THE CENTRE OF EXCELLENCE FOR BLACK STUDENT ACHIEVEMENT

Black Students Adventures in Engineering with the University of Ottawa

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Black Students Adventures in Engineering with the University of Ottawa

In Ontario, 87.2% of students graduated with a high school diploma in 2019 (Ontario Ministry of Education, 2020) and approximately 70% of students from the Toronto District School Board (TDSB) continue on to post-secondary education (PSE) (Sweet et al., 2010). Such high entrance rates into university are due to a competitive Canadian job market which renders a high school diploma as insufficient. PSE has been positively associated with higher individual earnings, citizen engagement and economic contributions (Sweet et al., 2010). This would mean that accessible PSE is a necessary endeavour towards supporting young people's upward economic mobility as well as maintaining a sustainable Canadian economy.

While this avenue is deemed important on a personal as well as a national level, Black students have been underrepresented in post-secondary streams in Canada. For African, Afro-Caribbean, and Black (ACB)[1] students, pathways to PSE have been limited or restricted by systemic barriers to access in PSE. These differential opportunities limit Black students from developing the skills necessary for careers in more advanced industries. One way of addressing these concerns is the development of interventions by education stakeholders in providing alternative pathways that recognize and support the needs of Black students, both financially and non-financially (Stol et al., 2016). PSE bridging programs exist as a means of reducing barriers to participation by responding to existing barriers that have a negative impact on students' trajectory in higher education. PSE bridging programs are specifically designed to prepare Black and other underrepresented students for participation in PSE spaces. Generally, these programs create accessible pathways to PSE participation for youth facing multiple and complex barriers.

About the Centre of Excellence for Black Student Achievement

[1] The authors of this report alternate between using the term Black and African, Afro-Caribbean, and Black (ACB) throughout the document.

The Centre of Excellence for Black Student Achievement is the first of its kind in public education in Canada. The vision of the Centre of Excellence is to improve Black students' schooling experiences and outcomes and support their wellbeing with the development of nine mandates (TDSB, 2021) that provide recommendations and support to TDSB schools and staff

to combat anti-Black racism, identify barriers to success, and provide access to appropriate resources and programs for Black students (i.e., scholarships, networking, mentoring). The mandates will also inform changes to policies and procedures within the TDSB now and in the future to ensure that all students benefit from the learning and innovative practices developed by the Centre of Excellence.

Partnership with the Faculty of Engineering Secondary School - University of Ottawa

Black Students Adventures in Engineering was an initiative between the TDSB's Centre of Excellence for Black Student Achievement and the Faculty of Engineering Secondary School at the University of Ottawa. The program offered African, Afro-Caribbean, or Black (ACB) students from middle school to high school the opportunity to take high school courses at the University of Ottawa while gaining credits toward their Ontario Secondary School diploma. The initiative was aimed at providing alternative pathways to post-secondary science and engineering fields exclusively for ACB students.

Research on student retention shows higher rates of program completion when students are given opportunities to engage in the larger college or post-secondary environment, including campus activities (Harper, 2014). More importantly, as the Centre of Excellence utilizes its mandates to provide recommendations and disrupt anti-Black racism— ongoing discussions

about representation in science and engineering continue to stir urgency and immediacy. Figuring out how to get Black students on a STEM path in K-12 education offers them a greater chance of making it to and through PSE.

As researchers, educators, institutions, and community stakeholders try to monitor and identify the source of anti-Black racism and racial imbalances in schools, there is increased interest in partnering with post-secondary programs aimed at boosting retention and creating access.

Scope of the Report

This report seeks to shed light on the initiative within its first year of implementation with the aim of assessing its efficacy and highlighting areas of improvement based on the students (n=16) who participated. The discussion generated is also intended to provide an evidence-based report on the Centre of Excellence's initiatives to transform Black students' learning,

achievement, and wellbeing. These are all part of the school improvement processes noted throughout the TDSB's multi-year strategic plan (TDSB, 2018).

Literature Review

Black Students' Identity in Education

For this report, the term "Black" is used to refer to any people of African descent, encompassing African, Afro-Caribbean, and Black (ACB) diasporic identities that are multidimensional and constructed by race, gender, sexuality, socio-economics, migration, ability, culture, and numerous other categories (Evans, 2019; Munroe, 2021a). This embodies intricate processes of how they navigate Canadian life and geographies. For Black students whose identities are on a continuum, the salience of their identity is, therefore, a primary consideration in understanding their school experience and the wider community (Munroe, 2021a). As Black children and youth adopt, adapt, and make their educational experiences their very own, ultimately, it contributes to their social identity formation.

Racial identity dimensions have been implicated—indirectly and directly—in the literature on Black students' motivation and achievement (Leath et al., 2019). More importantly, the nature of their Black identity and intersectionalities often creates differential learning and schooling experiences and outcomes.

Access to Post-Secondary Education for Black Students in Ontario

Ontario has one of the highest post-secondary participation rates, with more than 80% of secondary school students enrolling and up to 70% completing a post-secondary degree from universities, colleges, apprenticeships, and private training programs (Stol et al., 2016). However, a closer look at the data shows that youth (a) from low-income families, (b) of first-

generation descent, (c) of Aboriginal backgrounds, (d) from rural areas, or from the North, (e) with dependents, (f) with disabilities and, (g) under the care of the government have relatively low post-secondary participation rates (Stol et al., 2016). Another recent report by James and Turner (2017) indicated that Black youth were nearly twice as likely (20%) to drop out of high school compared to their White counterparts (11%). Furthermore, the analysis revealed that the longer Black families were present in Canada, the outcomes for Black students were more pronounced. In other words, third-generation ACB Canadians have greater education disparities and barriers, followed by second- and first-generation Canadians.

In a comprehensive review of Canadian literature, Cheung (2007) concluded that ethnicity and socioeconomic status were the two most important determinants of high school dropout rates and post-secondary participation. Another study noted that stratification of lower socio-economic status, discrimination within educational institutions, and feelings of alienation among marginalized groups all contributed to higher drop-out rates and lower levels of PSE achievement (Aronson, 2002). Furthermore, Aronson (2002) noted that these compounded factors meant that some students are less likely to aspire to and enroll in PSE. Taken together, these outcomes grossly underscore the need to support Black students in Ontario in accessing PSE pathways.

Other studies have shown that some first- and second-generation ethnic groups, including students of Caribbean and East African descent have lower levels of participation in PSE compared to students born in Canada (Aronson, 2002; Cheung, 2007; James & Turner, 2017). For example, the James and Turner (2017) report revealed that only a quarter of Black students (25%) at the TDSB applied to and were accepted by an Ontario university and 21% of Black students had applied to and were accepted by an Ontario college in 2011. Application rates to post-secondary education pathways in 2011 also revealed that 25% of Black youth applied to and were accepted into an Ontario university. This is in comparison to 60% of White youth applying and being accepted. One of the more noteworthy statistics in the James and Turner's 2017 report revealed that 43% of Black students in grade 12 at TDSB did not apply to post-secondary education in 2011. This was almost the same rate in which White youth were accepted into PSE spaces.

Another study by Robson et al. (2018) examined data from two cohorts of Grade 12 students in the TDSB to ascertain whether the transition to post-secondary education changed

between 2006 and 2011, particularly for underrepresented groups (Robson et al., 2018). The researchers' findings revealed that Black students, among other racial minority groups, were less prepared for post-secondary education than White students (Robson et al., 2018). Black students had lower than average GPAs, higher identification of special education needs, and lower likelihoods of taking academic-stream courses (Robson et al., 2018). These differences

remained stable between 2006 and 2011. Interestingly, Robson et al. (2018) found that Black students were more likely than White students to confirm a place in university in 2011—a significant difference from the 2006 cohort. However, there remained a significant difference

in the rates of applications and acceptances to PSE institutions for Black students. These outcomes are cumulative and maintain cyclical long-term impacts on Black students' economic and social mobility. The education experiences of Black students continue to be an ongoing concern for members of the Black community and education stakeholders.

