Broadening participation in STEM, caring intelligence as a leadership intelligence: perspectives of HBCU faculty leaders

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Abstract

Purpose – Within the scope of broadening participation and developing diverse talents in STEM leadership, this paper aims to deliver a research study that explores faculty leaders’ caring intelligence as STEM leadership intelligence. STEM leadership intelligence is the knowledge, skills, traits and aptitude essential to effective leadership in STEM education.

Design/methodology/approach – A previously developed STEM caring-oriented academic managerial leadership framework (SCAMLF) and a typology of STEM faculty leadership styles were used to thematically analyze the caring intelligence and leadership qualities of STEM faculty leaders. Interview transcripts of 18 STEM faculty leaders at Historically Black Colleges and Universities (HBCUs), provided by the Center for the Advancement of STEM Leadership (CASL), were used as data in this study.

Findings – The empirical evidence gained from this study highlighted important themes, descriptors and narratives for exploring caring intelligence and leadership intelligence of STEM faculty leadership in HBCUs.

Research limitations/implications – Although the generalizability of the study is limited because of the sample size, STEM caring was found to be the most common dimension present in the reflections of participating STEM faculty leaders with diverse leadership styles. Implications for future research on STEM leadership intelligence were discussed.

Originality/value – Studying caring intelligence as a form of leadership intelligence provides a new and innovative means of assessing STEM leadership intelligence. Caring intelligence can be employed to predict the mindset, performance and behaviors of STEM faculty leaders.

Keywords STEM education, Caring intelligence, Leadership intelligence, Caring, Leadership, Faculty leaders

Paper type Research paper

Introduction

University STEM caring paradigms offer an important concern for uncaring and siloed conditions occurring in STEM education and its scientific learning environments (Hendrickson et al., 2021; Krist and Suarez, 2018). These paradigms also place an emphasis on the academic welfare of caring recipients and the advancement of academic caring providers within STEM education. Taylor et al. (2021) confirmed that STEM caring discernably rests in faculty responsibilities in conjunction with compassionate, collaborative and transdisciplinary efforts to ensure the frontline academic learning success of students. Movingly, Gandhi-Lee et al. (2015) described university STEM faculty as “experts at the end of a STEM educational experience” (p. 33). While more visible in Historically Black College and University (HBCU) settings, STEM faculty have the opportunity and responsibility to be viewed as academic caregivers (Hendrickson et al., 2021). As academic caregivers, they are frontline providers of care in STEM academic environments (e.g. classrooms, laboratories,

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departments and schools/colleges) (Hendrickson and Francis, 2020). STEM caring can be heightened through efforts to increase faculty presence and involvement in university governance as well as broaden their participation in STEM leadership.

This paper promotes a novel way to assess caring intelligence as a form of STEM leadership intelligence. Scholarly works on leadership intelligence in STEM education are limited. However, STEM leadership intelligence is the socio-cognitive capacity for effective and appropriate leadership in STEM education. It also allows for the diagnosis of specified variables relevant to STEM leadership performance. STEM leadership intelligence provides a domain of potential relevance to explore the caring intelligence of STEM leaders. Caring intelligence is a manifestation of self-awareness, self-regulation or self-management and self-expression of caring to achieve intellectual and professional growth. Caring intelligence offers STEM leaders opportunities to guide, support, utilize and even spearhead the advancement of STEM caring.

The following research questions will be addressed in this work:

RQ1. Could caring intelligence of faculty be considered as STEM leadership intelligence?
RQ2. What characteristics of caring can be attributed to the caring intelligence of STEM faculty leadership?
RQ3. What leadership styles are associated with the caring intelligence of STEM faculty leaders?

Caring intelligence of STEM faculty
Hendrickson and Askew (2022) asserted that the cultivation of STEM caring requires caring intelligent STEM leaders in university administrative positions. Whether choosing an administrative (formal) or grassroot (informal) leadership path, Hendrickson and colleagues (2021; 2023) promoted the notion that caring is a core value of STEM faculty performance. Hendrickson and Francis (2023) described faculty as frontline academic caring agents within universities. They noted that faculty have “the duty of supporting and connecting with students on behalf of the institution” (2023, p. 2). Hendrickson and Francis (2023) categorized faculty caring as personal, pedagogical and academic. Distinctively, STEM faculty caring involves fidelities to scientific discipline and knowledge, in tandem with the concern for the welfare of STEM learners, colleagues, professionals and practitioners (Hendrickson et al., 2021).

Faculty caring has a complexity to its nature and study. Caring is value charged (i.e. physical, social, emotional, relational, ethical and cultural) (Zembylas, 2017). Caring is often assessed based on varying forms of human intelligence. Human intelligence is the cognitive capacity of generating and using knowledge to understand and adapt to conditions, circumstances and settings (Nambiar and Patil, 2023). By itself, caring can be a driver of intelligence (Doctor et al., 2022). Often overlooked, caring intelligence is a cognitive competency of professionals to recognize and appraise caring in themselves, others and work environment (Queirós et al., 2016). Caring intelligence can be defined as an “opportunity to understand expressions of STEM caring” within university administrative leaders (Hendrickson and Askew, 2022, p. 92). Caring intelligence is the ability to recognize the value, expressions and needs of STEM caring in employees, students, other institutional and community stakeholders and within STEM initiatives.

