# How to Develop Alaska Native STEM Students in Middle School and High School

**Dr. Michele Yatchmeneff, University of Alaska Anchorage**

Michele Yatchmeneff is Unangax (Aleut) who grew up living a traditional subsistence lifestyle in rural villages along Alaska's Aleutian chain. She earned a BS in Civil Engineering in 2005 and an MS in Engineering Management in 2009 at University of Alaska Anchorage. After earning her BS she began working in Alaska's construction and engineering industry, specializing in water and sewer projects in remote villages across the state. She also worked as the Deputy Director of the Alaska Native Science & Engineering Program (ANSEP). Professor Yatchmeneff earned her PhD in Engineering Education from Purdue University. She is currently an Assistant Professor of Civil Engineering at the University of Alaska Anchorage. Her research focuses on motivation and success for Alaska Native pre-college students.

**Dr. Herbert P. Schroeder, University of Alaska, Anchorage**

Herb Ilisaurri Schroeder received his PhD in civil engineering from the University of Colorado Boulder. He is currently Vice Provost for ANSEP (Alaska Native Science & Engineering Program) and Founder at the University of Alaska Anchorage and Professor of Engineering. In 2009, Dr. Schroeder was honored by the creation of an endowed chair in his name at the University of Alaska Anchorage with $4.4 million in donations from the ANSEP partner organizations. He is the recipient of the White House 2004 Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring; the Alaska Federation of Natives 2005 Denali Award, the greatest honor presented by the Federation to a non-Native; and the NACME 2009 Reginald H. Jones Distinguished Service Award.

**Dr. Matthew E. Calhoun, University of Alaska, Anchorage**

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## Introduction

Preparing students in science, technology, engineering, and mathematics (STEM) is a common problem in secondary schools across the nation[1]. According to the National Action Council for Minorities in Engineering, 96% of underrepresented minorities that graduate from high school are unprepared and not ready to study engineering by not taking pre-calculus, chemistry, and physics prior to arriving at the university[2]. In Alaska, Alaska Natives have the worst performance as compared to all other ethnicities in mathematics and science[3] and these courses are crucial to prepare and retain students in college for STEM degree programs[2,4–9]. These statistics are alarming; however, there is one longitudinal program, called Alaska Native Science & Engineering Program (ANSEP) that defies these rates and is a model of excellence[10–13].

This paper presents the new results from a multi-year qualitative case study of ANSEP and is an expansion of the ASEE paper titled "A Qualitative Study of Motivation in ANSEP Precollege Students" that was included in 2015 National Conference Proceedings[10]. ANSEP works with Alaska Native students from middle school to the doctorate level in hands-on STEM activities and requires students to complete college level mathematics and science courses, while in high school, which are needed to prepare them for STEM degrees[11,12,14]. This research study focused on answering "How do Alaska Native students participating in ANSEP describe the program's role at motivating them to take advanced mathematics and science courses in high school?" Also, understanding why this model program helped Alaska Native precollege students stay engaged and excel through the pipeline from middle school to the university. These results indicate that a university program can take an active role to better prepare students prior to entering college and by retaining students in a STEM degree at rates exceeding national averages.

## Background

In Alaska, Alaska Natives make up 23.3% (31,049) of the population[3]. They are second largest percentage of students after White students and are the largest minority group of students enrolled in pre-elementary through grade 12[3]. During the 2012-2013 academic school year, the four-year cohort graduation rate was 57.1% (1,235) for Alaska Natives and American Indians, which was the lowest among all other ethnicities[3]. During the 2012–2013 school year, Alaska Native students had the lowest performance compared to non-Alaska Native students in mathematics and science as assessed by the Standards Based Assessments and High School Graduation Qualifying Examinations for grades four through twelve[3].