While the achievement gap identified between Black, White, and other racialized students continues to grow, programs such as the Black Students Adventures in Engineering help to create alternative pathways to increase engagement and retention rates of Black students in higher education. As noted by Daniel (2018), "when Black students are provided with the necessary support and resources and exposure to models of success and narratives of success, the outcome is higher graduation rates and academic attainment" (p. 1).

Black Students in PSE STEM Engagement

The prevailing culture and structural manifestations in Science, Technology, Engineering and Mathematics (STEM) have traditionally privileged norms of success synonymous with hyper-masculine, White, and often middle-class and heterosexual demographics (Ong et al., 2018). Although STEM is a newer construct, STEM is encroached within the realm of science, which comes with a powerful socio-historical legacy and is reproduced as an objective, privileged way of being and knowing that is pursued by an intellectual elite (Burke & Wallace, 2020). Therefore, the profile of who continues with STEM into further education is stratified along multiple social axes and is often in favour of the dominant demographic group (Godec, 2018), specifically, White, middle-class men.

Inequalities in science participation are not only a social justice issue in PSE, but also a concern for the future supply of a skilled workforce and national economic competitiveness (Godec,

2018). Due to the exclusionary culture in science education, STEM has been an unwelcoming space for women, particularly racially/ethnically underrepresented students, and women of colour (Ong et al., 2018). As noted earlier, Black students in Canada have one of the lowest completion rates for post-secondary education and even greater dropout rates in STEM programs (Stolle-McAllister, 2011). This has been attributed to Black students experiencing

academic and cultural isolation, low performance expectations by students and faculty, lack of affinity spaces, and discrimination (Stolle-McAllister, 2011). Additionally, factors such as exclusion from social networks, Black representation, mentorship, and lack of knowledge about the culture of scientific communities, also contribute to the lower rate of participation and retention of ACB students.

Undoubtedly, intervention initiatives or bridging programs have been proven to be effective in the areas of attrition and persistence. According to Stole-McAllister (2011), initiatives aimed at addressing the complexities surrounding the participation and persistence of ACB students should aim to not only address financial barriers, but also to inform students about campus life, orient students to institutional culture, and help students develop social networks. The Black Students Adventures in Engineering program was designed to respond particularly in the areas of academic skills, exposure to science and engineering fields, and inform students about the broader social and cultural contexts of post-secondary institutions.

Program Context

Some of the most commonly cited barriers to Black students' participation in science and engineering are the lack of early K-12 exposure to STEM education and academic preparedness (Stolle-McAllister, 2011). As such, the Centre of Excellence was intentional with its outreach and targeted Grades 8 to 12 students and recent secondary school graduates. This targeted approach is tied to the process of academic progression in Ontario schools. Courses selected in Grades 9 and 10 often have impacts on students' program of study in Grades 11 and 12 as well as whether they graduate on time (i.e., after 4 years of high school). For example, students interested in STEM courses who miss out on taking the requisite electives such as "Exploring Technological Design (TDJ1O)" and "Creative Computing: Introduction to Computer Studies (ICS2O)" also miss out on taking the follow-up courses in Grades 11 and 12. This has a domino effect to applying and being accepted into science and engineering higher education programs.

To this end, the Black Students Adventures in Engineering program provided another pathway to support students that are currently interested in a future in STEM and those who missed out on taking "STEM" subjects such as TDJ1O and ICS2O in Grades 9 and 10. The initiative was presented by the Education Equity Secretariat at the Ministry of Education. Funding was provided to the Engineering Outreach Office at the University of Ottawa for Black, Indigenous,

and racialized students to attend their virtual design and /or computer science courses in July and August of 2021.

Program Objectives

The aim of this pilot project was to provide an initiative that not only addressed the need to increase participation of Black students in post-secondary science and engineering pathways,

but to also promote access to PSE. The program objectives were developed to provide a more targeted intervention as it relates uniquely to the needs of ACB youth.

The aim of the program was to:

1. Improve ACB students' post-secondary education pathways to engineering and science.
2. Support ACB students' ability to effectively navigate the broader social, academic, and cultural environment of PSE.

3. Provide early exposure to post-secondary engineering and science departments.
4. Support ACB students' development of academic skills.

Furthermore, a corresponding set of outcomes was also aligned to evaluate the efficacy of the program and highlight opportunities for further scope and development. The expectations were developed to align with the program objectives stated above:

1. Students are supported in gaining high school credits to enrol in post-secondary science and engineering fields.
2. Students have an understanding in navigating post-secondary academic systems, and social and cultural environments.
3. Students are provided with specialized support to gain self-confidence to enter and persist in a PSE program.

4. Students are supported in gaining academic skills in Technology Design and Computer studies.

Program Description

The courses ran over one[2] consecutive four-week period resulting in 110 hours of course time in the summer from June to July 2021 at the Faculty of Engineering Secondary School at the University of Ottawa. Students signed up for either one of two secondary school electives: Exploring Technological Design (TDJ1O), a Grade 9 course and Introduction to Computer Studies

(ICS2O), a Grade 10 course. Over the four-week duration, students received intense instruction in their chosen elective both synchronously and asynchronously. Students were expected to work and be available every weekday between 9:00 a.m. and 4:00 p.m. Synchronous sessions were offered Mondays, Wednesdays, and Thursdays by the University of Ottawa teaching staff.

Synchronous sessions were also held by the TDSB Graduation Coach on Thursdays. Asynchronous sessions included drop-ins to virtual office hours via Microsoft Teams. University of Ottawa teaching staff also held office hours two to three times per week by chat, email, and video call. During this time, teachers were available to answer students' questions. As a result, study skills and time management were critical expectations of the program. Students learned in real time how to adjust to the demands of post-secondary education as a STEM student.

Methodology

Research Design

This project adopted a survey design that included pre-and post-assessment questionnaires.

Study Site and Participants

[2] A second cohort was also offered and ran between July and August for ICS3O, however, only one student participated and as such will not be included in this analysis.

The Centre of Excellence for Black Student Achievement advertised the program across all TDSB schools in May 2021. Students who identified as ACB between Grades 8 to 12 and were interested in a career in STEM were encouraged to apply. Students in Grade 8 required a letter of recommendation from their principal.

In total, 17 students applied to participate between June and July. In the first cohort, 17 students completed the intake survey, two students withdrew from the program, and one student did not meet the application criteria. A total of 14 students were then successfully registered across the two courses. Nine students registered for TDJ1O, and five students

registered for ICS2O. Of the 14 registered students, five students withdrew, eight students successfully completed the program and one student failed to achieve a passing grade. Following the end of cohort 1 and 2, the 14 students who registered were invited to complete the post-survey, with eight students participating in the final survey.

Limitations to the Study

A very small number of students participated in the program and completed the survey. Results may be highly skewed owing to this. Secondly, the main source of data was surveys and although free-writing sections were also included, the analysis was limited in some areas by the depth of students' responses.