Furthermore, caring intelligence is the capacity to utilize caring knowledge, care for others and build caring relationships. Caring knowledge is a distinct and concrete understanding and awareness of caring habits, experiences and carescape. The carescape is the institutional structure, services, ethics and support that is representative of caring (Bowlby and Mckie, 2019). Additionally, caring intelligence uses the individuals’ knowledge of caring to effectively manage or regulate their levels of caring, as well as the caring of others. In addition, caring intelligence signifies caring efficacy. Caring efficacy is individuals’ confidence and conviction
Caring-oriented and express caring within relationships (Lukmanulhakim \textit{et al.}, 2019). Caring intelligence, as an efficacy, also involves interpersonal perceptions, facilitation, ethos, understanding, management, communication and utilization of caring. Caring intelligence can imbue individuals with a unique human-centered and nurturing social awareness. Caring intelligence can be used to associate caring competencies with individual performance. Caring intelligence ensures the conducting of acceptable caring behaviors and practices.

\textit{Caring intelligence as a STEM leadership intelligence}

Rewardingly, our study purports that caring intelligence can be used to explore caring competency in faculty leadership. In fact, caring intelligence should be regarded as a dimension of STEM faculty leadership intelligence. While leadership intelligence does not seem to be on the radar of STEM scholars, it is the next step in understanding STEM leadership. Issa and Akhigbe (2022) described leadership intelligence as the capacity of leaders to reason and critically think based on a cognitive interplay of high-level expertise, experience, knowledge, information and personal and social values. Furthermore, Leadership intelligence can be used to determine and predict the effect of leadership. Leadership effect is an outcome achieved because of cognitive orientation. Thus, Antonakis \textit{et al.} (2017) noted that intelligence augments a leader’s expertise, problem-solving competence and communication capacity to achieve a specific effect. Leonard and Maulding Green (2018) described the faculty leadership effect as the direct or indirect impact that faculty leaders have on their academic unit and students learning as well as their achievements.

To achieve the appropriate effect, leadership intelligence ensures a strategic and logical selection and use of leadership style(s) (Kaliappen \textit{et al.}, 2022). Leadership styles can be defined as patterns of habits, behaviors and personality traits that are displayed by leaders (Ali \textit{et al.}, 2013). Leadership styles are also specific and identifiable behavioral approaches or strategies toward influencing or directing subordinates. McCarthy \textit{et al.} (2019) asserted that leaders could use different leadership styles to handle the paradoxes of situations or contradictions and conflicts that occur in events. They purported that leadership intelligence provides leaders with the capacity to assess contextual patterns to address contradictions and enact appropriate leadership styles.

Like caring, Gage and Smith (2016) advanced the belief that leadership involves different forms of intelligence or multiple intelligences. Some of the identified intelligence of leadership are action, intuitive and emotional. Gage and Smith (2016) promoted Ronthy’s theory of leadership intelligence. Ronthy (2014) viewed leadership as the sum of rational, emotional, social and spiritual intelligence. This dimensionality in leadership intelligence offers the expanded capacity to “adapt knowledge and skills to different situations” (Alade and Windapo, 2021, p. 1392). Thus, leadership intelligence can be considered as leaders finding new ways to view the world and improve their effectiveness in leadership (Kaliappen \textit{et al.}, 2022).

Caring should be considered as a necessary intelligence of STEM leadership. Caring intelligence is a forward-thinking approach to leadership discernment and proficiency. Caring intelligence provides an opportunity to assess a leader’s ability to exemplify and generate caring environments and organizational cultures. Caring intelligence also presents a unique perspective for orienting and deciding appropriate leadership responses. Caring intelligence considers cognitive awareness that is needed for mindfulness, nurturing and empathetic concern for the welfare of others. STEM leaders can use caring intelligence to guide and direct their behaviors and realize the caring experiences within STEM initiatives. For this study, caring intelligence represents the cognitive capacity of STEM leaders to utilize caring knowledge. Caring intelligence also offers STEM leaders the efficacy to consider the paradoxes and appropriateness of leadership styles in achieving caring outcomes.
Methodology

Study design
The caring intelligence of STEM leaders is conceptually defined as the capacity for STEM leaders to recognize the meaning and realities of caring within themselves along with their disciplines, positions, relationships, work environments and communities. Caring intelligence can also identify caring patterns within participation and performance of STEM leadership. To examine caring intelligence as a form of leadership intelligence, this exploratory qualitative study completed a thematic analysis of interview transcripts of STEM faculty leaders to find patterns of caring and leadership. The design for this study was employed due to the limited research on the topic and the studied population, and the open-ended nature of the data collected. The exploratory qualitative study design provided an opportunity to utilize the findings gained from thematic analysis to build a clearer understanding of caring intelligence and leadership styles of STEM faculty leaders. Thematic analysis is a method of identifying, analyzing and interpreting contextual patterns within transcripts (data). Thematically, our study delved into the manifest (visible) and latent (underlying) context of STEM faculty leaders’ caring and leadership styles.