Alaska Natives are dramatically underrepresented in STEM degrees and professions[2,15–19]. The McDowell Group[20] reports that barriers to success in higher education for Alaska Natives and American Indians include: "high cost of college, poor academic preparation, homesickness, cultural differences, and learning styles" (p. 33). Alaska Natives and American Indians are less likely than other races to pursue bachelor's degrees[21]. The 2000 U.S. Census showed that only 6% of Alaska Natives completed a four-year college degree[22]. In that same census, of those that graduated high school in 1992, only 15% of Alaska Natives and American Indians were likely to have received their bachelor's degrees as compared to 24% of Hispanics, 31% of Blacks, 49% Whites, and 51% Asian/Pacific Islanders pursuing bachelor's degrees[21].

Many studies have shown that students who complete advanced mathematics and science courses while in high school are more academically prepared to pursue and succeed in STEM degree programs and professions[2,4–9]. Adelman[4] explains that students at a minimum need to complete about four credits in mathematics in high school to successfully pursue a bachelor's degree. Further, students need to complete over two credits in science, with two of those having a laboratory portion[4]. Adelman[4] recommends mathematics courses to include calculus, pre-calculus, or trigonometry, and science courses to be a combination of biology, chemistry, and physics. These are the same courses ANSEP recommends high school students to complete[14]. Adelman[4] justified these recommendations by noting that 95% of the students who completed these courses in high school along with English, history or social studies, a foreign language, and computer science ended up receiving a bachelor's degree. Additionally, success in STEM degrees leads students to becoming STEM professionals[1,5,13,23–27].

Frehill et al.[2] explains that underrepresented minority students are at further risk of being underprepared in mathematics than their non-underrepresented minority counterparts because often their teachers have low expectations for them in these courses and do not encourage them to pursue these courses. The "4% problem" is a representation of this: only 4% of underrepresented minorities are prepared with adequate mathematics and science coursework right out of high school to pursue engineering degrees[2]. Alaska Natives are of particular interest because they are more likely to be underprepared[2,3] and underrepresented in STEM[2,18,19,28]. It is important to understand how to encourage Alaska Native students to pursue the completion of advanced mathematics and science courses prior to enrolling in a STEM degree at the university level.

The number of students who complete the required courses in high school, pursue STEM degrees, and graduate with STEM degrees, demonstrate that ANSEP is successful at encouraging Alaska Native students to consider STEM degrees, pursue STEM degrees, persist in STEM degrees, and pursue STEM careers upon graduation[11–14]. Because of this success, ANSEP Precollege component participants were the focus of this study. ANSEP is a longitudinal STEM education and academic enrichment model that works with Alaskan students starting in middle school through doctoral degrees and subsequent professional endeavors[11–14]. ANSEP targets the recruitment of Alaska Native students, but it does not discriminate, so all students are welcome to apply to attend ANSEP components[14]. ANSEP prepares Alaska Native precollege students for STEM bachelor degrees in high school through Precollege components: "Middle School Academy", "Acceleration Academy", and "Summer Bridge."

The ANSEP Middle School Academy is an extra-curricular component for middle school students and includes having students build desktop computers while living on the University of Alaska Anchorage campus for a 12-day hands-on STEM experience[14]. The post-component educational requirements for the students are to complete Algebra I before graduating from middle school[11,12,14]. These students complete Algebra I in their middle schools[14]. Each Middle School Academy includes 54 participants[14]. There have been over 479 students who have participated between initiation in 2010 to 2013[11,12]. Of the students who have completed the

Middle School Academy between 2010 and 2013 and graduated from middle school, 77% have finished Algebra I[11,12], while only 26% of middle school students of all ethnicities have completed Algebra I nationally[29].

The ANSEP Acceleration Academy is a five week summer component for high school students[14]. Acceleration Academies vary in size from forty to seventy participants. The educational requirement for these students includes completion of courses for dual high school and college credit[14]. A majority of the students complete mathematics courses. Other courses the students have completed include science, engineering, or English courses. Of 190 students who participated during the period from 2010 to 2013; 95% advanced one grade level in mathematics, science, or engineering, while 79% of the participants completed the college level mathematics courses and 85% completed the college level science courses[11,12,14].

