Inquiring Rather Than Informing: An Approach for Holistic Development of Science and Engineering Student

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***Abstract*—*Contribution:* This article explores the impact of academic coaching on science and engineering students through a pilot study. The study proposes integrating academic coaching as a standard component of the student support framework.**

***Background:* Unlike mentoring or informing, coaching or inquiring practice encourages higher education students to engage in critical thinking and analyze complex problems, which can enhance their problem-solving skills. This helps students discover situations and options on their own, leading to the creation of action plans.**

***Research Questions:* 1) What is the degree of influence that the academic coaching approach has on the personal development of students? and 2) In what ways has academic coaching facilitated the achievement of academic goals for science and engineering students?**

***Methodology:* The coaching program was created for a one-semester term and was offered free to students at the Faculty of Science and Engineering at the University of Nottingham Ningbo China. Students who participated were new to coaching and had limited knowledge of it. To collect data, a survey was conducted using MS Forms, consisting of Likert and open-ended questions, and was distributed among the students who joined the coaching program. A total of 42 students participated, resulting in a participation rate of approximately 42%.**

***Findings:* The study discovered that integrating coaching practices could improve the holistic development of students. This has implications for the creation of student support systems in higher education, supporting personal tutorials, and strengthening the training of personal tutors and tutees.**

***Index Terms*—Coaching in higher education, science and engineering education, student well-being, student's self-efficacy.**

I. Introduction

THE DYNAMIC relationship between emotions, cognition, and motivation in academia is an exciting area of study in higher education. When students experience positive emotions, it profoundly impacts their studying habits. They become more organized with their study schedules and tailor their materials to their specific needs for better comprehension. These positive emotions also cast a bright light on students' assessment of their own learning and performance, enhance their strategic readiness for exams, and foster profound self-reflection on their study journey [1]. As educators and advisors, one of our essential roles is to support students in achieving their personal, academic, and professional goals. However, improving the learning experience inside the classroom only is not enough. That is because, in today's higher education environment, many undergraduate students require assistance in many directions, such as managing their studies, making decisions about their future education, and navigating various career options [2]. Additionally, many students face a difficult transition when entering higher education due to inadequate preparation [3], [4].

To effectively tackle these complex challenges, students must cultivate and sharpen essential skills, such as self-reflection, goal-setting, time management, and self-evaluation. There are three crucial elements to consider when it comes to enhancing students' learning experience. First, the cognitive aspect encompasses activities like practicing, structuring, and expanding on the information [5]. Next is the metacognitive dimension, which involves planning, monitoring, evaluating, and adapting strategies [5]. Finally, the motivational factor revolves around fostering a positive mindset, setting goals, and finding ways to make learning enjoyable [6]. Unfortunately, the existing study programs often emphasize subject-specific learning, neglecting the holistic development of students. Although a mentoring advisory approach is frequently employed to offer tips and advice to undergraduate students outside the classroom, this approach can inadvertently impact their academic performance in a negative way [7]. Academic coaching provides resources for navigating college and disciplinary contexts, while mentoring emphasizes career-specific paths.

This presents an opportunity to incorporate coaching practice to enhance the holistic development of students in higher education. This approach will enable the offering of comprehensive support to students, not only in academic areas but also in their personal and professional lives. Education encompasses more than just acquiring knowledge; it also involves empowering students to make informed decisions, manage their studies efficiently, and plan their future endeavors. By embracing coaching as an essential

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component of student well-being, students will be equipped with the necessary tools and guidance to navigate the complexities of higher education and beyond. This approach fosters an environment that promotes their holistic growth and empowers them to realize their full potential in all aspects of their lives [8]. Moreover, science and engineering education fosters effective learning techniques, encouraging critical thinking, problem-solving, teamwork, and determination. Young learners become keen observers, engage in collaborative conversations, and exhibit flexible thinking [9]. Science and engineering embrace setbacks and trial-and-error, building resilience and focus [10], [11]. It offers abundant coaching opportunities, cultivating risk-taking and perseverance.

At the University of Nottingham Ningbo China (UNNC), the personal tutorial practice serves a dual purpose of offering pastoral care and helping students adapt to university life [12]. It plays a critical role in addressing students' varying needs [13]. Establishing a positive personal tutorial relationship since the first year of study is linked to several positive outcomes for students. In particular, students with supportive personal tutors report higher academic self-concept and motivation than those with negative experiences [14]. The success of the tutor–student relationship depends on the tutor's authentic desire to help, which has implications for the entire institution regarding measurable student outcomes. Experiencing genuine care can establish a strong base for students to endure challenging situations [15].

The usual approach for optional personal tutorials involves mentoring, where students can receive guidance and ask questions about their studies in a broader context. This means the educators tell students what to do. In the ideal situation, as a mentor, the personal tutor is regarded as a reliable confidant, advisor, inspiration, and source of knowledge. Those seeking guidance from their mentors anticipate help settling in and getting acquainted with the university and department operations and procedures. Mentors also may offer direction and encouragement regarding job expectations and performance [16]. The motivation for this pilot study is to reverse the tutor's role to inquire about students instead of informing them. This study seeks to examine how academic coaching can enhance the self-efficacy of science and engineering students and how this practice can be integrated as a standard component of student support and well-being framework in higher education. The primary research questions are as follows.

1) What is the degree of influence that the academic coaching approach has on the personal development of students?
2) In what ways has academic coaching facilitated the achievement of academic goals for science and engineering students?

Developing science and engineering students involves nurturing intellectual growth through critical thinking, creativity, and effective communication [17]. This also requires instilling a global perspective, promoting awareness of societal impacts, and fostering personal and emotional well-being [18]. In this article, the holistic development approach is defined as a coaching approach that motivates students to increase self-awareness, make informed decisions, and take self-directed actions while maintaining work–life balance.

This article is structured as follows. Section II briefly reviews the literature on the potential of coaching in higher education, emphasizing science and engineering students. Section III provides an overview of the methodology used in this study, including the program delivery, coaching model, and student survey. The results of the study are presented in Section IV, followed by further discussion in Section V. Finally, Section VI concludes this article.