AtlasTi software was used to search for certain words, quotes and concepts within the data. The AtlasTi software provided an opportunity to code, categorize and manage the findings by themes and corresponding descriptors. The research themes and descriptors detected were categorized based on their centrality and density of occurrence based on STEM caring-oriented academic managerial leadership framework (SCAMLF) in STEM higher education and the typology of faculty leadership styles (Hendrickson et al., 2021; Francis and Askew, 2022). The SCAMLF was previously used to obtain the insights of STEM leaders who are academic managers or deans at HBCUs. This conceptual framework encompasses six dimensions drawn from a cross-disciplinary body of scholarship (Hendrickson et al., 2021): (a) STEM caring, (b) academic caring, (c) managerial caring, (d) leadership caring and (e) champion-driven caring. These dimensions of caring were used as thematic coding to extrapolate and interpret the rich data from the participants. The definitions and descriptors of each theme are presented in Table 1.

Leadership styles can provide great insight into the nature of any leader and overall intelligence. Kaliappen and collaborators (2022) asserted that the successful use of leadership styles is dependent on their intelligence. Leadership styles can be defined as the unique patterns of habits, temperaments and behaviors of leaders. Frederick et al. (2021) confirmed that the leadership styles of faculty help to broaden STEM (pp. 116–117). They unpacked that leadership styles of STEM faculty can support, bolster and expand the established values and qualities of learning environments (2021). In their study, Francis and Askew (2022) utilized a typology of leadership styles that can be used to examine STEM faculty leadership. Their typology consisted of intellectual, transformational leadership, transactional leadership, servant leadership and passive avoidant leadership (see Table 2). This typology was used as thematic coding to analyze and interpret the logic or leadership intelligence of the participating STEM faculty leaders. The definitions and descriptors for each theme are presented in Table 2.

Data collection
Data for this study was collected by the Center for the Advancement of STEM Leadership (CASL). CASL is a cooperative endeavor between the Virgin Islands, Fielding Graduate University, North Carolina A&T State University and the Association of American Colleges and Universities. Funded by the National Science Foundation's HBCU Undergraduate Program (HBCU-UP), CASL's mission is the research of leadership styles and strategies that impact STEM initiatives in HBCUs. The CASL research team performed 60–90 min virtual
STEM Caring
Responsiveness or development of collaborative relationships that value transdisciplinary inclusion and the welfare and academic achievement of STEM learners
Descriptors: (a) concern for the transdisciplinary; (b) responsive; (c) receptive; (d) connectedness; (e) responsible; (f) empathy; (g) compassion; (h) motivational; and (i) emphasizing broadening participation

Academic Caring
Concern for needs and behaviors that motivate and nurture continuation and determination in academic learning
Descriptors: (a) values-driven organizing; (b) developing creative pedagogue; (c) cultivating a culture of nurturing; (d) individualized consideration; (e) attention to academic progress; (f) empathetic responsiveness; (g) committed concern; (h) active support; (i) accessibility/availability; (j) need amenability; (k) mindfulness of differences; (l) communication; (m) compassion; and (n) hope

Administrative/Managerial Caring
Authoritative behaviors in academic services that invite and advance bureaucratic caring between employees, colleagues and students
Descriptors: (a) formal relationships; (b) bureaucratic; (c) communication; (d) trust; (e) cooperation; (f) responsibility to stakeholders; and (g) hope

Leadership Caring
Influential behaviors and interactions that are representative and reflective of a leader's power, virtue and ethics in caring about and for others
Descriptors: (a) authenticity; (b) humility; (c) kindness; (d) focus on others; (e) fairness; (f) honesty; (g) Vulnerability; (h) Attentiveness; (i) transparency; (j) courage; (k) prudence; (l) trustworthiness; (m) compassion; and (n) forgiveness

Champion-driven Caring
Dynamically fostering and cultivating active and expressive engagement as a vital, universal and transformational social mainspring
Descriptors: (a) commitment; (b) campaigning; (c) lobbying; (d) advocate; (e) respect; (f) inspirational; (g) encouragement; (h) concern; and (i) fairness

Source(s): Author's own creation based on the work of Hendrickson et al. (2021)

<table>
<thead>
<tr>
<th>Types</th>
<th>Definitions/Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transformational</td>
<td>A motivational leadership style that fosters strong relationships with students, colleagues and other academic and university stakeholders through aspiration</td>
</tr>
<tr>
<td>Leadership</td>
<td>Descriptors: (a) inspirational; (b) exchange (transactional); (c) visionary; and (d) legitimate authority</td>
</tr>
<tr>
<td>Intellectual Leadership</td>
<td>An academic and Scholarly-focused leadership style centered on leaders as a knowledgeable person with that “creates powerful ideas that spur scientific, social, technological and institutional revolutions” (Oleksiyenko and Ruan, 2019, p. 3)</td>
</tr>
<tr>
<td>Descriptors: (a) collaborate; (b) partnerships; (c) disciplinary oriented; (d) responsive; (e) sociable; (f) open to scholarly and academic opportunities; and (g) academic and scholarly role model</td>
<td></td>
</tr>
<tr>
<td>Transactional Leadership</td>
<td>A leadership style that is organizationally oriented and fixed within cultivating strong relational exchanges</td>
</tr>
<tr>
<td>Descriptors: a) mediate; (b) negotiate; (c) cooperate; (d) clarity in expectancies; (e) performance-oriented; (f) directive and (g) innovative</td>
<td></td>
</tr>
<tr>
<td>Servant Leadership</td>
<td>Leadership that places a priority on serving the institution, subordinates, colleagues, students and communities</td>
</tr>
<tr>
<td>Descriptors: (a) intuitiveness; (b) fairness; (c) self-effacement; (d) relational influence;(e) self-sufficiency; (f) good listener; (g) cognizance; (h) mindfulness; (i) stewardship; (j) empowerment; (k) empathy; (l) community cultivation and (m) integrity</td>
<td></td>
</tr>
<tr>
<td>Passive avoidant leadership</td>
<td>A reactive or inactive leadership style is established on reluctance, refraining and unwillingness to lead</td>
</tr>
<tr>
<td>Descriptors: (a)passive; (b) avoidance; (c) reserve; (c) abstaining; (d) reluctance; (e) unwillingness; (f) indifference (g) uncooperative; (h) unresponsive; (i) limited interest and (j) narrow involvement</td>
<td></td>
</tr>
</tbody>
</table>