Data Analysis

The following section provides a discussion and analysis of some of the themes that emerged from the data. The main themes that will be discussed in this section include:

1. Recasting Black students' pursuit of STEM
2. Importance of early pathways to post-secondary science and engineering for Black students
3. Opportunities for academic development
4. Navigating the social and educational aspects of post-secondary education
5. Feelings of belonging in post-secondary education spaces

Findings

Pre-Survey Findings

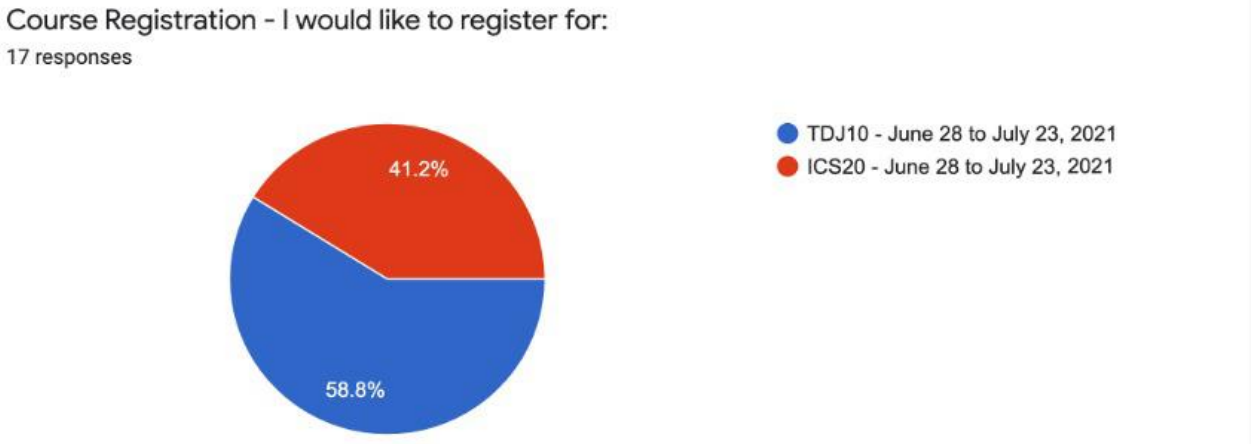
Theme 1: Recasting Black Students' Pursuit of STEM.

The theme of recasting Black students' pursuit of STEM is based on the idea that the narratives that have been pervasive are ones that reinforce constructed stereotypes of Black students

being uninterested and lacking a desire to be in the field of science. In response, the Black Students Adventure in Engineering program was designed and developed specifically for students who identify as African, Afro-Caribbean and Black. A total of 14 spaces were made available to Grades 8 to 12 students from the TDSB for each cohort. Firstly, the program was oversubscribed, with a total of 17 students completing the intake survey for the first cohort. Furthermore, 10 students indicated interest in signing up for TDJ1O and seven students indicated interest in ICS2O. See Figure 1 for student distribution by course. The high participation in TDJ1O is noteworthy as technology design courses are seen as pipelines into careers in engineering, graphic design, physics, and research scientists.

Figure 1

Course Registration



When asked about motivations and interests in taking either of the courses, the majority of students (88%) indicated their reason was to increase their employability and chances of success. Secondly, the most commonly reported motivation (70.6%) was to improve critical thinking, problem solving and decision-making skills. Students were equally as likely to report wanting to improve mathematical and logical thinking skills and to boost curiosity and cognitive skills (64.7%). Wanting to improve creativity skills (58.8%) was slightly more popular than having a desire to learn to take initiative (52.9%). Developing better communication skills was the least reported motivation (47.1%) but represented a little less than half of the students across the two cohorts.

When students were asked for examples of the types of activities they would like to participate in, their responses were more strongly aligned to being exposed to STEM in an enriched setting, specifically, computer programming, regardless of whether they chose to study TDJ1O or ICS2O. For example, one student noted, “Learn how to code, and control a robot, learn how to code a car” (Grade 9 student). Another response specifically included STEM: “Gain firsthand experience with how science, math, and technology solve real-world problems, as well as becoming acquainted with the fundamentals of building a computer from scratch” (Grade 11 student).

Furthermore, students’ responses about their desires for the program aligned with a desire to take up a career in engineering or related fields. One Grade 11 student stated their desire to

become a doctor: “I actually thought this would benefit my dream of becoming a doctor and I see that this is a very good opportunity.” Another student wanted to have an opportunity to test the ‘fit’ of the career: “I would like to learn about engineering and see if it is a good fit for me” (Grade 11 student).

The theme of recasting Black students' pursuit of STEM challenges ideas that Black students are not interested in and motivated to pursue a career in STEM. In their intake survey, youth were

keen to address their interest in science as well as highlight their academic capacity to do so. A Grade 8 student commented:

> I am excited for this opportunity because I want to find solutions and be a critical thinker. I am interested in going into an Engineering or Medical based career in the future. I also believe that I am not too young to start this significant journey. I am a grade 8 student who has been very involved with my education and specifically STEAM related projects, in my school career I have maintained grades of 80's-90's in my

> courses. My principal has kindly agreed to provide a letter of recommendation on my behalf.

Many of the narratives surrounding Black student achievement in general and in science specifically, have been historically produced. However, these narratives "remain contemporarily putative and are constantly reproduced in the everyday discourses that pervade the conversations of Blacks and other members of society" (Daniel, 2018, p. 6). Students were asked to provide "any other information" on the intake form. Students

referenced their positionality in their pursuit in STEM as well as what it meant to them personally. One Grade 9 student wrote:

> Would love to participate in this program as a 14-year-old Black boy. I feel I have to have all the tools and knowledge necessary to succeed. I also have type 1 Diabetes and my two career aspirations are first being Engineer and 2nd being a Doctor that can find the cure for type 1 Diabetes.

In general, the students' responses foreground conceptions of self and their potential for achievement. For example, one participant noted: "I am extremely creative, a critical thinker and have proficient problem-solving skills. It would be a beneficial opportunity to have the resources to channel those skills into physical models" (Grade 8 participant).

These observations are without any interventions on critiquing the constructions of self. However, the program itself did not focus on any further interventions on providing students with tools and strategies for critiquing existing constructions of Blackness within STEM. According to Daniel (2018), it is important to expose students to opportunities to challenge and change their own constructions of Blackness within STEM and themselves and it is important for that type of work to be done at the beginning of the program to support students struggling with feelings of belonging and alienation in post-secondary STEM spaces.

Theme 2: Importance of Early Pathways to Post-Secondary Science and Engineering for Black students.

The importance of having a space where the complexity of students' needs is addressed in relation to post-secondary pathways in science and engineering emerged as another theme.

Providing early education pathways that uniquely cater to the barriers that marginalized students experience is essential due to the fact that participation in PSE is not simply an exercise of financial alleviation. Access to PSE pathways begins as early as Grade 9 where

students are tasked with making career decisions through course selections. Data from the TDSB showed that Black students tend to be streamed into lower-ability groupings that have a significant impact on their later life academic choices (James & Turner, 2017). Therefore, designing pathways for Black students specifically is an important consideration, perhaps essential for their future economic and social mobility.

Post-Survey Findings

The following analysis is based on the responses of the post-survey which was completed by eight individual students in the course (including those who achieved a passing grade and those who did not) with a total of 11 responses.

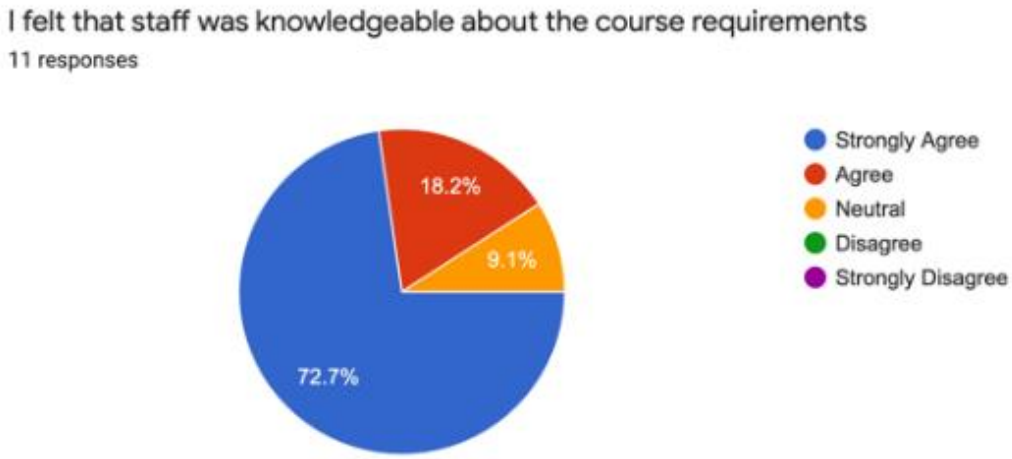
Theme 3: Opportunities for Academic Development