The ANSEP Summer Bridge component is a ten-week summer experience for recently graduated high school students who are planning to pursue STEM degrees[14]. Summer Bridge students complete a college level mathematics course and a paid internship within an external engineering or science organization[14]. Summer Bridge components vary in size from 20 to 30 participants. Between 1998 and 2013, there have been 250 participants of which 95% have continued on to engineering or science 4-year degree programs after participation in the ANSEP Summer Bridge component[11,12,14].

These three ANSEP components focus on precollege students and therefore were selected for this study. ANSEP Precollege components are aimed at challenging precollege students to prepare themselves for STEM bachelor degree programs[14]. During each of these components, ANSEP provides inspirational STEM experiences to encourage students to consider STEM degrees and careers[14]. STEM professionals design hands-on career exploration activities for the students.

There are many lenses to consider for understanding why Alaska Native students prepare themselves for STEM degrees and persistence in STEM degrees. Motivation was used as the theoretical lens for this study because it is linked to student success and persistence in STEM degrees[1,30–36]. Students' self-efficacy in mathematics and science is also related to student success and persistence in STEM degrees[7,13,32,34,37–39].

## Methods

### *Self-Determination Theory*

Ryan and Deci's self-determination theory of motivation was used as the theoretical framework for this study. Self-determination theory takes into consideration both *intrinsic* and *extrinsic* motivations[40–43]. Intrinsic motivation is when someone does something they are interested in or find pleasant, whereas extrinsic motivation is when someone does something to receive a reward[40].

In their use of the self-determination theory, Ryan and Deci[40–42] focused on the elements of *autonomy*, *competence*, and *relatedness* in terms of what people need in order to be motivated, either intrinsically or extrinsically[43]. *Autonomy* refers to a person's internal perceived locus of causality[40,41] or the sense of using self-direction to guide action[44]. An example could include a student choosing to take a science course as an elective versus being required to take the course. The theory argues the student would feel more motivated to succeed in the course because they had exercised autonomy in choosing to take the course. *Competence* refers to a person's perception or belief that they can do something or reach a certain goal; often positive feedback from others helps these feelings grow[41]. An example might include a student taking a mathematics course would feel more motivated to succeed if they believed in their mathematics ability and receive positive feedback from their teacher, compared to a student who did not feel confident in their mathematics abilities and/or received negative feedback from their teacher. *Relatedness* refers to a person's internal feeling that provides "a sense of belongingness and connectedness to the persons, group, or culture disseminating a goal"[40]. For example, a high school student may feel more motivated in a college mathematics course if there are other high school students taking the course with them because they feel they belong to the group.

### *Study Participants*

There were two types of participants for this study. Group 1 participants were high school graduates, former ANSEP Precollege component participants, and who were currently participating in ANSEP's University Success component at one of the University of Alaska's main campuses: University of Alaska Anchorage (UAA) and University of Alaska Fairbanks (UAF). Group 2 participants were current high school students and current ANSEP Precollege participants.

To recruit Group 1 students, information was handed out at an ANSEP University Success weekly meeting. Information about the study and a flyer was also emailed to ANSEP Group 1 students. Study flyers were also posted in the ANSEP Building. Students emailed Yatchmeneff to let her know they could participate. Yatchmeneff then verified they met study requirements and then contacted them to set up a date and time. Study participants then met with Yatchmeneff on the UAA campus where Yatchmeneff recorded their interviews. In two cases, Yatchmeneff could not meet face-to-face so met over the phone to conduct the interviews.

During the summer of 2014, three group interviews with two ANSEP Group 2 participants were completed. To recruit Group 2 participants, ANSEP staff emailed a study information page and consent forms to both the parents and students. Because ANSEP had already accepted these participants to the ANSEP Precollege components, their responses to participating in this study did not affect their participation in ANSEP. Parents and students emailed back the consent forms to indicate they could participate in the study. Yatchmeneff verified that prospective research participants submitted the proper forms. Group interviews with these students were set up through ANSEP Precollege staff.

ANSEP Middle School Academy students were not interviewed directly; however, we were able to include data about this specific component because many of the ANSEP Acceleration Academy study participants also completed the Middle School Academy component. Acceleration Academy participants partook in two of these three group interviews.