Source(s): Author’s own creation based on the work of Francis and Askew (2022)
semi-structured interviews. The interview is comprised of fifteen open-ended questions. CASL researchers used Zoom video conferencing to interview participants. The recordings of the interviews were transcribed and made into a database.

Study sample
The data for this study was derived from CASL’s HBCU Leaders Dataset. This dataset included interviews of leaders (including presidents, provosts, deans, chairs and professors) employed at 13 HCBUs at the time of data collection. The sample for this study consisted of 18 participating faculty leaders holding the position of professors ($n = 9$) and chairs ($n = 9$). As displayed in Table 3, 50% of the participants identified themselves as female. Seventy-eight percent of the participants reported having PhDs in a STEM discipline (i.e. Biology, Chemistry, Engineering Mathematics, Physics, Psychology); one participant had a Doctor of Arts (DA). Participating chairs and professors were identified by numbering to ensure anonymity and confidentiality. Chairs were numbered one through nine. Professors were numbered 1–9.

Results
Acquired from the analysis, the data extrapolated from the transcribed interviews supported themes that have relevance to the five dimensions of STEM caring-oriented academic managerial leadership framework (SCAMLF). The leadership styles of all the participating faculty leaders were identified. Two tables were created to display the caring observations and leadership styles of the participating STEM faculty leaders. Table 4 displays the findings of the participants who held the position of professors. Likewise, Table 5 provides the findings of participants who held the position of chairs. In this section, the observations on caring are presented, along with the leadership styles of STEM Faculty leaders.

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Gender</th>
<th>Degree level</th>
<th>Disciplinary area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professor #1</td>
<td>Female</td>
<td>PhD</td>
<td>Biology</td>
</tr>
<tr>
<td>Professor #2</td>
<td>Male</td>
<td>Doctor of Arts</td>
<td>Teaching of Chemistry</td>
</tr>
<tr>
<td>Professor #3</td>
<td>Male</td>
<td>PhD</td>
<td>Mathematics</td>
</tr>
<tr>
<td>Professor #4</td>
<td>Male</td>
<td>PhD</td>
<td>Nuclear Physics, Experimental</td>
</tr>
<tr>
<td>Professor #5</td>
<td>Female</td>
<td>PhD</td>
<td>Zoology</td>
</tr>
<tr>
<td>Professor #6</td>
<td>Female</td>
<td>PhD</td>
<td>Soil Physics and pore-scale modeling</td>
</tr>
<tr>
<td>Professor #7</td>
<td>Female</td>
<td>PhD</td>
<td>Physics</td>
</tr>
<tr>
<td>Professor #8</td>
<td>Female</td>
<td>PhD</td>
<td>Industrial organizational psychology</td>
</tr>
<tr>
<td>Professor #9</td>
<td>Female</td>
<td>PhD</td>
<td>Chemistry</td>
</tr>
<tr>
<td>Chair #1</td>
<td>Female</td>
<td>PhD</td>
<td>Anatomy and Neurobiology</td>
</tr>
<tr>
<td>Chair #2</td>
<td>Female</td>
<td>PhD</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>Chair #3</td>
<td>Male</td>
<td>PhD</td>
<td>Mathematics</td>
</tr>
<tr>
<td>Chair #4</td>
<td>Male</td>
<td>PhD</td>
<td>Chemistry</td>
</tr>
<tr>
<td>Chair #5</td>
<td>Male</td>
<td>PhD</td>
<td>Engineering</td>
</tr>
<tr>
<td>Chair #6</td>
<td>Male</td>
<td>PhD</td>
<td>Computer Science</td>
</tr>
<tr>
<td>Chair #7</td>
<td>NR$^b$</td>
<td>NR$^b$</td>
<td>NR$^b$</td>
</tr>
<tr>
<td>Chair #8</td>
<td>Female</td>
<td>NR$^b$</td>
<td>NR$^b$</td>
</tr>
<tr>
<td>Chair #9</td>
<td>Male</td>
<td>NR$^b$</td>
<td>NR$^b$</td>
</tr>
</tbody>
</table>

