access grades as well as content specific information about coursework, she could adjust planning to best serve student needs. She said:

“I did, (look at exam results) and then like I would check them, like on our midterm, and around the end of SI. Yeah, to check who was struggling with the content. And I would be like, we need focus on these certain subjects sometimes when making my planning sheet.”

Supplemental Instruction programs at the institutional level are difficult to institutionalize, and often rely on supplemental, or grant funding that fluctuates over time. Currently, turnover at UNIVERSITY has changed the ways in which the institutionally-run program operates in computer science. This change in human resources is an obstacle that could have negatively impacted implementation in the department, yet SI leaders adapted to the changes and took up leadership differently in the semester impacted by the change. According to Mathew:

"It's just kind of the team leader who is left to their own devices, which I think is fine for me. Like I think me and Vanessa, we're able to handle it, but in the future, I'm not necessarily sure that that'll work."

Matthew acknowledged in the quote that an institutional leadership change shifted the roles of the team leaders of SIs at the course level- he noted that while he and his experienced team leader peer "could handle it"- the next leaders may not be as well positioned to do so, given the way SI leaders cycle through towards internships and graduation.

SI sessions fluctuate in attendance—policies that faculty utilize to encourage participation, from "required" attendance, to faculty promoted, to extra credit models, led to shifting attendance frames—often as the deadline for getting a "required" session neared, the SI sessions were inundated with students, with varied amounts of engagement from those students. While SI leaders had differing opinions regarding the optimum numbers of SI students, the experienced fluctuation came with an opportunity to adapt strategies based on numbers of students in the room. A leader described his opinion on larger sized SI sessions:

"It works much better with smaller sessions. When you have bigger ones, it's easy for the ones that don't know it, and don't want to try. It's much easier for them to just sit back and not challenge themselves."

SI implementation can vary in different institutional, departmental, and even course contexts. In our study of supplemental instruction, we are interested in how practices and policies shape the agency of SI leaders to adapt and improvise. In this initial analysis, we found that SI leader community developed in informal engagement in the SI space, feedback-related data sharing with course instructors, collaborative coverage of SI sessions, and shifting resources for institutional SI support have facilitated adaptation and facilitation by SI leaders. We argue in turn that these experiences may support career development, as industry searches for individuals with these abilities.

VI. DISCUSSION AND IMPLICATIONS

Job-seeking students must have the adaptive, improvisational skills identified to make positive impressions in interviews and negotiate the workforce successfully. While these career adaptability skills are highly valued, they are

difficult for faculty to model in the curriculum. SI leaders demonstrate adaptive instruction, show evidence of practicing adaptive instruction, and improvise as needed to support SI students. This initial work highlights how structures built into the implementation of SI at Kean University may have supported this adaptive skill development. Further work will focus on how to assist leaders in identifying their career adaptability skills and transferring those skills into positive job search experiences.

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REFERENCES

- [1] A. S. Miner, P. Bassof, and C. Moorman, "Organizational Improvisation and Learning: A Field Study," *Adm. Sci. Q.*, vol. 46, no. 2, pp. 304–337, Jun. 2001, doi: 10.2307/2667089.
- [2] Patriotta, G., & Gruber, D. A., "Newsmaking and sensemaking: Navigating temporal transitions between planned and unexpected events," *Organ. Sci.*, vol. 26, no. 6, pp. 1574–1592., 2015.
- [3] D. Vera and M. Crossan, "Improvisation and Innovative Performance in Teams," *Organ. Sci.*, vol. 16, no. 3, pp. 203–224, Jun. 2005, doi: 10.1287/orsc.1050.0126.
- [4] A.-M. Nisula and A. Kianto, "The role of knowledge management practices in supporting employee capacity for improvisation," *Int. J. Hum. Resour. Manag.*, vol. 27, no. 17, pp. 1920–1937, Sep. 2016, doi: 10.1080/09585192.2015.1088885.
- [5] R. K. Sawyer, "Improvisational Cultures: Collaborative Emergence and Creativity in Improvisation," *Mind Cult. Act.*, vol. 7, no. 3, pp. 180–185, Aug. 2000, doi: 10.1207/S15327884MCA0703_05.
- [6] R. K. Sawyer, "Group creativity: musical performance and collaboration," *Psychol. Music*, vol. 34, no. 2, pp. 148–165, Apr. 2006, doi: 10.1177/0305735606061850.
- [7] M. Howlett, G. Capano, and M. Ramesh, "Designing for robustness: surprise, agility and improvisation in policy design," *Policy Soc.*, vol. 37, no. 4, pp. 405–421, Oct. 2018, doi: 10.1080/14494035.2018.1504488.
- [8] "Johnston, C. S. (2018). A systematic review of the career adaptability literature and future outlook. *Journal of Career Assessment*, 26(1), 3–30."
- [9] P. A. Creed, T. Fallon, and M. Hood, "The relationship between career adaptability, person and situation variables, and career concerns in young adults," *J. Vocat. Behav.*, vol. 74, no. 2, pp. 219–229, Apr. 2009, doi: 10.1016/j.jvb.2008.12.004.
- [10] J. Koen, U.-C. Klehe, and A. E. M. Van Vianen, "Training career adaptability to facilitate a successful school-to-work transition," *J. Vocat. Behav.*, vol. 81, no. 3, pp. 395–408, Dec. 2012, doi: 10.1016/j.jvb.2012.10.003.
- [11] N. M. Lockie and R. J. V. Lanen, "Impact of the Supplemental Instruction Experience on Science SI Leaders".
- [12] N. Lozada, "The Benefits of Supplemental Instruction (SI) for the SI Leader," vol. 3, no. 1.
- [13] C. Anfuso *et al.*, "Investigating the impact of peer supplemental instruction on underprepared and historically underserved students in introductory STEM courses," *Int. J. STEM Educ.*, vol. 9, no. 1, p. 55, Sep. 2022, doi: 10.1186/s40594-022-00372-w.
- [14] M. B. Miles, A. M. Huberman, and J. Saldaña, *Qualitative Data Analysis: A Methods Sourcebook*, 4th ed. Los Angeles: SAGE Publications, Inc, 2019.