II. Literature Review

A. Student Well-Being in Higher Education

Engaging youth requires thoughtful support and guidance. Listening to their voices and empowering them through student-led initiatives creates accessible and effective well-being systems [19]. Policymakers must collaborate with students, faculty, and partners to improve outcomes and approach higher education well-being as a dynamic, student-centered field. Creating a supportive learning environment involves strategic approaches to marketing, recruitment, curriculum, assessment, feedback, and experiential learning. By prioritizing student well-being and fostering autonomy, competence, and a sense of belonging, students can be empowered to enhance their skills and thrive in higher education [20]. The relationship between teachers and students affects the well-being of both students and staff. A study explored student and staff involvement to understand student well-being amid diverse relationships. Themes from data analysis highlighted the influential role of the educational environment, emphasizing the benefits of a student-centered, integrated, inclusive, and caring setting. Staff well-being emerged as a crucial factor, interconnected with student well-being in higher education [21]. A study exploring student engagement and well-being throughout an academic term revealed diverse activity patterns. Fluctuations in engagement and well-being occurred, influenced by assessments, with an intriguing correlation between engagement and happiness but an unexpected link to academic outcomes [22]. Encouraging and implementing student feedback promotes a greater sense of belonging and empowerment among students. In another study, 2776 student responses provided valuable insights for educators and administrators to effectively enhance student well-being and address psychological distress. Diverse suggestions highlighted their potential to support students and promote wellness [23]. Some of the suggestions included approachable and understanding lecturers, clear lectures, promoting student interaction, and removing obstacles to services such as counseling and career guidance.

B. Approaches to Support Students' Well-Being

Four approaches to support students' well-being, highlighting their unique characteristics, were presented in [24]. While all approaches emphasized nurturing, personal growth, and a

caring environment, they varied in the specific methods used to implement and embody these principles. A study on student-led mental health events showcased their positive influence on well-being, with many participants agreeing that these vibrant campus gatherings nurtured and championed their mental health. It emphasized the need for engaging events that educate and empower students to reach their full potential [25]. A study explored how university faculty support students in enabling programs, their self-perceived competence, and their impact on their lives [26]. It offered a new academic vision, emphasizing student-centered support and collaboration with university counselors. The study highlighted a core principle of care and compassion in the enabling programs. On the other hand, graduate students engaged in advanced studies encounter various psychological challenges tied to culture, community, support services, supervisors, and peer dynamics. To support their well-being effectively, a holistic university-wide approach is essential. Creating an academic research culture that values the welfare of every member would immensely benefit these students [27]. Research findings show positive outcomes from coaching interventions, providing academic, emotional, and psychological support for students' professional growth [28]. To enhance effectiveness, it is essential to carry out comprehensive preparation, incorporating both group and individual sessions, pairing learners with coaches who share similar interests, exploring the potential of online coaching, and conducting careful studies across various healthcare fields and cultural backgrounds.

C. Engineering Student Self-Efficacy

It is crucial to recognize the significance of self-efficacy when it comes to the academic success of undergraduate engineering students. Researchers designed and validated self-efficacy measures specifically for engineering students. The concept of self-efficacy in engineering can be broken down into two categories: 1) general engineering self-efficacy, which pertains to overall self-belief and 2) engineering skills self-efficacy, which examines various engineering abilities [29]. Notably, high levels of general self-efficacy predicted academic success, while the intrinsic value of engineering influenced students' aspirations to pursue a career in the field. In a study of self-efficacy, achievement goal orientation, and task value, researchers found that self-efficacy had direct and indirect effects on engineering design skills, with performance goals mediating the relationship [30]. High engineering self-efficacy predicted creativity, while intrinsic value influenced students' commitment. The study introduced a model for identifying individuals' self-perceptions in engineering design tasks.

D. Coaching Strategies in Education

When we think of coaching, we often envision a sports coach propelling athletes toward victory. Coaching encompasses diverse fields today, empowering individuals to unleash their potential, excel, and conquer goals. Higher education is among the domains reaping the rewards of coaching's versatile applications. Researchers conducted a study to examine the effects of coaching relationships, communication between students and their tutors, and the utilization of coaching strategies in inquiry-based learning on students' learning dispositions and identities [31]. Results highlighted the complexity of coaching for learning, with notable improvements in independence, confidence, autonomy, and awareness of learning identities. The research highlights the distinctiveness of coaching for learning when compared to other coaching methods. It reveals increased inquisitiveness, comprehension, innovation, and involvement during the coaching process. Unveiling the potential of Mindful Effective Learning, a transformative 10-module program merging mindfulness, coaching, and study strategies, a study explored its impact on university students' learning abilities [18]. The findings showcased enhanced self-regulation, encompassing self-awareness, metacognition, and organizational skills while fostering improved emotional control and motivation through a growth-oriented mindset and heightened confidence in their intellect. The research was conducted to compare nursing students who underwent a self-directed learning program together with blended coaching to a control group. The experimental group showed superior progress in self-directed learning abilities and reported higher satisfaction with their clinical practice. These findings validate the program's efficacy in boosting self-directed learning and enhancing nursing students' satisfaction with clinical practice [32]. Conventional education methods, such as compulsory courses, in-person lectures, and final exams, fall short of equipping independent learners for upcoming obstacles. Therefore, a research study explored the methods used by academic coaches, tools fostering self-directed learning abilities, and coaching activities tied to a program called Self-Active I-Learning (SAIL) [33]. The results, including student feedback and achievements, demonstrated that coaching enhances self-directed online learning and can be applied across various fields of study. A randomized control trial was conducted to investigate the effect of academic coaching on college students' metacognition, which is a crucial component of self-regulated learning [7]. The study divided undergraduate students into three groups: 1) those who received in-person academic coaching; 2) those who received online academic coaching; and 3) a control group. The results of the study, as indicated by the Metacognitive Awareness Inventory subscales, showed that students who received academic coaching demonstrated an improvement in their metacognition. The beneficial impact was noted in both the face-to-face and virtual coaching settings. The study suggested that academic coaching holds promise as a valuable intervention for enhancing college students' metacognition beyond traditional classroom settings.

E. Fostering Self-Efficacy Through Coaching

Coaching, whether in one-to-one or group settings, empowers students to unlock their full potential and enhance self-awareness and self-efficacy, transcending socioeconomic barriers and promoting personal growth [34]. Researchers advocate for universities to adopt coaching to address students' social capital and role model needs. Career services should prioritize outreach to ethnic minorities and provide

immigrant coaches for better outcomes. Interventions should consider sociocultural context, challenge stereotypes, and promote self-efficacy [35]. Researchers explored the connection between students' self-efficacy of being given autonomy in student-centered learning environments and their ability to regulate themselves and feel confident in their abilities [36]. The investigation also considered the influence of study motivation on this relationship. The findings revealed that when teachers demonstrate supportive behavior toward autonomy, it boosts the self-efficacy of intrinsically motivated students. However, students motivated by other factors might require additional forms of support from their teachers to foster a sense of self-efficacy.