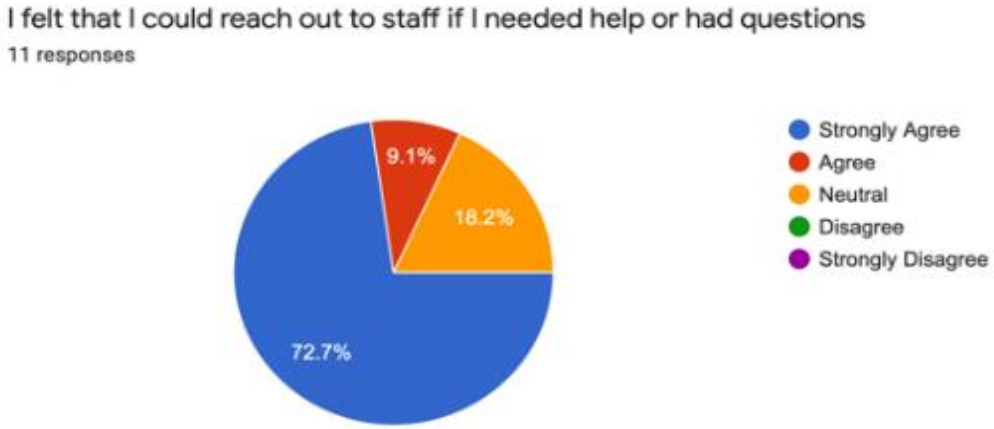
Another main objective of the program was to provide academic support towards gaining a high school credit in either TDJ1O or ICS2O. Similarly, students should leave the program feeling equipped in pursuing either of these courses later in secondary school. As stated previously, a

team of staff from both the University of Ottawa and a TDSB Graduation Coach were the primary sources of learning and support before and during the program.

Students were asked to indicate whether they perceived staff as knowledgeable about the course and whether they felt they could reach out for support. Figure 2 shows that 73% of students "strongly agreed" in either situation. For example, one student commented, "I really liked my teacher. She explained everything very well and was always available to help!" (Grade 9 participant). Furthermore, roughly 82% of students expressed that they felt seen by the staff.

Figure 2
Students' Perceptions of Staff Knowledge and Capacity to Provide Support

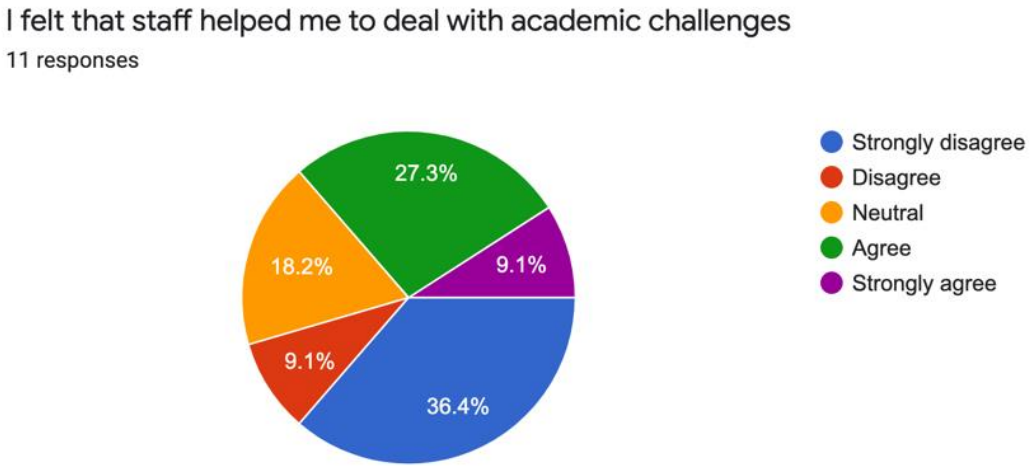




However, only 27% of students "agreed" that they were supported when faced with academic challenges in the program (see Figure 3). One student noted, "I struggled with technical issues that caused me to fall way behind in this course not allowing me an opportunity to catch up" (Grade 11 participant). In another question, 64% of students felt satisfied with staff engagement.

Figure 3

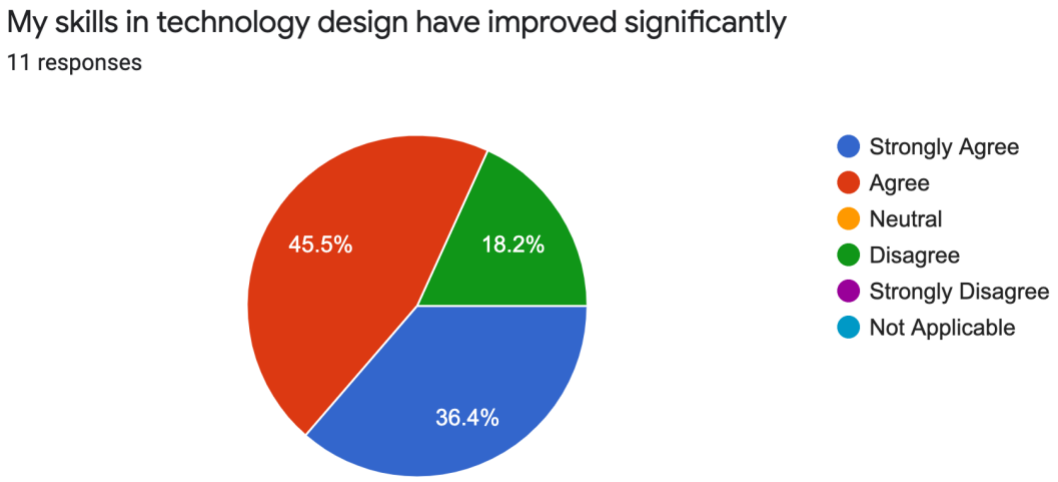
Students' Perceptions of Support by Staff

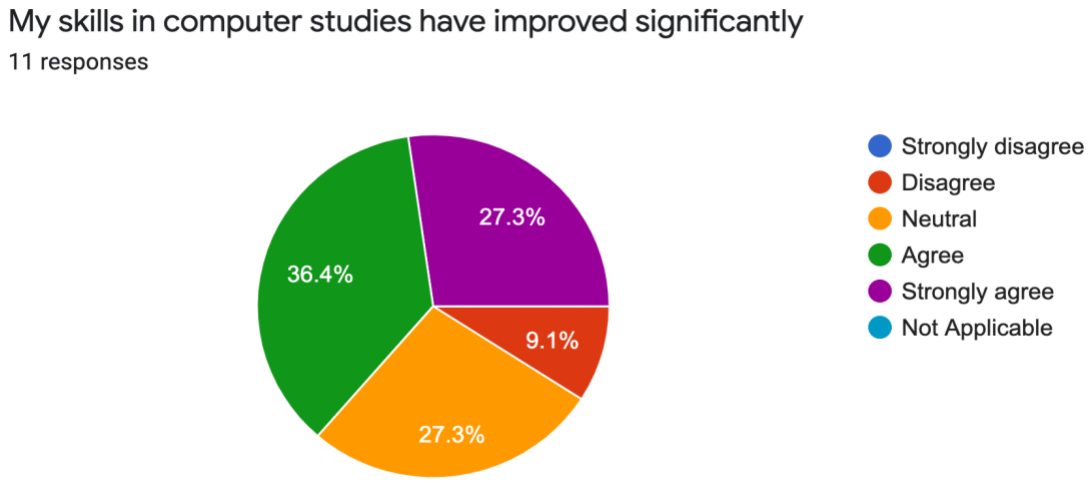


In addition to providing personalized support, the program was evaluated on whether students were provided opportunities to gain sufficient academic skills in either TDJ1O or ICS2O courses. In total, 82% of students "strongly agreed" or "agreed" that they learnt a lot in either of the two courses. An analysis of skills gained by course breakdown yielded similar results. Figure 4 shows that approximately 82% of students "strongly agreed" or "agreed" that their skills had significantly improved in TDJ1O. On the other hand, roughly 64% of students "strongly agreed" or "agreed" that their skills in ICS2O had significantly improved.