To summarize there were eight Group 1 participants, eight (100%) were Alaska Native, four (50%) were female, and six (75%) were attending UAA. To summarize the twenty-two Group 2 participants that partook in three separate group interviews, 17 (77%) were Alaska Native and 12 (55%) were female. Table 1 below summarizes all of the study participants by total, Alaska Native, and female participants.

The first eight Group 2 Acceleration Academy group interview participants consisted of two female Alaska Native participants, three male Alaska Native participants, one female non-Alaska Native participant, and two male non-Alaska Native participants. Therefore, this first Group 2 Acceleration Academy group interview consisted of 5 (63%) Alaska Native participants and 3 (38%) female participants. The second eight Group 2 Acceleration Academy group interview consisted of three female Alaska Native participants, three male Alaska Native participants, one female non-Alaska Native participant, and one male non-Alaska Native participant. Therefore, this second Group 2 Acceleration Academy group interview consisted of six (75%) Alaska Native participants and four (50%) female participants. The Summer Bridge group interview participants consisted of five female Alaska Native participants and one male Alaska Native participant. Therefore, this Group 2 Summer Bridge group interview consisted of six (100%) Alaska Native participants and five (83%) female participants. Table 1 below summarizes Group 2 total, Alaska Native, and female participants.

**Table 1. Summary of Study Participants, Number and Percent Alaska Native and Female**

| **Participants** | **Total Number of Participants** | **Number Alaska Native** | **Percent Alaska Native (%)** | **Number Female** | **Percent Female (%)** |
|---|---|---|---|---|---|
| **Group 1 Summary** | 8 | 8 | 100 | 4 | 50 |
| | | | | | |
| **Group 2 Acceleration Academy** | 16 | 11 | 69 | 7 | 44 |
| **Group 2 Summer Bridge** | 6 | 6 | 100 | 5 | 83 |
| **Group 2 Summary** | 22 | 17 | 77 | 12 | 55 |
| | | | | | |
| **Total Summary** | 30 | 25 | 83 | 16 | 53 |

ANSEP asked its high school students to complete trigonometry or pre-calculus, chemistry, and physics as part of their participation in the ANSEP Precollege components. All eight (100%) of the Group 1 participants completed trigonometry or pre-calculus or higher prior to attending University of Alaska. Only one (14%) of the seven Group 1 participants had not completed chemistry in high school. Only one (14%) of the Group 1 participants had not completed physics in high school. Refer to Table 2 for a summary of the mathematics and science courses each of the study participants participated in.

During the Acceleration Academy group interviews, of the sixteen total Acceleration Academy participants, three were rising 9th graders, three were rising 10th graders, six were rising 11th graders, and four were rising 12th graders. Because of this, they may not yet have had the opportunity to take some of these courses. Six (38%) of the sixteen Group 2 Acceleration Academy participants had completed trigonometry or pre-calculus or higher. Seven (44%) of the sixteen Group 2 Acceleration Academy participants had completed chemistry. None of the sixteen Group 2 Acceleration Academy participants had completed physics. All six (100%) of the Group 2 Summer Bridge participants had completed trigonometry or pre-calculus or higher. All six (100%) of the Group 2 Summer Bridge participants attempted to complete chemistry but only five (83%) successfully completed chemistry with one completing only half of the chemistry course successfully. All six (100%) of the Group 2 Summer Bridge participants had completed physics. Refer to Table 2 for a summary of the mathematics and science courses each of the study participants completed.