F. Coaching Science and Engineering Students

Science and engineering education foster unique learning through hands-on experiences, fueling critical thinking, problem-solving, collaboration, and determination [10]. It embraces setbacks as stepping stones, cultivating risk-taking, persistence, resilience, and focus in students' pursuit of knowledge. Accordingly, the traditional relationship between science and engineering students and the academic advisors and mentors needs to be rethought. Coaching holds significant value for science and education. Incorporating coaching practices paves the way for universities, students, and the business community to establish a productive and mutual collaboration, thereby fostering the growth of students' competitive edge and guaranteeing its continuous development [37]. A few dedicated staff members within the Faculty of Science and Engineering (FoSE) at UNNC, who had received training as performance coaches, were inspired to join the coaching in line no. 387.386 team. In a study, science and engineering students mentored peers in research and culture. Expert guidance was valued for research, while student mentors excelled in cultural aspects. Students felt more confident mentoring in culture than in technical areas. However, challenges remained, as students in international settings felt lost. The study suggests a management plan to provide local support, address these concerns, and improve the overall mentoring experience [38]. Another study showcased several instances that shed light on how students tackle their studies and the connection between their approach and results. Initially aiming to understand student requirements for better teaching, the research unexpectedly unveiled that engaging in dialogs with students had the potential to directly influence their learning experience. It was found that students often misspend significant amounts of time and energy due to their struggle to maintain proper concentration [39]. A coaching-based approach was advocated in [17] to produce well-rounded engineering graduates who align seamlessly with a broader conception of engineering success, empowering individuals to take command of their learning journey. In [40], a design education model used graduate students as coaches to address limited technical knowledge in undergraduate design education. Implemented in a capstone course on materials science and engineering design, it empowered graduate student coaches to mentor, guide, and inspire the undergraduate design team, providing expertise and mentorship.

It is worth noting that in previous science and engineering education coaching experiments, either a combination of coaching and mentoring was employed, or the focus was primarily on teaching a specific scientific or engineering discipline. In many cases, though called coaching, students were guided by their academic advisors to tell them what to do, which is more mentoring than coaching. Coaching was the approach used in other instances, but it focused on students who were having difficulties or had some disabilities. This study is a trial of deploying a coaching approach on students in several science and engineering schools and departments. Leading students by asking, not by telling, is investigated as a potential practice of students' pastoral care in higher education.

III. Methodology

In 2021, the author embarked on a journey to provide science and engineering students with a more comprehensive range of coaching methods, serving as an additional service to support their personal, academic, and professional aspirations. The underlying motivation was to leverage coaching as a proven approach to help these students gain a deeper understanding of their identity, identify their goals, assess their progress, and create effective plans to achieve them. A few dedicated staff members within the Faculty of Science and Engineering (FoSE) at UNNC, who had received training as performance coaches, were inspired to join the coaching team. Their voluntary contribution allowed them to offer free coaching services to undergraduate students. These coaches were driven by helping students in the first place. Some coaches were motivated by their desire to fulfill the coaching hour requirements needed to obtain qualifications from the International Coaching Federation (ICF). A team of student support advisors and Learning Community Forum (LCF) representatives collaborated to further promote and engage students in this project. Together, they designed an attractive poster that was displayed on the faculty's digital screens and was shared extensively across various social media channels.

This collective effort aimed to actively involve students in becoming enthusiastic participants in the coaching initiative. By raising awareness through the visually appealing poster, students were encouraged to embrace the opportunity and seek the support they needed to flourish academically and beyond. This innovative approach demonstrated the commitment to comprehensively supporting science and engineering students. By integrating coaching methods and empowering dedicated staff members and student support advisors, the approach aimed to foster an environment where students can thrive, achieve their goals, and realize their full potential.

A. Coaching Program Delivery

The coaching delivery was carefully crafted to ensure that every coachee's coaching journey could be completed within

a single semester. It involved three key sessions strategically placed throughout the term: 1) an initial coaching session at the semester's onset; 2) another session at its conclusion; and 3) an additional follow-up session available upon request. At the start of each semester, a call for coaching applications was sent out, and the administrative staff played a pivotal role in connecting students (coachees) with their preferred coaches.

During the coaching sessions, the coachee was encouraged to identify one or more specific areas they wished to address and, if possible, share these topics with the coach ahead of time. These sessions typically lasted approximately an hour and kicked off with a warm and welcoming ice-breaker introduction. Afterward, the coach and coachee will come to an agreement on the terms of coaching that they both approve of. These terms may include respect, confidentiality, being nonjudgmental, dedication, honesty, patience, empathy, and a willingness to experience discomfort. It is important to note that all coaching sessions were conducted privately, maintaining an exclusive one-on-one setting.

B. Coaching Model

The coaching methodology embraced a holistic approach, nurturing the overall development of the coachees through the utilization of a professional coaching model known as P3-growths [17]. This model was carefully crafted to demonstrate progress in three successive phases: 1) presence; 2) purpose; and 3) partnerships. It centered around the student's ability to attain complete self-awareness, make informed decisions, and take self-directed actions toward transformative change.

The different phases of this model can be compared to the organic development of a plant, beginning with the sprouting of a seed and its strong rooting into the ground (presence), followed by the upward growth of a shoot system (purpose), and the subsequent development of leaves and branches that extend outward (partnerships). Over time, this development reaches its peak when the tree produces fruit. The P3 model provides a structure for evaluating the extent, scope, and range of relationships, promoting overall development.

Personal growth is determined by how far an individual advance through the three levels of relationships—self, others, and group/audience—known as the three P's. The extent to which they progress within each level is crucial. The coaching program has been thoughtfully created to cover a wide range of topics, starting with self-awareness and building meaningful connections. It then guides individuals in discovering their academic life purpose and developing a unique personal brand. The program also includes mentoring, empowerment, leadership, and the ability to make a lasting impact. The focus was always on achieving all program aspects by asking the coachees instead of telling them what to do.

C. Participants

The study was done on undergraduate students in the FoSE at UNNC. Students who did not participate previously in coaching programs and have not had much awareness of coaching joined the program delivered by this coaching station. The study was carried out while adhering to the research conduct and ethics code of UNNC. The researcher obtained approval for their Research Ethics application from the faculty research officers before starting the data collection process. Coachees who signed up for the program were invited to complete an online survey via MS Forms at the end of the program. Participation in the survey was entirely voluntary, and no incentives were provided to the participants.

