2021 ASEE ANNUAL CONFERENCE

Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time

Exploring Student Academic Motivation and Perceptions of Teamwork and Communication

Paper ID #33908

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Introduction

There was a national effort in 1972 to increase the number of people from underrepresented minorities in science, technology, engineering, and mathematics (STEM) fields. Despite an increase from 1995 onwards, there is still a gap between portion of them and U.S. population demographics (Palmer, Maramba, & Dancy, 2011). One of the approached to mitigate this challenge is to provide community-based outreach programs for the underserved youth populations (C D Edwards et al., 2018). One of these well-known societies is the National Society of Black Engineers (NSBE). NSBE offered the Summer Engineering Experience for Kids (SEEK). This program can foster a great environment for students to improve their knowledge in STEM fields (Byars-Winston, 2014). Furthermore, academic organizations and institutions proved that summer outreach programs can increase students' interests in STEM-related fields (Jeffers, Safferman, & Safferman, 2004).

Many of these summer outreach programs follow the K-12 engineering education principles by utilizing the project-based learning (PBL) approach. The PBL is introduced by Kilpartick and this method is used in education by Dewey. This method is based on designing or creating product, solving problem, investigating, and developing an answer (J Dewey, 1980; J Dewey, 2008; Kilpatrick, 1918). The PBL approach improves group work skills and collaboration while keeping students more engaged in learning by keeping them motivated as the key element of this strategy (Harun, Yusof, Jamaludin, & Hassan, 2012; Huang, 2010). The fundamental norms of a group of students working together are communication and collaboration skills as well as an intrinsic motivation to become an effective group (Blumenfeld, Marx, Soloway, & Krajcik, 1996). Brett Jones identified five teaching strategies that can affect students' academic motivation (2015, p. 9). He used MUSIC as an acronym for these five components, including empowerment, utility, success, interest, and caring. This paper aims to discern the various aspects of students' academic motivation and their relationship with specific outcomes and processes, including group work skills, communication skills, and teamwork processes of elementary-aged students as they engage in a summer outreach program. We conduct preliminary explanatory analysis and uncover relationships between the MUSIC model's different components with those outcomes and processes. Specifically, our paper addresses the following research questions:

- **RQ1:** What is the relationship between the various components of academic motivation and group work skills?
- **RQ2:** What is the relationship between the various components of academic motivation and communication skills?
- **RQ3:** What is the relationship between various components of academic motivation and team processes?
- **RQ4:** What are the interrelationships between group work skills, communication skills, and team processes, controlling for academic motivation?

Having group work skills, communication skills and team processes are essential for most of the engineers. Students need to develop these skills to being a successful engineer. Thus, understanding approaches to develop these skills is important, even at such a young age. The outcome of this study can help designers of outreach programs such as SEEK identify which

academic motivation components could be focused on so that students may develop better communication skills, group work skills and team processes.

Literature Review

Outcomes and Processes: Group Skills, Communication Skills, and Team Processes

The process of developing life skills begins before age five (Gardner, 1989). One of these life skills students can develop in the school environment is working in groups (Robinson & Zajicek, 2005; Townsend, 1983). Working as a group allows students to support and help each other's learning when they have a similar purpose of accomplishing shared goals (Gillies & Ashman, 1998). Successful groups are advantageous for students in different ways: 1) groups enhance student's reasoning and higher thinking; 2) groups help students learn to accommodate other students' perspectives about problems; 3) groups help students develop cognitive processing and integrating information; and 4) groups help students learn how to give and receive encouragement and foster acceptance among their team members (Bossert, 1988). Other authors have similar articulated that benefits of group work include learning teamwork skills, improving deeper learning, and fostering engagement if students find themselves valuable members of the group (Sage, Vandagriff, & Schmidt, 2018). However, placing children in a group does not mean that they will cooperate (D. W. Johnson & Johnson, 1999). Some students might pressure others to accept their ideas or dominate discussions. The group of students needs some norms to become an effective team. These required norms include the following: communicating and listening to others; collaborating and having mutual appreciation among group members for their skills and abilities; and being academically motivated (Blumenfeld et al., 1996; Slavin, 2014; Young, Knight, & Simmons, 2015).