Figure 4

Students' Perceptions of Academic Skills Gained in TDJ1O or ICS2O

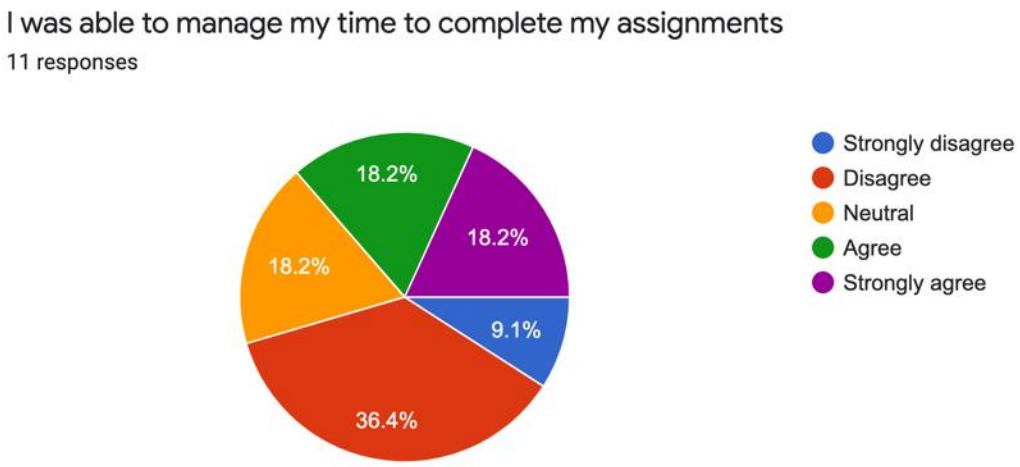




Other academic skills such as written and oral skills were also evaluated as these skills are seen as important to schooling in general as well as for a career in science and engineering. Thirty-six percent and 27% of students "strongly agreed" that they were able to improve their oral and written skills, respectively. However, 18% of respondents felt there was no improvement in either of these skills. Students also had difficulties with time management and workload, with 36% feeling that they were unable to complete assignments within the given time (see Figure 5). One student noted, "I couldn't manage my time because I had too many difficulties with the program" (Grade 11 participant).

Figure 5

Students' Indication of Time Management in either Course



Theme 4: Navigating the Social and Educational Aspects of Post-Secondary Education.

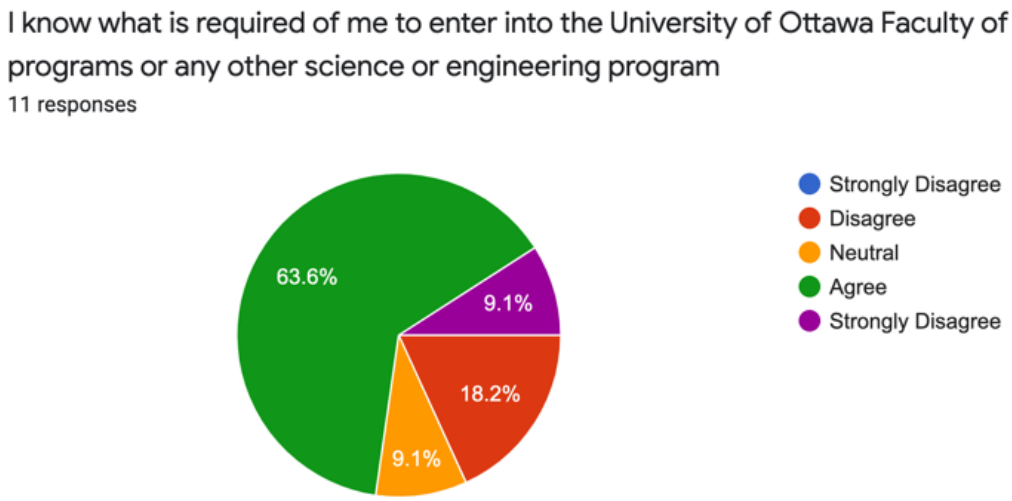
This theme is concerned with Black students' understanding of post-secondary academic systems, and the social and cultural environments of PSE spaces. Students were asked whether they understood the requirements to pass the two courses offered by the University of Ottawa. Fifty-four percent of students "strongly agreed" that they understood these requirements.

Furthermore, Figure 6 shows that when asked whether they understood the requirements to be accepted into the University of Ottawa or any other science or engineering program, nearly 64% "agreed" with this statement, while 18% expressed that they did not have an understanding. Another way of getting at students' perceptions of self-efficacy in these

scenarios was to ask whether they understood what they needed to do personally to graduate from secondary school on time and the appropriate credits to pursue a science or engineering degree. Approximately, 55% of the students "strongly agreed" that they understood what was needed of them, while 9% felt that they still did not have a personal understanding of the work needed to be accepted into a post-secondary science or engineering program.

Figure 6

Students' Response to Gaining Entry to PSE Science or Engineering



Being able to navigate the social and cultural aspects of PSE is important for ACB students. Previous research has contributed empirical evidence concerning the factors affecting historically marginalized students' participation and persistence in STEM fields (Morgan et al., 2013). Ong and her colleagues (2018) argued that social identity was among the most important factor in participation and persistence in post-secondary STEM. Other empirical contributions include the role of stereotype threat in hindering women's performance in mathematics (Spencer et al., 1999); institutional variables affecting undergraduate STEM student completion rates (Griffith, 2010; Perna et al., 2009); faculty influence on women's persistence in science (Johnson, 2007); the postbaccalaureate career and educational goals of women in STEM majors (Cole & Espinoza, 2011); and the overall role of gender-based stereotypes (Nassar-McMillan et al., 2011). While some scholars have drawn on stereotypes to explain the underrepresentation, particularly of Black women in STEM, these have included a lack of interest among these women to pursue STEM-related majors and occupations. Evidence

of STEM aspiration gaps has yet to be proven in any empirical study (Bonous-Hammarth, 2000; Smyth & McArdle, 2004; Staniec, 2004).

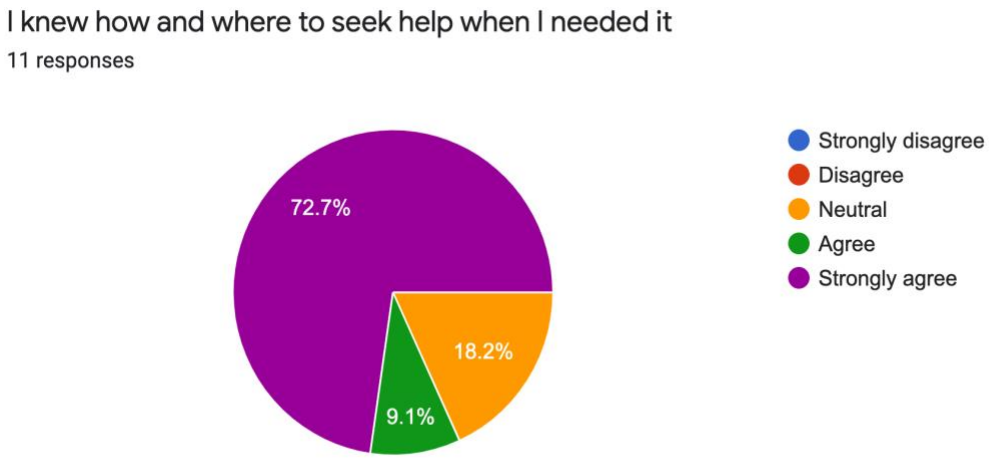
In that regard, roughly 36% of students expressed that they were able to meet new people and half as many (18%) expressed that they were not able to make any new friends in the program which could have been the result of having to do the program virtually. One participant noted:

> Since this course was virtual it was not easy to make friends. Most people had their cameras off and did not talk. I was able to connect with my group members due to the fact we worked on all the projects together (Grade 11 participant).

Other areas of support in developing a social identity in the classroom included connecting with and talking to teachers. Roughly 74% of students "strongly agreed" that they were very comfortable doing so. Furthermore, 73% of students stated that they felt they knew how to access various resources and help when needed (see Figure 7).