D. Student Survey

To assess the impact of coaching on students' experience, the participants were given a concise survey to complete. Coachees were also encouraged to complete the survey at the end of the program. The survey comprised 20 questions, including open, 14 5-point Likert, and two 10-point scale questions. Excel and SPSS were utilized to analyze the responses. Thematic analyses were used for student responses to the open questions to explore the impact of academic coaching on science and engineering students' personal and academic development. This involved a systematic approach to identify, analyze, and report patterns within the qualitative data derived from the responses. Ninety-nine undergraduate students have joined the program of this study, and 42 participated in the survey. Fig. 1 illustrates the distribution of participants based on their year of study. The majority of participants were junior students, with 38% from year 1 and 46% from year 2. Senior student participation was 16%, evenly split between year 3 (8%) and year 4 (8%). Fig. 2 displays the division of student participation across various departments and schools. Specifically, the data pertains to three engineering departments: 1) Architecture and Built Environment; 2) Electrical and Electronic; and 3) Mechanical Engineering. Each of these departments contributed equally, with an 8% participation rate. Additionally, students from two science schools—Mathematical and Computer Sciences—had a 15% participation rate each. The School of Geographical Sciences had an 8% participation rate. It was intriguing to observe a significant presence of year 1 students despite them not being classified as science and engineering students yet. It is worth noticing that in UNNC, Year 1 is regarded as a preliminary year; therefore, they could also be considered the majority in this study, as demonstrated in Fig. 2.

IV. Results

A. Quantitative Data

As part of an evaluation of the participant's knowledge of coaching prior to joining the coaching station, they were asked to rate their awareness of coaching on a scale of 1–10. The results are depicted in Fig. 3, where a score of 10 indicates complete awareness of coaching, while a score of 1 indicates no awareness. Out of the responses collected, only 6% of participants ranked their awareness at 9, and 8% ranked it at

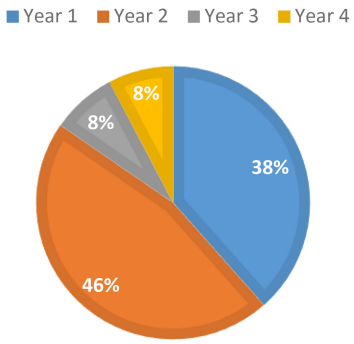

Fig. 1. Participants breakdown by year of study.

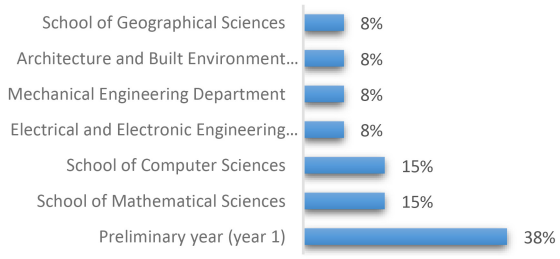

Fig. 2. Participants breakdown by the program of study.

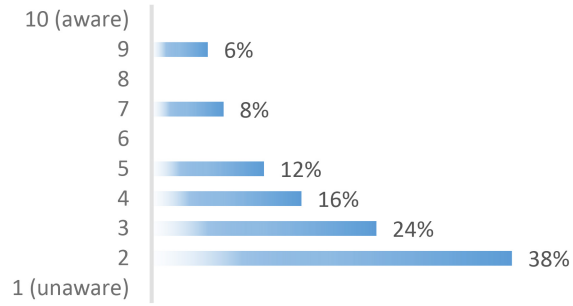

Fig. 3. Participants' awareness of coaching before joining the program.

7. The majority (86%) were unaware, with 38% ranking their awareness at 2 and 24% ranking it at 3.

As part of the investigation into the coaching program's impact on participants' interpersonal skills, they were asked to rank six given statements, with the one having the highest impact at the top. Fig. 4 displays the responses received. Most of the time (27%), the participants agreed that coaching offered them effective strategies to achieve their goals, which they ranked as the most impactful coaching skill. Meanwhile, 22% of the time, the participants ranked improved ability to focus on tasks as the most significant. Motivation, confidence, self-esteem, self-advocacy, decreased stress, and feelings of reassurance or support were equally chosen 17% of the time by participants as having the highest impact. Clarifying goals was considered the most effective skill 11% of the time, while improving communication or writing skills was chosen 6%.

As part of an assessment of the coaching program's impact on participants' personal development, they were asked to answer a Likert question consisting of six statements on a 5-point scale. Fig. 5 illustrates their responses. All participants either strongly agreed (62%) or agreed (38%) that coaching

Fig. 4. Impact of coaching on the coachees' interpersonal skills (descending order).

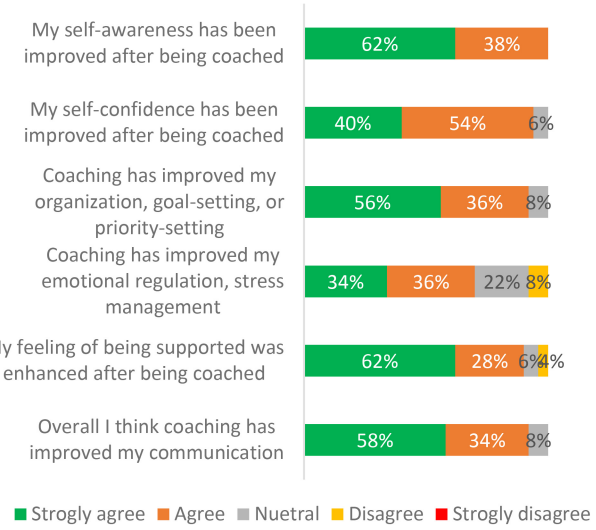

Fig. 5. Impact of coaching on students' personal growth.

had improved their self-awareness. 94% of them strongly agreed or agreed that their self-confidence had increased, with only 6% being neutral. In terms of goal-setting and priority-setting, 92% of participants either strongly agreed (56%) or agreed (36%) that coaching had helped them improve their organizational skills, and 8% had no opinion. With regards to emotional regulation and stress management, 70% of participants either strongly agreed or agreed that coaching had improved their ability to manage stress, but 8% disagreed, and 22% had no opinion. 90% of participants either strongly agreed or agreed that they felt more supported during their coaching term. This statement, along with the improvement in self-awareness, had the highest percentage of strong agreement, at 62%. Furthermore, 92% of participants either strongly agreed (58%) or agreed (34%) that coaching had enhanced their communication skills in general.