**Table 2. Summary of Study Participants and Precollege Mathematics and Science Course Completion**

| Participants | Total Number of Participants | Number and Percent Completed Trigonometry | | Number and Percent Completed Chemistry | | Number and Percent Completed Physics | |
|---|---|---|---|---|---|---|---|
| | | Number | Percent (%) | Number | Percent (%) | Number | Percent (%) |
| **Group 1 Summary** | 8 | 8 | 100 | 7 | 88 | 7 | 88 |
| | | | | | | | |
| **Group 2 Acceleration Academy** | 16 | 6 | 38 | 7 | 44 | 0 | 0 |
| **Group 2 Summer Bridge** | 6 | 6 | 100 | 5.5 | 92 | 6 | 100 |
| **Group 2 Summary** | 22 | 12 | 55 | 12.5 | 57 | 6 | 27 |
| | | | | | | | |
| **Total Summary** | 30 | 20 | 67 | 19.5 | 65 | 13 | 43 |

*Interview Schedules*

The first interview schedule asked Group 1 participants individual interview questions, the second interview schedule asked Group 1 participants group interview questions, and the third interview schedule asked Group 2 participants group interview questions. Each participant was asked about the self-determination theory elements of autonomy, competence, and relatedness. For autonomy, Participants was asked: “During ANSEP Precollege, did ANSEP let you use self-direction to guide your own actions?” For competence, participants were asked: “During ANSEP Precollege, did ANSEP allow you to believe that they can be successful in school and/or do they offer positive feedback?" For relatedness, participants were asked: "During ANSEP Precollege, did ANSEP allow you to feel like you belong here?"

*Analysis Procedures*

A transcriber was hired to transcribe the interviews. After receiving all of the transcripts from the transcriber, NVivo a qualitative analysis computer software package was used to listen to each interview and correct the transcripts for spelling and wording errors. Then the transcribed data was put into NVivo, which was used throughout the rest of the analysis process. Each of the transcripts were coded line-by-line. A first cycle coding process was employed and then a second cycle of coding, as discussed below. Yatchmeneff was the only coder, therefore there was no need to check for inter-rater reliability.

The first cycle of coding included "Simultaneous Coding" which are two separate coding techniques: "Evaluation Coding" and "Themeing the Data"[45]. "Evaluation Coding" was used to develop "non-quantitative codes to qualitative data that assign judgments about the merit, worth, or significance of programs or policy"[45]. "Evaluation Coding" was used to develop codes that consider the evaluation of ANSEP Precollege components. Positive (+) and negative (-) symbols were used at the beginning of many of the codes to correspond to the coding as being positive or negative about ANSEP.

Saldaña[45] explains that "theme" can be many things including a category, domain, and unit of analysis. During the first cycle of coding, the "themes" that were developed constituted elements from the self-determination theory of motivation. Saldaña[45] argues that "themes should be stated as simple examples of something during the first cycle of analysis, then woven together during later cycles to detect processes, tensions, explanations, causes, consequences and/or conclusions" (p. 177). "Themeing the Data" was used to develop codes based on elements of the self-determination motivation theory. Examples of first cycle of analysis included codes that pertain to who or what was motivating or demotivating them to take more mathematics and science courses in high school and towards success in school. Positive (+) and negative (-) symbols were used at the beginning of many of the codes to correspond to the coding as being motivational or being demotivation.

Saldaña[45] described "Analytic Memos" as "a place to 'dump your brain' about the participants, phenomenon, or process under investigation by thinking and thus writing and thus thinking even more about them" (p. 41). "Analytic Memos" can act as a "prompt or trigger for written reflection on the deeper and complex meanings it evokes"[45] (p. 42). Examples of "Analytic Memos" that Saldaña[45] provided includes reflections about personal connections to the data, study's research questions, codes, definitions, patterns, categories, themes, concepts, assertions, possible networks, theory, problems with the study, personal or ethical dilemmas, future directions of the study, other analytic memos, and study's final reporting (pp. 43–50). "Analytical Memos" were used to help deeply contemplate the meaning of the data and used them to help analyze the data[45].

*Reliability and Validity*

According to Creswell[46], triangulation is "the process of corroborating evidence from different […] types of data […] in descriptions and themes in qualitative research" (p. 259). The researcher then examines each type of data to find evidence to support the theme[46]. Two different data types were collected for this study: individual interviews and group interviews. These data were used to triangulate and validate the findings[46]. Triangulation "ensures that the study will be accurate because the information draws on multiple sources of information" and "in a way encourages the researcher to develop a report that is both accurate and credible"[46] (p. 259). Validation "means that the researcher determines the accuracy or credibility of the findings"[46] (p. 259).