Table 3.
HBCU faculty leader: individual and institutional characteristics

Note(s): $^a$Degree level was self-reported by the respondents. $^b$NR=Not Reported

Source(s): Author’s own creation/work
<table>
<thead>
<tr>
<th>Caring observations</th>
<th>Leadership style</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 (a) STEM Caring (responsiveness; success); (b) Academic Caring (collaboration); and (c) Administrative/Managerial Caring (bureaucratic support, forthcoming, helpful)</td>
<td>(a) Transactional Leadership (systematic, hands-on)</td>
</tr>
<tr>
<td>#2 (a) STEM Caring (motivation, responsible); (b) Academic Caring (active academic support); (c) Administrative/Managerial Caring (collaborative); (d) Champion-driven Caring (supportive)</td>
<td>(a) Transformational Leadership (lead by example); (b) Intellectual Leadership (research and educational-driven)</td>
</tr>
<tr>
<td>#3 (a) STEM Caring (importance and emphasis on STEM; producing success); (b) Academic caring (attentive; supportive; fulfilling student needs); and (c) Leadership Caring (attentive; student focused)</td>
<td>(a) Transformational Leadership (high expectations, leading by example, supportive, cordial, friendly, upbeat)</td>
</tr>
<tr>
<td>#4 (a) STEM Caring (commitment and closeness); (b) Administrative/Managerial Caring (supportive); (c) Leadership Caring (enable, facilitate, building relationships, contribute ideas, create sustainability for students, provide for educational needs, coaching, advising, assist with academic development); and (d) Champion-driven caring (creating initiatives and opportunities)</td>
<td>(a) Passive avoidant Leadership (reluctant; not seeking position)</td>
</tr>
<tr>
<td>#5 (a) STEM caring (building a community that provides student-driven support); (b) Academic Caring (belief in student potential); (c) Leadership Caring (believing in subordinates and their potential); and (d) Champion-driven Caring (creating new initiatives; contributing, cultivation, paving a way for future and current students, obtaining support, interaction, obtain and maintain funding, petitioning, seeking ways to offer opportunities and experiences)</td>
<td>(a) Intellectual (supportive of subordinate intellectual pursuit, aiding in writing grants, create and sharing ideas and ways to do things)</td>
</tr>
<tr>
<td>#6 (a) STEM Caring (mentoring, supportive, working side-by-side with students, working hand in hand, sharing real-life experience, facilitation and aid) and (b) Leadership Caring (presence and interaction)</td>
<td>(a) Transactional (organized, efficient and structured relational exchanges)</td>
</tr>
<tr>
<td>#7 (a) STEM Caring (encouragement, disciplinary concern and funding) and (b) Academic caring (nurturing, strengthening, success, retention and keeping students’ interest)</td>
<td>(a) Intellectual Leadership (academic driven, mentoring, directional nudge and motivation)</td>
</tr>
<tr>
<td>#8 (a) STEM caring (progressively support student development) and (b) Academic caring (reaching out and supporting underprivileged students; motivate, broaden perspective, openness and supportive)</td>
<td>(a) Transactional Leadership (inclusivity, dialogue and obtain input from others)</td>
</tr>
<tr>
<td>#9 (a) STEM Caring (support given tools for and inclusivity); (b) Academic Caring (passionate about teaching students and research and students publishing, creating safe space, attentiveness, supportive, responsive, accommodative of students); and (c) Champion-driven Caring (leading the cultivation of support and caring spaces)</td>
<td>(a) Passive Avoidant leadership (hands-off and delegating)</td>
</tr>
</tbody>
</table>