During an intervention aimed at examining the effectiveness of academic coaching in helping participants achieve their learning goals, the participants were presented with five statements and asked to rate their level of agreement on a 5-point Likert scale, with 1 indicating the least helpful and 5 indicating the most helpful, as shown in Fig. 6. According to the survey, the majority of participants (85%) found academic coaching to be either very helpful or helpful in reducing or managing their study-related stress. However, 15% of participants had a neutral stance. Regarding improving writing, reading, study skills,

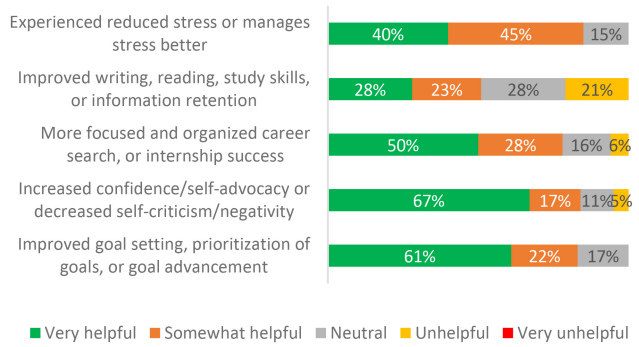

Fig. 6. Ways academic coaching assisted in attaining academic objectives.

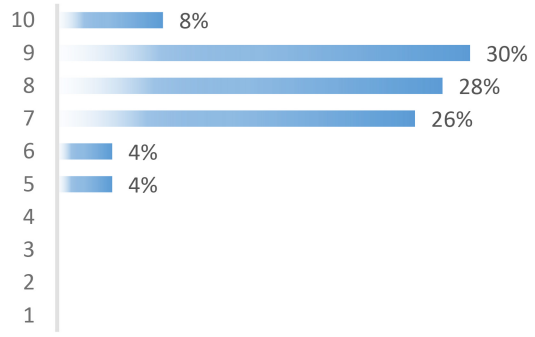

Fig. 7. How academic coaching made a difference in where the coachee is.

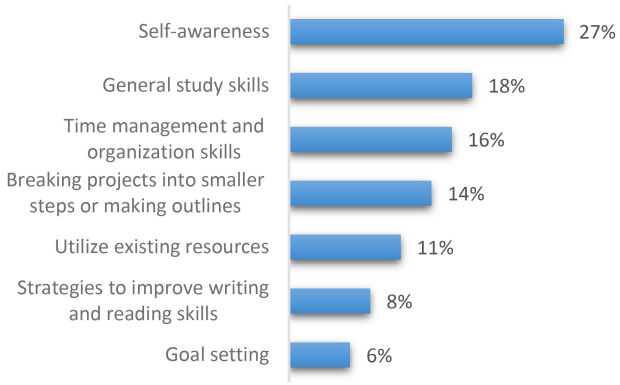

Fig. 8. Impact of coaching on the coachees at the academic level (descending order).

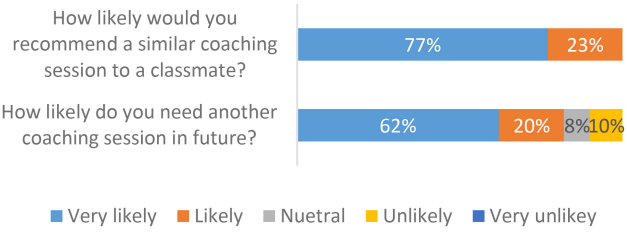

Fig. 9. Future coaching and recommendation.

or information retention, 28% of participants found academic coaching very helpful. In comparison, 23% found it helpful, 28% found it neutral, and 21% found it unhelpful. Regarding focusing on their career, 78% of participants found academic coaching to be either very helpful (50%) or helpful (28%). Only 6% found it unhelpful, and 16% had a neutral stance. When it came to increasing confidence and self-advocacy or reducing self-criticism and negativity, most participants (67%) found academic coaching to be very helpful or helpful (17%). In comparison, 5% found it unhelpful, and 11% had a neutral stance. Regarding goal-setting, prioritization, or goal advancement, 61% of participants found academic coaching to be very helpful or helpful (22%), while the rest were neutral.

The researcher was curious about the effects of academic coaching on the participants' progress. In order to determine this, the participants were asked to rate on a scale of 1–10 how much academic coaching had impacted their progress. The results, shown in Fig. 7, indicate that all participants rated academic coaching as five or higher. Additionally, 66% of participants rated it eight or higher, while only 8% rated it 5 or 6.

As part of the investigation into how coaching affects a student's academic growth, participants were asked to rank seven statements in terms of their impact, with the most impactful at the top. Fig. 8 shows the responses received. Self-awareness was ranked in the top 27% of the time, which was a significant difference from the other items on the list. General study skills came in second and ranked in the top 18% of the time. Time management and organizational skills were ranked in the top 16%, slightly above breaking projects into smaller steps, which was ranked in the top 14%. Utilizing existing resources was ranked at 11%, strategies to improve writing and reading skills at 8%, and goal setting was ranked in the top 6% of the time.

After completing the coaching program, all participants agreed to recommend it to their peers. According to the data displayed in Fig. 9, 77% of them highly recommended it, while the remaining 23% said they would recommend it. Moreover, the majority of the participants (82%) expressed their interest in attending another coaching session in the future, with 62% of them being very likely and 20% being likely. Only 10% of the participants showed disinterest in future coaching, while 8% remained neutral.

B. Qualitative Data Analysis

To evaluate the effectiveness of the coaching approach, the study conducted a comprehensive qualitative analysis of participant feedback collected from open-ended survey questions. In an intervention, students were asked how coaching influenced their goal-setting abilities. A thorough thematic analysis of the responses revealed significant insights into the impact of the coaching approach on their personal and academic achievement. Four key themes emerged from the analysis.

1) Enhanced Decision-Making and Goal-Setting: A recurring theme from the responses is the significant impact of academic coaching on students' decision-making and goal-setting abilities. The participant's quote manifests this, "*Coaching helped me set my goals··· my answers led me straight to my decision*." This sentiment echoes across other narratives, highlighting, "*The questions my coach asked me*

were powerful··· led me to find proper ways to plan and enhance my progress."

2) Development of Self-Awareness and Independent Learning: Participants consistently reported increased self-awareness and an ability to undertake independent learning. One case is illustrative: "*Coaching helped me focus on a clear goal··· I aim to self-learn many things to be at the same level as my classmates*." This reflects a broader trend where coaching encourages students to understand and take charge of their learning needs. Another participant's insight, "*Coaching is about finding the problem, locating the problem*," further emphasizes this growth in self-awareness and proactive learning strategies.