Other related life skills that take time and support to develop are social skills (Caulfield & Caroline, 2006; McKinney, McKinney, Franiuk, & Schweitzer, 2006; Oakley, Felder, Brent, & Elhajj, 2004). In a project-based learning environment, a team of students aim to solve a problem posed by their teachers. Having a disagreement is a common occurrence in every team, and students can learn how to utilize the disagreement for finding a better solution when they have strong communication skills (Glaser, 1994). Group members may have different perceptions of their communication quality (Murray & Enarson, 2007), and in such cases, scaffolding mentoring can provide supports to help students learn how to communicate effectively. The program under investigation provides this kind of mentoring scaffolding approach.

One of the instructional methods used by teachers is encouraging collaborative learning in which a group of students works together to achieve a common goal (Prince, 2004). Collaboration can help students solve problems (Ku, Tseng, & Akarasriworn, 2013). Furthermore, several studies found that collaboration improves students' performance by developing higher order-thinking when students discuss their ideas in the group (Chung, 1998; S. D. Johnson & Chung, 1999; Mergendoller, Bellisimo, & Maxwell, 2000). Students will more engaged in learning when they feel they are an accepted group member (Willms, 2003). For example, girls have positive perceptions about team processes when they are in a group comprised of other girls. As shown in prior research on SEEK, girls felt less positive about their team processes and were less engaged when they were in a co-ed team (Beauchamp, Edwards, Knight, & Lee, 2019). Thus, in addition

to focusing on the outcomes (i.e., skills) of team-based problem-solving, it is important to also understand the processes in which students engage as they work together. There are various approaches to assessing collaboration. Instructors can assess collaboration, or students can perform self-assessments. Self- or other- reports can also be utilized to assess individual differences in teamwork (Angelo & Cross, 1993; Loughry, Ohland, & DeWayne Moore, 2007Assessing teamwork from different perspectives develops valid evidence for further research (Lijuan Wang, MacCann, Xiaohua Zhuang, Liu, & Roberts, 2009).

Academic Motivation

Motivation has a considerable impact on each learning group to be more productive (Slavin, Hurley, & Chamberlain, 2003). Motivated students invest more energy and effort in their learning (D. W. Johnson & Johnson, 1999). One way of conceptualizing academic motivation is the MUSIC model, which was initially developed to help teachers implement strategies for improving students' motivation (Jones, 2009). This instrument can also indicate students' perceptions of their academic environments (Jones & Carter, 2019). The MUSIC model consists of five components.

- eMpowerment: Students' ability to control learning materials and environment.
- Usefulness: Students' understanding of the coursework, which is helpful for their future.
- Success: Students believe that they will be successful if they make an effort.
- Interest: Students find the content interesting.
- Caring: Students believe that their teachers and other students care about their learning.

The academic motivation consists of a variety of perceptions of the learning environment, including empowerment, usefulness, interest, success, and caring. The empowerment is students' ability of making decision about the course materials they are learning and their control over learning environment (Deci & Ryan, 1991). Children in the elementary schools feel more motivated when do not feel that they are controlled by teachers, parents, and grades (Gordeeva, Sychev, Pshenichnuk, & Sidneva, 2018). The usefulness component is based on the perception of students about alignment of coursework with their future goal. Students feel more motivated when their learning material is consistent with their future career (Wigfield, 1994; Wigfield & Eccles, 2000). The interest component is based on how students perceive course topics and instructional methods, interesting (Hidi & Ann Renninger, 2006; Renninger, Hidi, Krapp, & Renninger, 2014). Further, the success component is formed on expectancy for success (Wigfield, 1994; Wigfield & Eccles, 2000). This component reflects students' self-efficacy about the coursework (Bandura, 1986). The caring component is based on students believes that instructors care about their success and well-being (Noddings, 1992).

Motivation can be perceived as a student's intention and engagement in learning as student's action (Christenson, Reschly, & Wylie, 2012). In other words, motivation theoretically directly affects students' engagement, and engagement directly relates to students' performance and learning (Jones, 2015). Elementary students demonstrated more academic motivation and learning when school settings focused on improving skills and understanding (Meece, Anderman, & Anderman, 2006). Furthermore, developing intrinsic motivation in younger children will contribute to their future motivation in school and learning match and science (Gottfried, 1990). In our current study, therefore, it is important to understand students'

academic motivation and how different elements of motivation connect to the desired learning outcomes and processes. Simply placing students in teams would not theoretically lead to developing those skills if students were not academically motivated within the learning environment.