**Source(s):** Author’s own creation/work

### Table 4.
Caring observations associated with leadership styles of STEM faculty in HBCUs (Professors)
<table>
<thead>
<tr>
<th>Caring observation</th>
<th>Leadership style</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 (a) STEM Caring (engage, broaden participation and actively involve); (b) Administrative/Managerial Caring (getting involved and motivate); and (c) Leadership Caring (calmness, thoughtfulness, thinking creatively and student focused)</td>
<td>(a) Intellectual Leadership (active scholar and researcher, involve students in research, active research agenda); (b) Servant Leadership (leadership by example, love collaborating with people and self-identified)</td>
</tr>
<tr>
<td>#2 (a) STEM Caring (mindfulness and compassion) and (b) Academic Caring (supportive, opportunities for expression, connectedness, exposure for students, honesty and hands-on teaching)</td>
<td>(a) Servant Leadership (listening, empathy, prioritizing stewardship and committing to the growth of people)</td>
</tr>
<tr>
<td>#3 (a) STEM Caring (supportive); (b) Leadership caring: motivation; (c) Academic caring (mentoring and support, i.e. meet them where they are academically and institutional); (d) Leadership caring (motivation) and (e) Champion-driven caring (supportive and setting up curriculum innovation)</td>
<td>(a) Transformational Leadership (motivate and developing opportunities for success)</td>
</tr>
<tr>
<td>#4 (a) STEM Caring (cohesiveness, supportive; disciplinary focus, i.e. keeping at the forefront and outreach); (b) Academic Caring (uplift the traditional overlooked, supportive); and (c) Champion-driven Caring (powering through and sacrifice)</td>
<td>(a) Transformational Leadership (visionary, ambitious and delegate task)</td>
</tr>
<tr>
<td>#5 (a) STEM Caring (connectedness); (b) Academic Caring (comfort, hope, pitching in; donating); (c) Administrative/Managerial Caring (helping and supportive); and (d) Leadership Caring (encouragement, communication and collaboration)</td>
<td>(a) Transformational leadership (lead by example, motivate, communicate and fostering strong relationships)</td>
</tr>
<tr>
<td>#6 (a) STEM Caring (collaboration, communication, retention plan, monitoring; engaging; connectedness; expression of positivity; broadening participation)</td>
<td>(a) Transactional (honest communication; shared governance, receive and utilization of feedback and insight from stakeholders)</td>
</tr>
<tr>
<td>#7 (a) STEM Caring (supportive community; providing services); (b) Academic Caring (mentorship, support, fulfilling needs and relationship building); (c) Administrative/Managerial caring (connectedness closeness and providing for students); (d) Leadership caring (Connectedness); and (e) Champion-driven Caring (developing supportive initiatives)</td>
<td>(a) Transformational (transformative, inspire); (b) Servant leadership (Supportive, work directly, mentoring, advising, inspire subordinates to become change agents, development of leaders; self-identified)</td>
</tr>
<tr>
<td>#8 (a) STEM caring (high-level of strategic support); (b) Leadership Caring (solving tangible minority community problems to education and collaboration); and (c) Champion-driven Caring (providing opportunities)</td>
<td>(a) Servant Leadership (unselfish, supportive and galvanizing)</td>
</tr>
<tr>
<td>#9 (a) STEM Caring (representation and compassion) and (b) Academic Caring (cultural understanding, compassion, positivity, understanding, accountability, cooperation, attentiveness and supportive)</td>
<td>(a) Servant Leadership (inclusion, listening and representing subordinates)</td>
</tr>
</tbody>
</table>

Table 5. Caring observations associated with leadership styles of STEM faculty in HBCUs (Chairs)

Source(s): Author’s own creation/work
Caring observations

Because there were no interview questions specifically designed to the caring of participants, the thematic analysis encompassed extrapolating themes based on the participants' responses to all interview questions. The five dimensions of SCAMLF identified were identified in the transcripts. Several descriptors of the thematic framework were identified within the transcripts. Additional descriptors emerged within each theme. Overall, a dimensional narrative of STEM faculty leaders was realized. The findings of the analysis are presented below for each of the dimensions.

STEM Caring. As seen in Tables 4 and 5, STEM caring was a very observable theme in the transcripts of all participating faculty leaders (i.e. professors and chairs). The substantial descriptors of STEM caring offered based on the responses of participating faculty leaders were responsiveness, motivation, responsibility, emphasis on the importance of STEM, commitment closeness, the building of community, mentoring, concern, engagement, connectedness, representation and compassion (see Tables 4 and 5). The most common and overarching descriptor found was support or supportiveness. Hendrickson et al. (2021) noted that the supportiveness of STEM frontline leaders can “foster cultures and environments of STEM caring” (p. 343). Therefore, STEM caring is active caring. Active caring is a tangible and measurable demonstration of altruistic support and involvement. The following quotes offer a glimpse into some of the participants’ experiences of STEM caring:

Professor #4: In STEM departments, there was always that commitment to push (forward) students to have these successful careers beyond the undergraduate level; offering mentorship and closeness with the faculty members and department chairs.

Professor #6: STEM is facilitating students to be successful in STEM careers . . . offering a good paying summer job that will prepare them to make a good living and lift their families up is often a big factor.

Professor #7: We do a lot to encourage our students through opportunities like our STEM Day. It is an annual event that allows students to present results from their research.

Chair #1: STEM is getting new students to participate (get them involved), and existing students to be more actively involved.

Chair #3: I think that STEM has always provided a lot of support in terms of allowing students to grow.

Academic Caring. As seen in Tables 4 and 5, academic caring was a visible theme in the transcripts of seven professors (1,2,3, 5, 7, 8 and 9) and five chairs (2, 3, 5, 7 and 9). The common descriptors of academic caring based on the responses of the participating faculty leaders were collaborative, attentive, supportive, belief in students, compassion, nurturing, openness, provision of student needs and success (see Tables 4 and 5). Notably, academic caring was observed to be active and linked to the expectations and mission of HBCUs. Hendrickson and Francis (2020) support this contention. They observed that HBCUs are well known for academic nurturing and cross-familial caring. Thus, the HBCU environment can provide STEM initiatives with a footing and authenticity of academic caring. The following quotes tender substantive views of academic caring:

Professor #3: And I think there is an emphasis on student needs first. And so, the student needs might very well vary from the high quality of faculty to emphasis upon retaining students, providing the background material that is needed to keep them going and getting them to the desired level to continue. And so again, recognizing where the student is, and meeting the student at their needs.

Professor #5: The main thing is believing in the students; in their potential.
Professor #7: All the faculty at the university are big on really trying to nurture students. We don’t just go and give them the cold shoulder if they ask a question. We try to bend over backwards to help them out, and the students get that.

Chair #3: So, we get a lot of students. We meet them where they are academically. And the whole institution really wants to make students successful. They get them to a point where they can be successful contributing members of society and the community.