3) Improvement in Communication Skills: Several students highlighted improving their communication skills as a direct outcome of coaching. One noticed a distinct enhancement in family interactions: "*Coaching helped me to better communicate with my family*." The emphasis on self-communication and logic in conversations reflects the holistic development approach's influence on interpersonal skills.

4) Motivation and Vision for Future Endeavors: Academic coaching also notably inspired students to visualize and pursue their future aspirations. One participant's experience is telling: "*Coaching inspired me to visualize an image of how I would become··· It motivated me to allocate frequent time slots in my busy schedule to practice writing*." This theme underscores the role of coaching in academic achievement and nurturing broader life goals and personal interests.

In another intervention, students were asked how coaching helped them to achieve their goals. The thematic analysis of participants' responses identified several key themes.

5) Structured Planning and Progress Monitoring: A significant theme emerging from the responses is the role of coaching in fostering structured planning and progress monitoring. This is clear from a participant's statement, "*I set a regular plan for each week and a general plan for the semester··· I reviewed my plan weekly*." This structured approach, coupled with regular reviews, appears crucial in helping students achieve their academic goals, as evidenced by the participant's achievement: "*I've accomplished 80% of my objectives, as evidenced by my strong performance on my final exams*."

6) Enhanced Social and Personal Life Balance: Participants reported an improvement in balancing their academic, personal, and social lives due to coaching. One participant's testimony reflects this balance: "*I can find more time than before to make phone calls with my family··· Later, this made my holiday time with my family more enjoyable*." This improvement in managing personal relationships, alongside academic commitments, highlights coaching's role in fostering a well-rounded life for students.

7) Empowerment in Self-Directed Learning: Coaching has significantly empowered students in self-directed learning. This is illustrated by the response, "*I had to learn chemistry on my own··· After being coached, I decided to find a few sources to learn from*." This empowerment in seeking knowledge independently and effectively utilizing available resources demonstrates the influence of coaching on students' learning autonomy.

8) Development of Goal Achievement Habit: A novel insight from the responses is developing a habitual approach to goal achievement. A participant's experience is a case in point: "*I found that I started to grow a habit··· Monitoring my daily achievements and writing down my reflections*." This shift from goal-setting to forming a habit of regular reflection and adjustment signifies a more profound, more sustainable impact of coaching on students' approach to their goals.

In a third intervention, students were asked to express their opinions on how coaching could improve their learning experience. The thematic analysis of participants' responses revealed the following themes.

9) Strategic Planning and Time Management: A prominent theme from the responses is the critical role of coaching in aiding students with strategic planning and time management. The participants emphasized the unique workload of their field, stating, "*Science and engineering students would benefit greatly from having a detailed plan for the semester*." The coaching approach motivated them to manage the rigorous demands of their courses. One participant mentioned, "*I developed the skill of taking small steps. This also improved my time management*." These insights highlight how coaching aids in developing effective planning strategies, which are crucial for managing complex academic loads.

10) Fostering Self-Reliance and Independent Learning: Coaching also played a significant role in fostering self-reliance and independent learning skills. This is illustrated by the statement: "*Coaching helped me to improve my learning experience. I developed self-study skills and became a more independent learner*." This theme underscores the value of coaching in cultivating autonomous learning strategies, a critical aspect for science and engineering students who often encounter complex and self-driven projects.

11) Enhancing Communication Skills and Networking: Another key theme is the importance of improved communication skills and networking. A participant notes, "*This also improved my communication skills and relationships with classmates, other students, and people in general*." This improvement is vital in science and engineering fields, where collaborative projects and networking can significantly impact learning and career opportunities.

12) Positive Mindset and Problem-Solving Skills: Finally, coaching is instrumental in instilling a positive mindset and problem-solving skills, as described by the statement: "*I started to feel positive and considered the possibility that the problem may not have been with me. Coaching has helped me to think out of the box*." This change in perspective is crucial for science and engineering students who often face challenging coursework and need to approach problems creatively.

To answer the first research question, "What is the degree of influence that the academic coaching approach has on the personal development of students?" Fig. 10 visualizes the common patterns from the thematic analysis of participants' responses to the open-ended questions. For the second research

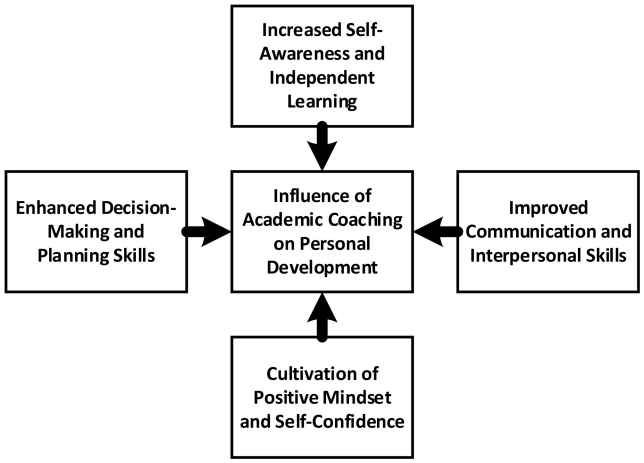

Fig. 10. Influence of academic coaching approach on the personal development of students.

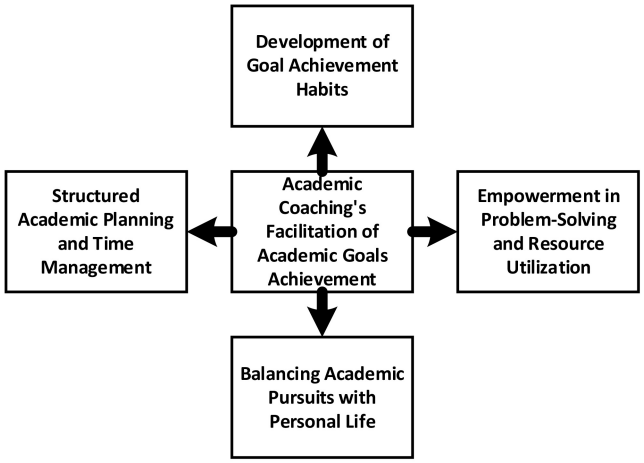

Fig. 11. Academic coaching facilitation of academic goals achievement.

question, "In what ways has academic coaching facilitated the achievement of academic goals for science and engineering students?" common patterns among the defined themes were identified and illustrated in Fig. 11. As illustrated in Fig. 11, a common theme was the development of structured academic plans and enhanced time management skills. This aspect directly contributes to achieving academic goals by providing a clear framework and efficient use of time, which is essential in rigorous fields like science and engineering. Participants noted the formation of habits aimed at goal achievement, such as regular reflection and progress tracking. This pattern indicates the holistic approach's emphasis on self-motivated and continuous personal and academic development. Coaching encouraged students to become resourceful and effective problem-solvers. This empowerment is key to achieving academic goals, particularly in science and engineering, where innovative and critical thinking is paramount. Many responses highlighted an improved balance between academic commitments and personal life. This balance is a core principle of the holistic development approach, ensuring that students maintain a healthy work–life balance while pursuing academic excellence.