Figure 7

Students' Understanding of Where to Get Support When Needed



Theme 5: Feelings of Belonging in PSE Spaces.

This theme, feelings of belonging in PSE spaces, provided a more explicated analysis of the classroom climate as it pertains to Black students' ability to thrive in particular STEM PSE spaces. The following is an analysis of the students' assessment of their self-confidence as well as the learning environment. These understandings are also important in gaining insight into the challenges as well as the supports that exist to hinder or support students' participation.

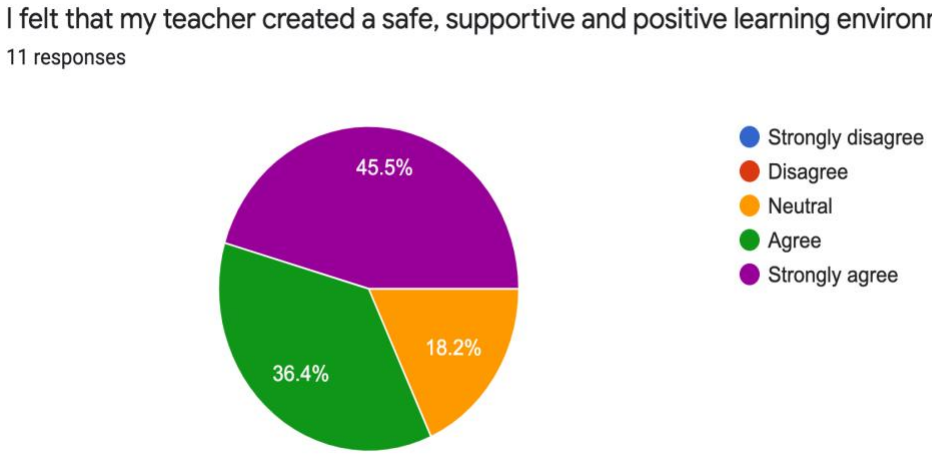
Firstly, an area of interest was students' perceptions of the instructor's level of responsiveness in creating a safe, supportive, and positive learning environment. Nearly 73% of students

"strongly agreed" that the teacher cared about the well-being of students. A similar percentage of students also "strongly agreed" that the instructors went out of their way to make them feel confident in their learning. These included approximately 64% of students expressing that the instructors provided clear and useful feedback and that the students felt comfortable approaching the teacher for assistance.

Furthermore, students were asked to report whether their teacher was active in creating a safe, supportive, and positive learning environment. This time 45% of students "strongly agreed" that they felt safe and supported in the learning environment, while roughly 18% of the students were unable to definitively respond to the question (see Figure 8). However, while many of the students reported feeling safe, roughly 55% of students were unable to respond to whether the teacher was committed to promoting an environment that respected and celebrated diversity.

Figure 8

Percentage of Students Feeling Safe and the Teacher was Committed to Celebrating Diversity



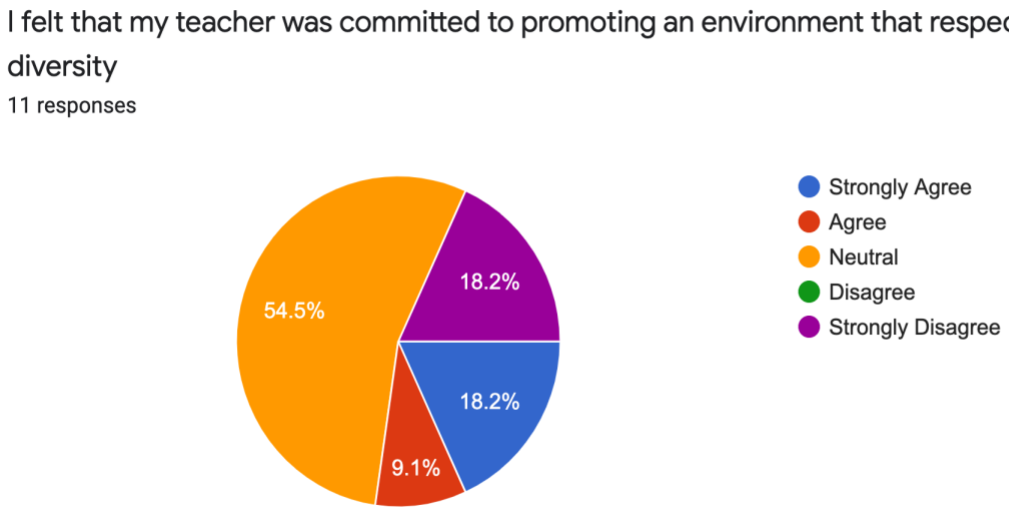
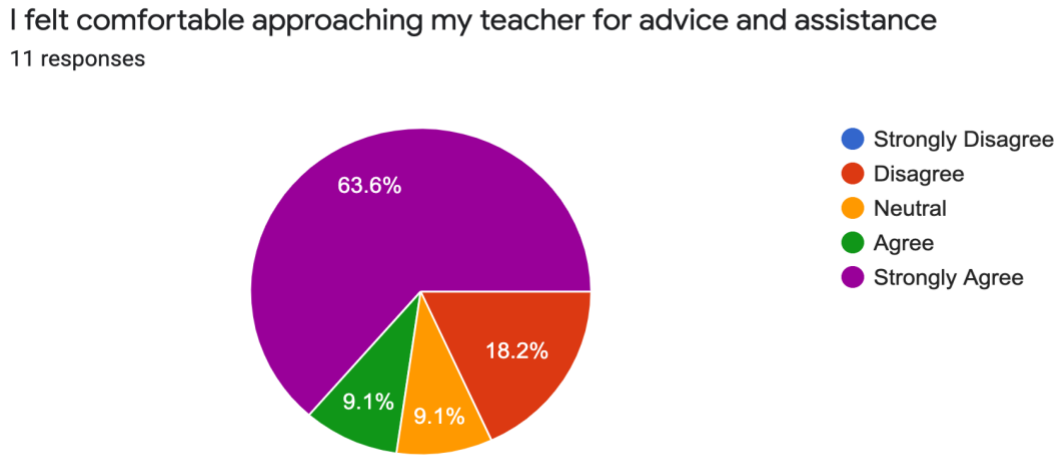
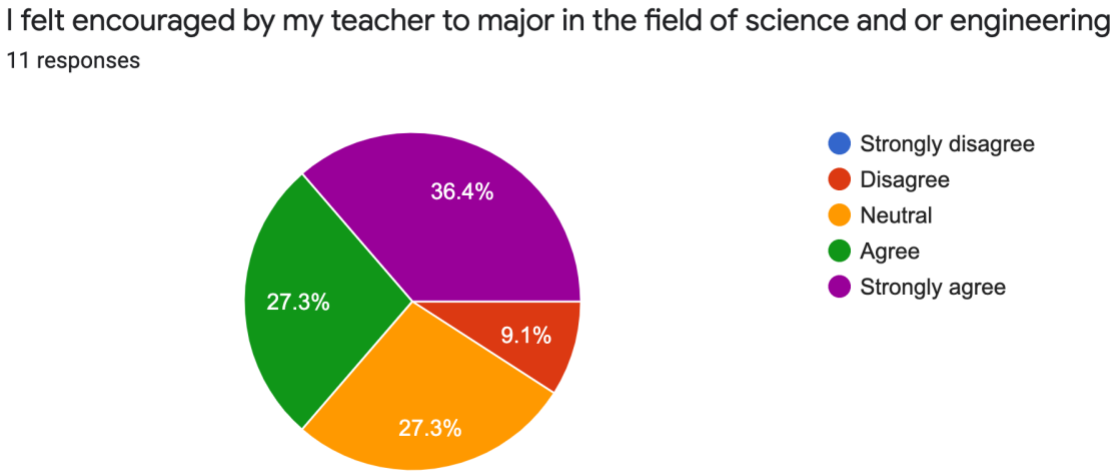


Figure 9 shows that most of the students, approximately 64%, acknowledged that they were able to approach their teacher to get the support they needed. However, only 36% of students felt strongly encouraged by their teacher to major in the field of science and/or engineering, with 27% of students not able to identify whether this was indeed the case.