Chair #4: I think it is clear in the HBCU mission to uplift those who may have been traditionally overlooked, keeping in mind the African American heritage.

Administrative/Managerial Caring. As seen in Tables 4 and 5, Administrative/managerial caring was a detectable theme in the transcripts of three professors (1, 2 and 4) and three chairs (1, 5 and 7). Descriptors of administrative/managerial caring were supportive, forthcoming, helpful, collaborative, getting involved, motivate, connectedness and closeness. Often unnoticed, our findings spotlight active caring provided in STEM education by university administrators. Chair #5 offered significant insight into gaining administrative (managerial) caring. He commented that support for STEM education from the administration can be achieved when they realize its institutional importance. The following quotes provide support of this work’s findings on Administrative/Managerial caring:

Professor #1: He [Chair] helped you. Maybe, because I didn’t have to go through a lot of hierarchy, I kind of appreciated that.

Professor #2: Administrators at these institutions became more collaborative.

Professor #4: Certainly, the upper-level administration at those institutions had to be supportive of those departments to be able to deliver and serve and stay productive.

Chair #1: And so, it was his [Dean] mission to make sure that he motivated, especially the younger faculty who were coming in to make sure that they get involved in research.

Chair #5: Administration became more supportive and helpful in developing and growing the STEM areas, including on the engineering programs.

Leadership Caring. As seen in Tables 4 and 5, leadership caring was an observable theme in the transcripts of three professors (3, 4, 5 and 6) and five chairs (1, 3, 5, 7 and 8). The descriptors of leadership caring, based on the responses of participating faculty leaders, were collaborative, connectedness, facilitating, building relationships, contributing ideas, creating sustainability for students, providing for educational needs, coaching, advising, assisting with academic development, believing and success. Our findings support the notion of active caring in STEM faculty leadership. The following quotes tender supportive observations of leadership caring:

Professor #4: Relationship between my leadership and STEM success at my university ... Well, surely, my leadership has been tied to the ability to actually contribute ideas that are fundable ... to sustain students and to also provide those students with current and extended educational needs that they have, both classroom but out of classroom as well, and the coaching and advising and whatnot, so they can be successful, which is very human intensive in terms of trying to develop those students.

Professor #6: Well, there’s leadership in the classroom, which is really your job (to lead the class). I’m very interactive with students.

Chair #7: Well, what’s unique is that the STEM leaders are hands-on. We’re more closely connected to the faculty and more closely connected to the students.

Chair #8: I’d rather build a collaborative team of individuals who can go on and build their collaborative teams. So, then you have this exponential growth of leaders.
Champion-driven Caring. As seen in Tables 4 and 5, Champion-driven caring was an apparent theme in the transcripts of four professors (2, 4, 5 and 9) and four chairs (3, 4, 7 and 8). Some significant descriptors of champion-driven caring were supportive, creating initiatives and opportunities, leading the cultivation of support and caring spaces, powering through and sacrifice. Thus, our findings support that champion-driven caring is “transpersonal, transformative, and transactional” (Hendrickson and Askew, 2022, p. 94). The following quotes offer supportive comments of Champion-driven caring:

**Professor #2:** Because the Chief Administrator loved that program, the STEM division obtained a lot of support from the Chief Administration.

**Professor #9:** I would say that I am really been big in getting our department and college to a more technical space and improve their technology, especially with the pandemic. And so, I helped to create some of the training courses for the faculty.

**Chair #8:** I try to make areas where students can learn life lessons, areas where my colleagues learn and grow. I help provide those opportunities for them.

**Leadership styles**
During the interview process, the participating faculty leaders were asked to describe or self-identify their leadership styles. As seen in Tables 4 and 5, All of the leadership styles were identified as themes and characterized throughout the faculty leaders’ transcripts: (a) four Intellectual leaders (Professors #2, #4 and #7; Chair #1); (b) five Transformational leaders (Professors #2; Chairs #3, #4, #5, #7); (c) three Servant leaders (Chairs #1, #2 and #9); (d) four Transactional leaders (Professors #1, #6 and #8; Chairs #6) and (e) two Passive avoidant leaders (Professors #4 and #9). These tables also offer descriptors used in the thematic analysis. While most of the leadership styles were identified based on inferences, Chair #1 and Chair #7 self-identified as servant leaders. Chair #1 stated, “Yes. I see myself as more of a servant leader because I believe in doing so others can see what you’re doing and follow what you’re doing. I love working with people. I see myself as a servant leader, that type of style.”

Additionally, Professor #2, Chair #1 and Chair #7 were classified as having features of a secondary leadership style (see Tables 4 and 5). While both have characteristics of intellectual leadership, Professor #2 has qualities of transformational leadership and Chair #1 was depicted as Servant leadership. Although Chair #7 claimed his desired leadership style to be transformative, he self-identified as servant leadership. STEM faculty leaders can enhance their influence by utilizing more than one leadership style. As faculty, the intellectual leadership style offers an academic leadership foundation. Transformational, transactional and even passive avoidant approaches can build upon recognized intellectual recognition, reputation and disciplinary standing. Similarly, transformational leadership could be considered as compatible with servant leadership. Echols (2009) believed that the synergies between both leadership styles create a potential for acceptance and inclusiveness in leadership. Thus, STEM faculty leaders should be encouraged to adopt more than one leadership style. The following is the supporting quote taken from the Chair #7 interview response:

I always claim my desired leadership style is transformative. I want to inspire people to do their best, make a change, become a change agent, and things like that. However, it probably turns out to be more of a servant leader because I do support my staff. I like to see the people whom I work with or who report directly to me grow. I like to see them get leadership positions.