V. Discussion

Learning through science and engineering education creates a wonderful environment for developing effective learning techniques that involve practical participation. These experiences stimulate critical thinking, innovative problem-solving, a team-oriented mindset, unyielding determination, and other versatile skills essential for learning in various fields [41]. Young learners become smart and skillful observers during scientific exploration and engineering challenges, engage in collaborative conversations with mentors and peers, and display flexible thinking by generating hypotheses and brainstorming potential solutions. The core of science and engineering is rooted in the realization that knowledge arises from initial setbacks, embracing an iterative process of trial and error. Throughout this process, science and engineering students build the ability to take risks, persevere in facing challenges, cultivate resilience when faced with frustration, and maintain an unwavering focus on their objectives. For those reasons, science and engineering education allows for many coaching opportunities.

A. Coaching Science and Engineering Students

In the study presented in this article, a pilot coaching program was conducted to promote the holistic development of undergraduate students from various departments and schools in the FoSE. As the findings revealed in Fig. 3, most participants had limited knowledge about coaching before joining the initiative. This lack of awareness could have posed a challenge, as students may have had varying expectations of the program's outcome. Nevertheless, this presented an opportunity to test the initiative's effectiveness and gather feedback from participants on the potential growth they could achieve despite their busy study schedules.

Many participants enrolled in this coaching program were in their first year of preliminary studies, even though they had not yet been classified as science and engineering students. It appears that during their first year of study, some students may feel unprepared for higher education and, therefore, seek guidance and mentorship. This aligns with previous research that suggests first-year students require specialized assistance to facilitate a smooth transition from secondary to higher education [4]. It is important to clearly understand what first-year students are expected to know and stay connected with them to bridge or prevent any gaps between their knowledge and expectations [42]. In addition, first-year students have recently had their first personal tutorial experience. It is crucial for the success of the student–tutor relationship that there is a sincere willingness to provide support [15].

Fig. 4 shows that when the participants were tasked to prioritize the potential effects of coaching on their interpersonal skills, strategies to meet goals and improved ability to focus on tasks were consistently ranked as the top choices. This indicates that students require more than just instruction or direction in identifying their goals and tasks—they also need holistic support for their personal and professional growth. The figure highlights that writing skills appeared at the bottom, indicating that coaching should focus on developing skills

related to planning, monitoring, and reflecting on the metacognitive dimension. This was further emphasized in Fig. 5, as all participants strongly agreed or agreed that coaching improved their self-awareness. The majority strongly agreed their feeling of being supported was enhanced after they enrolled in the coaching program, which is expected to indirectly lead to a higher sense of belonging to their institution. The participants have reported a significant improvement in their communication skills, with 92% attributing it to the coaching sessions. This is because the coaching process requires them to face challenges and engage in deep thinking, prompting them to explore and reflect on themselves in response to the coach's questions.

At the academic level, as evidenced in Fig. 6, most participants strongly agreed that academic coaching boosted their confidence and self-advocacy while reducing negative self-criticism related to their studies. Despite the 5% of participants who disagreed, coaching still significantly impacted students' experiences by helping to alleviate negative emotions along their academic journey.

Also, coaching primarily involves thinking and reflection, which may explain why 21% of the participants did not feel that coaching had enhanced their writing abilities. However, if students were guided to self-coach and develop their journaling skills in the program's later stages, this could positively impact their writing skills, providing an additional benefit. Moreover, the professional career coaching provided in the program helped participants focus on their career search and secure internship opportunities. This aligns with previous research emphasizing the importance of a comprehensive advising approach that includes academic and career guidance [43].

Coachees' reflections showcased the GROW coaching model in higher education [44]. They involved identifying what students aspired to achieve, what resources they possessed, and exploring available options to create a proper plan to attain their goals. This plan was obviously dynamic and subject to continuous reviews to adapt to changing circumstances. As extrinsic motivation, rewarding students will further enhance their progress.

The qualitative data analysis sheds more light on the impact of coaching on student's personal development, as illustrated in Fig. 10. The participants reported that they had experienced significant improvements in their ability to make informed decisions and plan effectively. These findings resonate with earlier research, suggesting that coaching is an effective learning approach that boosts both proficiency in self-directed learning and the satisfaction derived from learning practices [32]. This reflects the holistic development approach that emphasizes self-awareness and informed decision-making as crucial components of personal growth. A typical pattern emerged across the responses, indicating increased self-awareness and a move toward independent learning. These match the findings in [18], which state that coaching improves students' self-awareness and evaluation ability. This emphasizes the holistic approach's goal of fostering self-directed actions and autonomy in students' learning processes. Participants frequently mentioned improvements in their communication skills in personal and academic contexts. This is a fundamental aspect of holistic development, encompassing academic prowess and effective interpersonal communication. It was also noticed that the coaching process led students to develop a more positive mindset and greater self-confidence. These outcomes mirror prior research outcomes, showing that coaching has notably enhanced students' self-reliance, learning connections, confidence, independence, and recognition of their learning identities [31]. This aspect of personal development is crucial to the holistic approach, as it promotes a balanced and resilient attitude toward challenges.

The thematic analysis revealed that academic coaching significantly aids in attaining academic objectives, as illustrated in Fig. 11. A recurring theme was the creation of structured study plans and improved time management, crucial for success in demanding areas like science and engineering. These findings align with the research presented in [18] and [32], demonstrating that coaching enhanced the capabilities for organization and elaboration in handling study materials. Students reported establishing routines conducive to goal realization, such as consistent reflection and progress monitoring, reflecting the coaching's focus on self-driven and ongoing personal and academic growth. The outcomes of this study are in harmony with prior research, which suggests that coaching enhances students' metacognitive abilities, which are crucial for initiating and supporting self-regulated learning [7].