Simon[47] argued that a review conducted by experts can improve a study and ensure the data collected answers the research question. Dr. Alice L. Pawley, Dr. Monica E. Cardella, Dr. Allison Godwin, and Dr. Linda P. Lazzell were the panel of experts that reviewed the research design, findings, and conclusions. Using a panel of experts increases our research construct validity and increases the likelihood that the individual and group interview questions measure what they are intended to measure.

Pawley and Phillips[48] used Walther and colleagues'[49] typology of quality strategies to develop a table that shows their quality plan for making the data (p. 8, Table 2). Pawley and Phillips[48] argued that the use of these quality strategies "help improve the quality of interpretive research in engineering education" (p. 7). Following Pawley and Phillips'[48] example, a table was generated that represented the quality plan for developing the data. Table 3 includes the quality plan for making the data.

**Table 3. Quality Plan for Making the Data**

| Making the Data Phase | Reflection Questions | Process Plan to Address |
|---|---|---|
| Recruiting | How do we make sure we interview the "right" people? "Right" in terms of explicit criteria (people who identify as Alaska Native and also who have participated or are participating in ANSEP Precollege components) but also "right" in terms of wanting to understand how they describe that ANSEP motivates them to take advanced mathematics and science courses in high school. | • Ask participants for self-identification of gender, race, and their participation in ANSEP Precollege both in recruitment phase and interview phase.<br>• Diversity interview pool not only with respect to gender and race but UA campus, ANSEP Precollege components, and other theoretical salient characteristics. |
| Interviewing | Do the participants say anything "useful" (in terms of answering the research question) through their stories, based on their | • Articulate concerns or other thoughts about the data through "Analytic Memos."<br>• Become comfortable with the |

| | | |
|---|---|---|
| | responses and prompts? | interview schedule to be able to ask appropriate follow-up interview questions during the interviews. |
| Processing Data | Did we collect and transcribe what the participants said accurately? Did participants report their perceptions as they desired? | • Collect transcripts while re-listening to interviews.<br>• Request panel of experts read through transcripts and correct, change, or otherwise comment on what participants said. |

Pawley and Phillips[48] developed a table that maps their analysis steps (p. 13, Table 5) to Walther et al.'s[49] topology of quality strategies table (p. 640, Table 1). Following Pawley and Phillips'[48] example, a similar table was generated to map our analysis steps to Walther et al.'s[49] typology of quality strategies (p. 640, Table 1). Table 4 includes analysis steps mapped to Walther et al.'s[49] typology of quality strategies (p. 640, Table 1).

**Table 4. Analysis Steps Mapped to Walther et al.'s[49] Topology of Quality Strategies (p. 640, Table 1)**

| Description | Making the Data | Handling the Data |
|---|---|---|
| *Validation:* How can we improve the research findings' capacity to appropriately capture and represent aspects of the social reality observed? | Presented data collection method for collective scrutiny to the panel of experts. | Documented research insights mapped to "Analytic Memos." |
| *Theoretical Validation:* Do the concepts and relationships of the theory appropriately correspond to the social reality under investigation? | Designed the interview protocol to facilitate inquiry into the concept of self-determination theory of motivation focusing on intrinsic and intrinsic motivation and elements of autonomy, competence, and relatedness. | Regularly returned to the conceptual framework to see how we might situate data ("Analytic Memoing"); Described understanding of the self-determination theory of motivation and data and their alignment to panel of experts for their collective scrutiny. |
| *Procedural Validation:* Which features of the research design improve the fit between reality and the theory generated? | Built memoing and reflection on the data collection based on interviewer's self-determination theory of motivation lens into the analytic process. | Built "Analytic Memos" into the analytic process. |
| *Communicative Validation:* Is the knowledge socially constructed within the | Situated method within a conceptual framework recognized as valuable by | Process required that we connect claims to direct readings of the transcripts. |