**Discussion**
One of the main questions of this research was: What leadership styles are associated with the caring intelligence of STEM faculty leaders? To respond to this question, our findings, as seen
in Tables 4 and 5, confirmed the presence of caring within all aspects of STEM faculty leadership transcripts. We also found descriptors of active caring within the recognized caring dimensions. Therefore, the findings of our work lead us to believe that STEM faculty leadership is caring in nature. While the leadership styles of the participating faculty leaders may vary, all transcripts of participating STEM faculty leaders included significant implications of supportiveness as a primary identifier of STEM caring. STEM faculty leaders can be motivated by the pursuit of STEM care. Furthermore, the discoveries also listed in Tables 4 and 5 reinforce the notion that opportunities for broadening participation in STEM higher education can be achieved through acts of STEM caring by faculty leaders. Expanding on the discovery by Hendrickson et al. (2021), this current study of STEM faculty leadership revealed a linkage between champion-driven caring and transformational, servant and passive-avoidant leadership styles. Thus, champion-driven caring is a quantum-level occurrence associated with STEM faculty approaches to leadership.

There is limited research on the effect of gender and disciplinary on STEM faculty leaders’ caring and leadership. By aligning the findings of Tables 3–5, the reported gender and STEM disciplinary data delivers an added contextual dimensionality to our findings. Our work spotlighted that STEM caring descriptors that centered on supportiveness were found in the transcripts of female STEM faculty leaders with diverse disciplinary backgrounds (i.e. Biology, Zoology, Psychology, Physics). Most of the female faculty leaders identified with either transactional, intellectual or servant leadership. Chair #1 considered herself to be both intellectual and servant leadership. Including gender and disciplinary value of STEM leaders helps to provide additional context on caring and leadership intelligence. This work advances that gender and disciplinary identity has a dominant influence on the caring and leadership intelligence of STEM leaders.

Limitations and future research directions
Even though evidence of caring dimensionality and leadership styles was prevalent in the transcripts of STEM faculty leaders, there were limitations to this study. Due to the sample size, we do not presume the generalizability of the research findings. Furthermore, the original research protocol focused on leadership styles for broadening participation in STEM leadership as well as successes and challenges in STEM. Therefore, the salience of caring was inferred from respondents’ transcripts. Although the data used in this study was based on in-depth interviewer-administered data collection, it was self-reported. Thus, consideration must be given to social desirability bias. Social desirability bias is a systematic error that happens based on participants offering favorable responses to researchers. Likewise, we acknowledge the lead author’s position as an HBCU faculty could result in creating interpretative biases or misinterpretations.

Due to the participants’ candor and openness, the findings of this research provided significant implications concerning caring intelligence as a leadership intelligence (see Tables 4 and 5). This work also offers an important preliminary foundation for future research studies that directly assess leadership intelligence and caring intelligence of STEM leaders. We propose the development of an instrument that would provide a valuation of caring intelligence of STEM faculty leaders. Future research studies with the instrument will help expand our research beyond the HBCU context and other leadership roles (i.e. president, provosts, deans and students). We also see the potential of further researching the association between STEM leadership intelligence and diversity and gender issues.

Conclusion
Importantly, STEM faculty are the primary provider of caring within universities, like HBCUs. Their caring can be viewed as guidance, experience, expertise, support and a voice
for the academic initiatives, disciplines, faculty (peers) and students. For the success of any
STEM initiative within university settings, there is a need to broaden the participation and
development of faculty as STEM leaders. Whether by assuming formal or informal
leadership roles, STEM faculty are vital in improving teaching, learning and academic
environments. STEM leadership places faculty in influential roles and positions to champion
STEM caring reforms. Thus, there is a continued necessity to find new avenues to understand
the caring attributes of effective STEM leadership, especially in terms of faculty, gender and
discipline.

Our work asserts that STEM faculty leadership development can be enhanced through
the inclusion of leadership intelligence. While limited in studies of STEM leadership,
STEM leadership intelligence can be described as the knowledge, skills, traits and aptitude
needed to effectively lead in STEM education. The intelligence of leadership has been
viewed as the sum of rational, emotional and spiritual intelligence (based on Ronthy’s
theory). However, we offer caring intelligence as a form of STEM leadership intelligence.
Caring intelligence provides an understanding of STEM faculty leaders’ awareness,
realization and expression of caring. Based on our findings, the very essence of STEM
leadership is caring for and about STEM education. Thus, the implication of this study
asserts associations between caring intelligence and leadership practices and behaviors of
STEM leaders. Through our use of an STEM caring-oriented academic managerial
leadership framework (SCAMLF) and typology of faculty leadership styles, this work is an
opening for continued research efforts to explore caring intelligence as a STEM leadership
intelligence.

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Perspectives of STEM faculty leaders


Further reading


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