Furthermore, these findings resonate with existing literature, highlighting metacognition's beneficial effects beyond the classroom in empowering students to select, utilize, and oversee cognitive strategies in various learning scenarios [3]. The coaching process fosters students' abilities to be resourceful and skillful at problem-solving, an essential skill in fields requiring innovative and critical thinking. This can also lead to students wasting a significant portion of their study time when they are not able to focus [39]. Notably, many participants emphasized a more harmonious balance between academic and personal life. This equilibrium is a fundamental aspect of the holistic approach, promoting a healthy work–life balance while striving for academic excellence.

These common patterns identified in the thematic analysis comprehensively answer the research questions. Academic coaching profoundly influences students' personal development by enhancing decision-making, fostering self-awareness, improving communication skills, and cultivating a positive mindset. Simultaneously, it facilitates the achievement of academic goals through structured planning, habit development, empowerment in problem-solving, and balancing academic and personal life. These findings demonstrate the effectiveness of the academic coaching approach in aligning with the principles of holistic development in science and engineering education.

B. Insights and Reflections

Engaging in coaching practices can offer substantial benefits to science and engineering students. The following are

some insights on how coaching can positively impact their educational journey.

1) *Critical Thinking and Resilience:* The practice of coaching is highly compatible with science and engineering education, as it contributes significantly to the overall development of students. Coaching enables students to engage in critical thinking and analyze complex problems, advancing their problem-solving skills in scientific or engineering fields. Additionally, coaches have a crucial role in promoting creativity by encouraging the exploration of diverse perspectives and strategies, which empowers students to tackle challenges with innovative thinking. Coaches continuously provide support and encouragement, instilling confidence in students, celebrating their achievements, and guiding them through setbacks. This comprehensive approach fosters resilience and a growth mindset, empowering students to overcome obstacles and succeed in their science or engineering pursuits.
2) *Independence and Accountability:* In contrast to mentoring, where the focus is on identifying areas of the mentor's expertise or experience desired by the student, the integration of coaching within the framework of student support in higher education entails assisting students in establishing specific, measurable, achievable, relevant, and time-bound (SMART) goals. Coaches hold students accountable for their progress, fostering consistency and aiding them in staying on track, instilling a sense of discipline and dedication. Unlike mentoring, which operates with flexible time constraints, coaching operates within clear time boundaries. This allows educators and personal tutors to allocate their time to other teaching and research responsibilities, as they do not need to extensively address the tutee's specific problems. Instead, they employ powerful questioning techniques to facilitate the tutees' self-discovery of their current situation, available options, and the subsequent development of action plans. The tutors can then follow up with their tutees as coaches and, if needed, fulfill the mentor role.
3) *Personalized Guidance:* In the era of information abundance, where diverse sources are readily available, students no longer rely on someone simply providing them with information. Instead, the focus should shift toward delivering customized and personalized advice. One-size-fits-all approaches are ineffective, and the most valuable guidance can arise from the students themselves through self-advising, which emerges from coaching. Coaching and offering personalized support becomes instrumental in enabling students to uncover their distinct strengths, interests, and aspirations. Through the guidance of coaches, students can identify areas for growth and develop tailored strategies to elevate their science or engineering skills, fostering a truly individualized learning experience that aligns with their unique needs and goals.
4) *Cultivating Self-Coaching:* Regular coaching sessions help students understand their learning styles, preferences, and motivations, leading to increased self-awareness. This self-awareness allows students to make informed decisions, reach their full potential, and become self-directed learners. Self-directed learning requires developing self-advising skills to maintain effectiveness, especially in the absence of an instructor. Skilled self-coaches take responsibility for planning, monitoring, and evaluating their learning using internal dialog and self-motivation to solve problems and achieve goals. Students identify learning challenges, find solutions, and stay motivated by questioning themselves. Unlike traditional mentoring, self-coaching has no confidentiality, disclosure, time constraints, or physical location concerns. This approach is well-suited for the current state-of-the-art generative AI technology. It emphasizes the importance of developing questioning skills rather than just answering them. Improving self-coaching skills empowers students to become more successful self-directed learners.

C. Recommendations

The following are a few recommendations for learning and teaching authorities in higher education.

1) A comprehensive training program could be created to enhance the coaching skills of personal tutors on a wide scale. This training will serve as an essential foundation to equip general coaches in higher education with the knowledge of the GROW coaching model. The goal is to promote a coaching approach to personal tutorials and enhance the overall quality of personal tutoring. Through this program, tutors will develop advanced questioning and active listening skills, enabling them to integrate the coaching approach into their practice during personal tutorials, teaching delivery, and research supervision.
2) Higher education institutions can enhance their student support framework by integrating coaching as a recognized component. Optional coaching sessions could be offered to students as part of a mini-coaching program that spans one semester, including at least two sessions. During the first session, students will be introduced to the coaching approach and establish mutual agreements with their coach. The coach will then guide on a topic chosen by the student. In a follow-up session with the same coach, students will reflect on their personal and academic growth. This semester-based mini-coaching program may be repeated as many times as students choose. To implement this framework, specialized coaches will require intensive training.
3) A wide range of student training programs can be developed to increase awareness of coaching and its potential influence on personal, academic, and professional growth. The objective of this training is to equip students with self-coaching skills, which will enable them to take responsibility for planning, monitoring, and evaluating their learning. With the help of internal dialog and self-motivation, skilled self-coaches can confront

potential learning or personal challenges. This approach will produce self-directed and self-regulated learners with a strong sense of discipline and dedication, empowering them to progress and become future leaders.

VI. Conclusion

This study explored the use of coaching in higher education, specifically its impact on science and engineering students. Coachees were surveyed using a combination of Likert and open-ended questions to gather feedback on their experience with a semester-long coaching program. The results indicated that incorporating coaching practices could enhance the overall development of students in these fields. Additionally, this article suggested that traditional personal tutorial programs could benefit from a shift toward coaching rather than mentoring. Tutees could gain the necessary tools to navigate their learning journey more independently by being asked powerful questions instead of being provided direct guidance. Suppose coaching is a recognized component of the student support framework. In that case, it can foster an environment that promotes holistic growth and empowers students to reach their full potential in all aspects of their studies and life. As a result, it is recommended that learning and teaching authorities in higher education consider providing training in coaching practices for personal tutors and tutees. This study also has potential implications for the design of student support frameworks in higher education.

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