Figure 9

Percentage of Students Able to Seek Help from and Feel Supported by the Instructor





Overall, students commented that they enjoyed the program and thought it would be a beneficial program for more Black students. One student commented, “The program is already amazing. I just wish more people knew about it” (Grade 10 student). Other general considerations for improvement were regarding time constraints, including the four-week duration of the program, which meant that teaching and learning were accelerated and made it difficult for students to keep up. Students also commented on having more time spent on learning content and less time completing assignments. As one student added in their comments, “Less assignments and more learning time”. It was also mentioned that extra academic support should be provided daily after the course to help students. A student commented, “more student help programs after daily course”. Other areas of improvement were around more technical details of the program including the software used and having the platforms accessible in English. One student had a suggestion to “Changing the Brightspace to English”.

Discussion

The analysis draws on some important considerations in the design, development and operationalization of programs that cater to the long-term success of ACB students in relation to transitioning to post-secondary. Firstly, recasting Black students’ pursuit of STEM was important in disrupting narratives of ACB students that have been historically produced and remain contemporarily putative, such as being lazy and uninterested in STEM fields. These

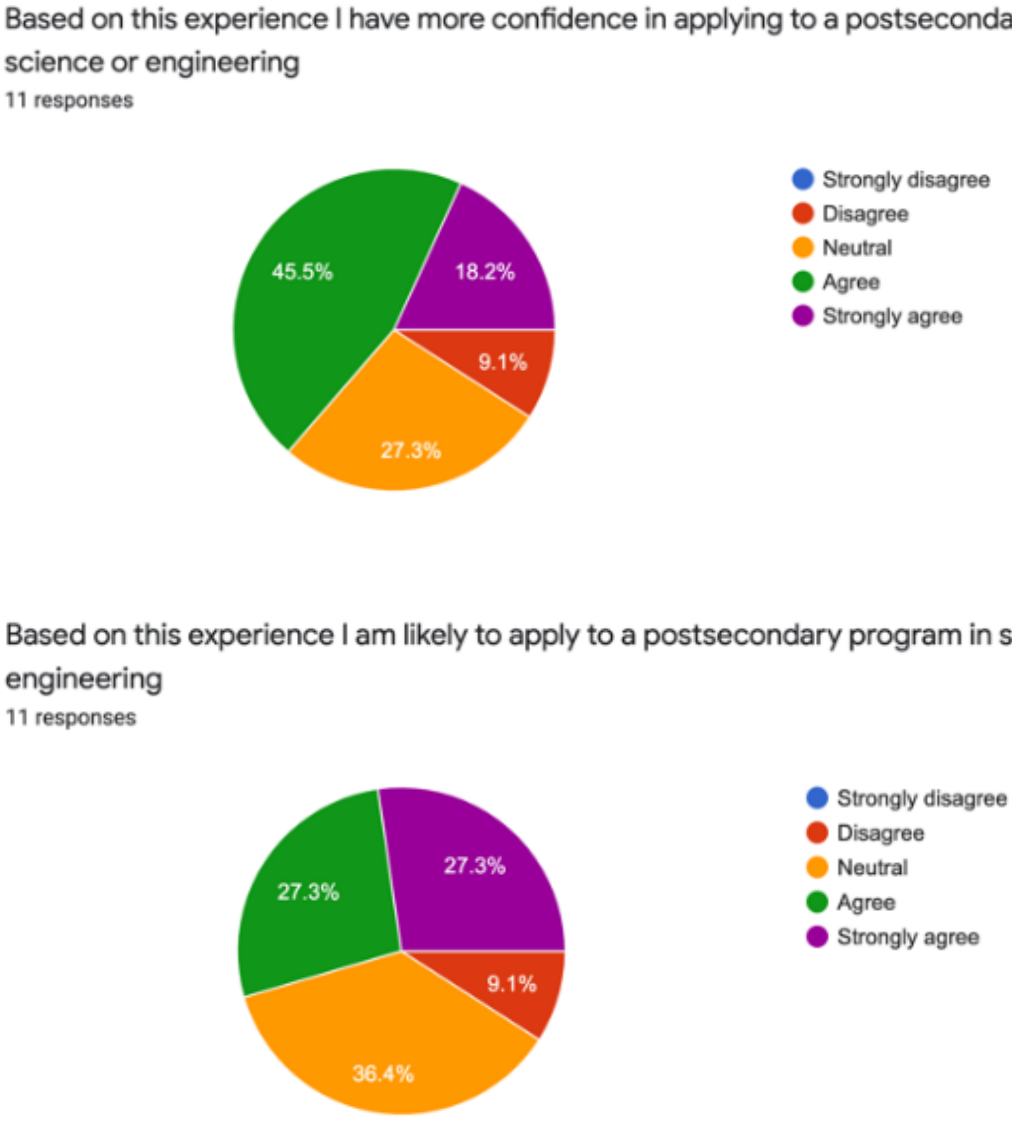
perceived markers of Blackness have traditionally framed notions of essentialism in relation to ACB students' pursuit of excellence (Daniel, 2018). Furthermore, these conceptions are reinforced through a multitude of sources with limited opportunities to challenge these ideas. Not only is there no research supporting these claims, research that has looked at the career aspirations of students found that race and ethnicity were unrelated to making decisions about careers (Edwin et al., 2019; Fouad & Byars-Winston, 2005). The Black Students Adventures in Engineering program received more applications than there were spaces in its first year of inception. Furthermore, applicants to the program mostly articulated career aspirations in STEM as one of the major reasons in wanting to take part in the initiative.

Secondly, the importance of early pathways to PSE also emerged as a theme. In Canada, post-high school (PHS) planning and preparation are made relatively early in students' educational journey, so interventions are most likely to be effective with an understanding of the effects of important antecedents on students' PHS pathway choices. In other words, decisions that students are expected to make about their careers early on in high school and in regards to the courses they should take have an impact on their post-secondary applications. The Black Students Adventure in Engineering program catered to students as early as Grade 8 all the way up to students who had recently graduated and were still considering a career in science and/ or engineering. Inviting students as early as Grade 8 and those beyond Grade 12, not only provided early exposure to Grade 9 and Grade 10 courses, but also accommodated students already beyond Grades 9 and 10.

Additionally, consistent with findings that highlight that early academic exposure helps students aspire to PSE and improve retention rates (Edwin et al., 2019; Fouad & Byars-Winston, 2005), students most commonly cited that the experience was an opportunity to advance to a career in STEM. One may even argue that indication of these aspirations for a career in STEM is also a strong signal of aspirations to PSE, given that the majority of STEM careers require post-secondary education. However, Figure 10 shows that together, roughly 64% of students either "strongly agreed" or "agreed" that they were confident in applying to a post-secondary program in science or engineering, and nearly 55% "strongly agreed" or "agreed" that they were likely to apply.

Figure 10

Students' Indication of Confidence to Apply to Post-Secondary Science or Engineering and Likelihood of Applying



The ability to support academic development should be one of the central justifications in creating a program that uniquely caters to Black students' transition into PSE. Promoting a culture of high expectations while providing access to rigorous content knowledge, academic skills, and non-cognitive skills (Farrington et al., 2012) is foundational in advancing equitable learning environments. While academic skills allow students to engage with content knowledge

more deeply, non-cognitive skills, such as study skills, time management, and self-management, help students improve their ability to gain content knowledge and use their academic skills to solve problems. However, the data showed that some students struggled with time management (see Figure 5) and a few felt that they did not get the academic support needed (see Figure 3).