| | | |
|---|---|---|
| relevant communication community? | multiple research communities. | Wrote a description of claims that offered evidence used to argue each claim, and presented these arguments with evidence to panel of experts for their collective scrutiny. |
| *Pragmatic Validation:* Do the concepts and knowledge claims withstand exposure to the reality investigated? | Set aside 60 to 90 minutes for each interview, and started each interview with the question "Can you please define what motivation is or what motivation is to you?" Which was guided by protocol informed by conceptual framework of self-determination theory of motivation. | Presented research results to ANSEP and panel of experts for their collective scrutiny. |
| *Process Reliability:* How can the research process be made as independent as possible from random influences? | Developed and followed standard operating procedures for data collection and transcription for consistency.<br><br>Interview procedures were built on traditional interview practices, followed a standard procedure, and were approved by Purdue University and University of Alaska Anchorage IRB offices. | Documented and submitted analytic processes to panel of experts for their collective scrutiny. |

The panel of experts both reviewed and approved each step in making the data and handling the data. Also the reflective process of "Analytic Memoing" was also used in order to develop deep understandings of the data. These techniques have helped improve this study's trustworthiness.

**Results**

Findings suggest that ANSEP Precollege academic coursework and social engagement components positively contributed to Alaska Native participant motivation to take and successfully complete advanced high school and college-level mathematics and science courses while in high school. This study also attempted to determine if Alaska Native ANSEP high school students are gaining a sense of autonomy, competence, or relatedness to motivate them to take advanced mathematics and science courses.

In terms of autonomy, participants were asked if ANSEP allowed them to use their own self-direction to guide their own actions. The responses were mixed. Many of the Group 1 participants and a majority of the Group 2 participants indicated that ANSEP did allow them to use their own self-direction to guide their own actions. The autonomous activities included hands-on team STEM activities, exposure to STEM careers, and taking more mathematics or science courses. However, several also felt that ANSEP did not allow them to use their own self-direction to guide their own actions. Many students that mentioned that they felt like ANSEP did not allow them to use their own self-direction to guide their own actions mentioned this because they felt there were more opportunities provided within engineering and fewer opportunities provided within science. They also felt that the study sessions during the ANSEP Acceleration Academy and Summer Bridge components were too restrictive but to combat this they said they should be able to select the times they would study and what they studied.

In terms of competence, participants were asked if ANSEP allowed them believe in themselves and if they received positive feedback. All of the study participants explained that ANSEP allowed them to believe in themselves and that ANSEP staff also provided positive feedback. Participants explained that they believed in themselves because they knew ANSEP would always be there to support them in future precollege opportunities and on into college.

In terms of relatedness, participants were asked if ANSEP allowed them to feel like they belonged at ANSEP and at UAA. All of the study participants explained that ANSEP allowed them to feel like they belonged. The reasons participants provided included that the ANSEP Building felt “Homey” or like a second home and because of the relationships they were able to foster with their ANSEP peers.

It was determined that overall ANSEP allowed participants to gain a sense of autonomy, competence, or relatedness to motivate them to take advanced mathematics and science courses. ANSEP was also successful at helping its ANSEP Precollege participants gain a greater sense of competence and relatedness than it was at increasing their sense of autonomy. Figure 1 represents a summary of the findings for how ANSEP was success at helping its ANSEP Precollege participants gain senses of autonomy, competence, and relatedness and motivating its Alaska Native precollege students to take and complete advanced mathematics and science courses. In essence, the collective combination of each of these elements are required in order to help motivate Alaska Native students to take and complete advanced mathematics and science courses.

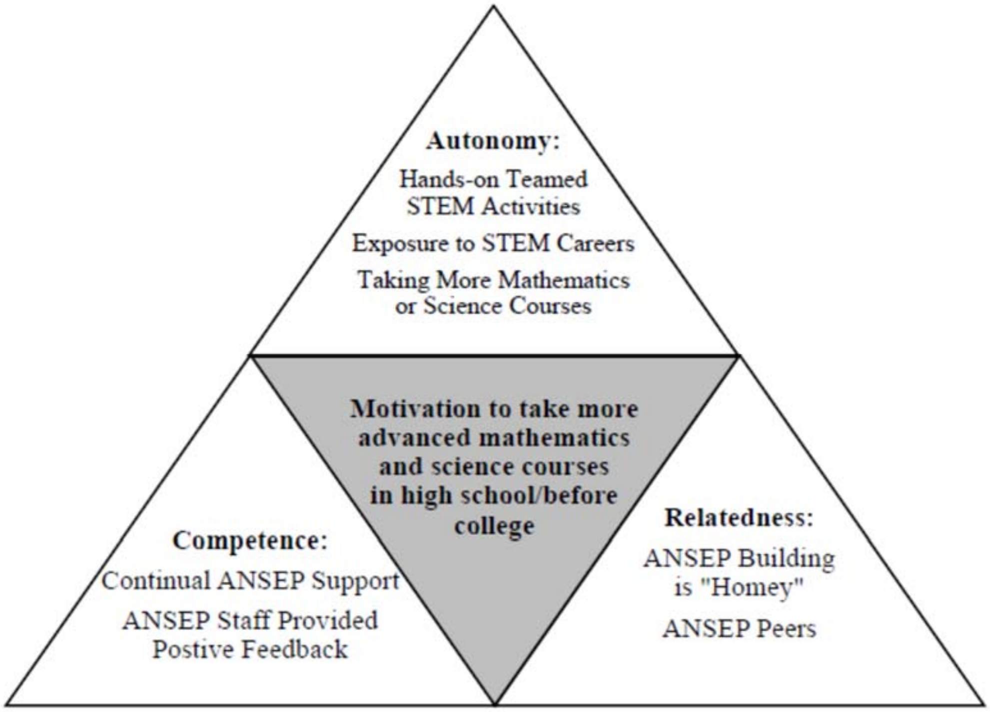


**Figure 1. Summary of Findings for Autonomy, Competence, and Relatedness**

## Conclusions

During the 2012-2013 school year, Alaska Native students were overrepresented in the group of students who dropped out of school and had the lowest performance compared to non-Alaska Natives students in mathematics and science as assessed by two separate tests scores[50]. For example, Alaska Native tenth graders tested 56.8% below proficient in mathematics on their Standard Based Assessments, with 27.7% of the these being far below proficient[50]. Meanwhile, 79% of the ANSEP Acceleration Academy students have successfully completed their mathematics courses taught at UAA, which provides evidence that Alaska Native ANSEP Precollege students are capable of overcoming these educational crises. ANSEP not only provided opportunities for high school students to take and complete advanced mathematics and science courses, but ANSEP also helped high school students feel that they could self-direct their own actions, believe they can be successful, and feel like they belonged in the advanced STEM educational community of ANSEP and at UAA.

Ultimately, the ANSEP Precollege components may be empowering Alaska Native high school students to overcome the educational barriers that have prevented them from succeeding in mathematics and science courses. ANSEP students' high rates of successful completion of advanced mathematics and science courses indicates that if given the chance, these students will not only complete these courses but excel. In 2014, 11 (42%) of the 26 Summer Bridge participants were ready for Calculus II or higher their first year of college. When students accomplish a difficult task, like building a computer or completing their first college level mathematics or science course, it causes these students to realize they can go further. They can reach for higher and higher educational and career goals, like becoming an engineer or scientist managing Alaska's natural resources.

*Limitations*

Limitations for this study include that this study focused on interviewing "successful" students (for example, Group 1 students were attending college for STEM degrees and therefore already took sufficient high school math and science courses needed for admissions to college). This study does not incorporate students' views of "unsuccessful" students, or students who did not pursue STEM degrees. We could include views of "unsuccessful" students but it is outside the scope for this particular study. But interviewing "successful" students could lead to a future study where research to collect data with "unsuccessful" students, who did not end up pursuing STEM degrees, is pursued. Also, the researchers would be considered an "insider" of ANSEP and this could have been a limiting factor for this study because someone who was not an "insider" of ANSEP may have had unbiased views.

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