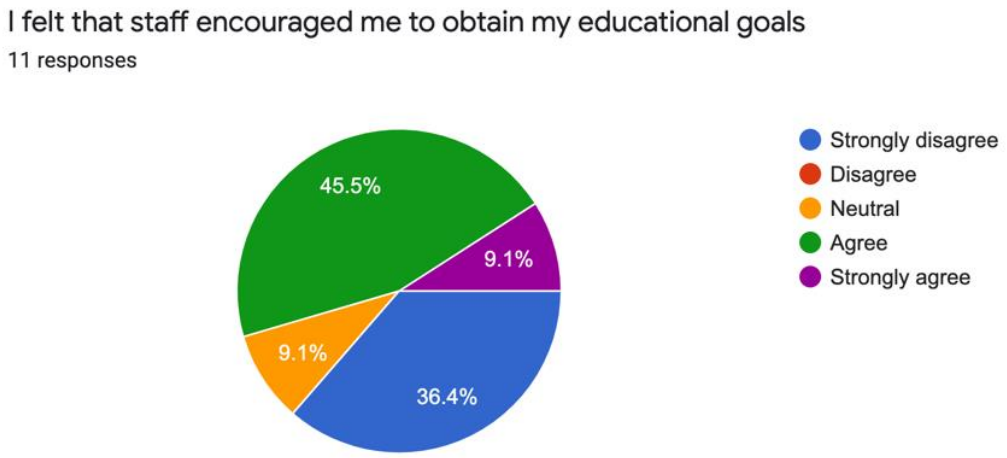
Furthermore, while many students indicated that they learned a lot in their courses overall, a few indicated that there was no improvement in the skills related to TDJ1O or ICS2O. This is worrisome given the small size of the cohort. Additionally, while most of TDJ1O students indicated that they learnt a lot in the course, comparatively, a much lower percentage of students who took ICS2O felt the same way (see Figure 4). Finally, and most noteworthy, a little

over half of the students indicated that they felt encouraged by staff to reach their educational goals (see Figure 11). This is important as data from the James and Turner (2017) report indicated that Black students routinely navigated feelings of discrimination, embedded within a culture of low expectations and being streamed into lower academic courses by their teachers.

While this was a good first step in supporting Black students academically, the analysis also revealed different results in relation to being encouraged to pursue a career in STEM. Almost one-third of the students were either “neutral” or “disagreed” that they were encouraged to pursue a degree in STEM (see Figure 9). However, two important takeaways are that a relatively high number of students felt comfortable seeking support from their teachers (Figure 9) and the majority of students felt that their teachers created a safe and supportive environment (see Figure 8).

Figure 11

Students' Perceptions of Feeling Encouraged



STEM education researchers emphasize the acquisition of Twenty-first Century skills in supporting students' careers in STEM as well as the notion is seen as necessary to adapt and thrive in an ever-changing world (Partnership for 21st Century Learning, 2016). Twenty-first

Century skills include knowledge construction, real-world problem solving, skilled communication, collaboration, use of information and communication technology for learning, and self-regulation (Partnership for 21st Century Learning, 2016). While students felt that their skills in TDJ1O and ICS2O improved, fewer students agreed that this was also true regarding their abilities in oral and written communication.

Related to the acquisition of content knowledge and skills are also students' ability to navigate the social and educational aspects of post-secondary education and feelings of belonging. Research has shown that orientation to the academic, social, emotional, and cultural aspects of PSE is necessary in supporting underrepresented students' transitions (Stolle-McAllister, 2011).

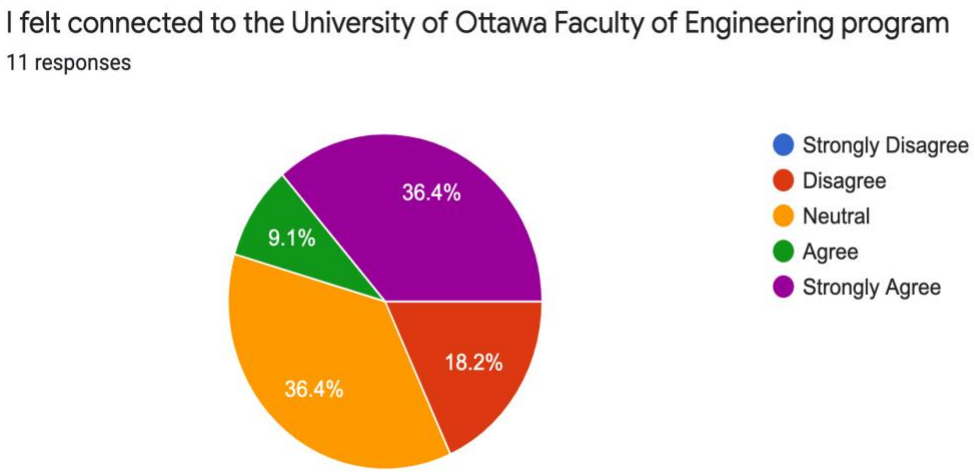
Particularly in science or STEM spaces, academic integration in science and socialization into the scientific milieu are considered to be significant considerations in being successful (Bowman & Stage, 2002). While the majority of students understood the expectations of the program and of themselves, a smaller percentage did not leave with these same understandings.

Similarly, a sense of belonging is also important to students in general and being able to form a community with other Black scholars is particularly important for ACB students. Tinto (1993)

argued that social integration was more important than academic integration as academic work occurs against a backdrop of the social conditions of the space. In that regard, a relatively high percentage of students reported not being able to make new friends and expand their social networks and these have been argued as important coping mechanisms for underrepresented students (Tinto, 1993). The ability to leverage social and educational resources at the university also seemed to have an influence on students' feelings of belonging. In general, a relatively small number of students felt connected to the program, and a few others felt disconnected from the program which was similar to reports of their ability to navigate the social and educational climate of the university (see Figure 12).

Figure 12

Percentage of Students Feeling Connected to the University of Ottawa



The results show that while the program has been very impactful in the areas of social and academic well-being, a few students still experienced challenges with creating social connections in the space. Therefore, more work needs to be done in connecting students to the social and educational aspects of PSE as well as addressing students' social-emotional needs in the space.

Conclusion

The Black Students Adventures in Engineering program is a pilot project aimed at increasing Black students' transition to post-secondary pathways to science and engineering. The research component involved pre-and post-surveys. Based on the responses from the students, the main themes that were identified included acknowledging Black students' pursuit of STEM and providing early pathways to PSE. These were identified as important in assisting students in making decisions about their post-secondary education pathways. The students articulated that early exposure to requisite courses that were antecedent to a career in STEM was the main reason for participating in the program. Another theme that was highlighted was the importance of having access to academic content knowledge, academic skills, and non-cognitive skills. Fourthly, being able to leverage academic, social, and cultural contexts was important to accessing a host of resources in pursuit of not only academic, but also personal well-being. Finally, feelings of belonging have been widely cited as a factor in engagement, retention, and participation of historically marginalized people in PSE. While the majority of students felt that they were in a safe environment, the findings also revealed that there were limited opportunities by instructors in actively advancing an environment that promoted Black student success.

The Black Students Adventures in Engineering program highlights the importance of providing intentional programming for Black students to support them in navigating post-secondary educational spaces. In addition, the program underscores that Black students seek spaces to be successful but need support in accessing these spaces. Additional efforts should be made to provide focused programming that centralizes the importance of the experiences of Black students and the provision of individual academic support.

Recommendations

The following recommendations are provided based on the evaluation of the program:

- Provide opportunities to help students challenge long-held conceptions of Blackness and STEM spaces, e.g., workshops, academic fairs and community events that focus on the celebration of Black success.
- Provide opportunities for other ACB mentors that can provide a network of supports, both academically as well as an awareness of the social aspects of PSEs.
- Increase the length or duration of the program to help with time management of the course.
- Include the development of non-academic skills such as critical-thinking and time-management, and soft skills such as oral and written skills.
- Adopt equitable and culturally responsive teaching methods. Teachers need to be intentional about creating safe and supportive spaces where Black students can thrive.
- Provide Professional Development opportunities for teachers to better support Black students' pursuit of STEM. Black students need to be encouraged into STEM spaces.

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