Overview of SEEK study context

NSBE's SEEK program places particular emphasis on racially underrepresented students. Over 20,000 children have participated in this program since 2007. The SEEK outreach program provides a three-week summer class for 3rd-4th grade students. The primary approach of this three-week program is based on the PBL method. Children learn engineering and other STEM fields by engaging in content knowledge by having hands-on experience. In this three-week summer program, children are randomly assigned into groups. Each group of students is assigned to work on a specific engineering task each week. There is a weekly competition at the end of each week to present what they had worked on and be assessed by their peers and mentors. This three-week program provides an environment to improve students' group work, communication, and collaboration skills.

Research Methods

Virginia Tech and Purdue University researchers designed and implemented data collection approaches with NSBE team partnership. This effort was supported by an award from National Science Foundation (NSF), and researchers were tasked with gathering data to assess the effectiveness of the three-week program. We followed a study design that collected a range of assessment data from students on the first day of the camp, including, for example, students' conceptual knowledge in math, science, and engineering, as well as a range of self-report data pertaining to perceptions of engineering, attitudes toward math and science, and different skill areas. Similar kinds of data were collected on the next-to-last day of the program from each student as well as students' perceptions of various elements of the program, including team processes and their levels of academic motivation. Data were collected in the paper-pencil format, and our research team transcribed all assessments into a data base.

We base this paper on the 2019 rendition of the program. Assessments were completed by 1,125 elementary-aged students. After omitting students whose parents did not complete an IRB consent form and excluding students with missing data, our sample included approximately 1,052 students. The demographic composition of the sample based on race is: 86.0% Black or African American, 8.5% multi-racial (with African American), 2.7% Hispanic or Latino, 1.4% Asian, 0.6% multi-racial (without African American), 0.4% white, 0.2% American Indian or Alaska Native, and 0.1% Native Hawaiian or Pacific Islander. As we note in the Introduction, we focus our analysis on academic motivation, group work skills, communication skills, and team processes, including self-reflection and collaboration skills.

The academic motivation survey was developed by Dr. Brett Jones (2017) to help teachers assess students' perceptions of their learning environments (Table 1). This instrument has five components, including empowerment, usefulness, interest, success, and caring. Items in this survey were formatted in a 4-point Likert scale with three items for each component. These items

have four options, including no, maybe, yes, and definitely yes. We used the average of items in each component to generate a mean scale score. The college and elementary school version of this instrument has been indicated to produce valid scores (Jones & Sigmon, 2016; Jones & Skaggs, 2016; Pace, Ham, Poole, & Wahaib, 2016). This instrument showed a good reliability estimate in this research. Table 1

Name	Item
	I was able to do a good job.
	I liked what I did.
	What I learned could help me in school.
	I knew I could do well.
	I could do it my way.
	My mentor was helpful.
Academic	It was useful to me.
Motivation	What I did was interesting.
(Alpha=.883)	My mentor cared about how well I did.
	It was easy to do.
	I made decisions.
	What I did was fun.
	I can use what I learned.
	My mentor likes me.
	I had choices.
	I am a good listener.
Communication	I am good at following directions.
Skills (Alpha= 668)	When I say something, people understand me.
(Aipna=.008)	When other people want to say something, I listen to what they want to say.
	I can work with other people.
	I can work well in a group.
Group work Skills (Alpha= 732)	I think that all people in a group should help in doing a job.
(*************************************	When I am in a group, I do what I am supposed to do.
	I think what other people want to say is important.

Team Processes (Alpha=.773)	My teammates shared ideas and answers with one another.		
	I asked my teammates questions when I didn't understand something.		
	My teammates helped each other understand when we had problems.		
	My teammates made people feel comfortable working in the group.		
	My teammates stayed on the assigned task.		
	My teammates tried to find out why when we did not agree with one another.		

The group work and communication skills items were derived from the Youth Life Skills (YLS) Inventory developed by Robinson and Zajicek (2005). The origin of this instrument is from Townsend and Carters (2003) Leadership Skills Inventory. Items in this survey formatted in 3-point Likert-format scale: 1- no 2- not sure, and 3- yes. The communication skill and group work skills (Table 1) have four and five items, respectively. We averaged the items to generate the mean scale for each element. The reliability estimates for communication and group work skills were adequate (Rutherford, Townsend, Briers, Cummins, & Conrad, 2002). The communication and group work skills instruments are presented adequate reliability in this research.

The team processes items were adopted from Angelo and Cross's (1993) classroom assessment techniques and Manitova online resource (Table 1). The self-reflected scale assesses the students' collaboration in the group. Items are formatted in a 3-point Likert scale: 1- rarely, 2- sometimes and, 3- always. We used the average score of these six items in order to conduct the analysis. The team processes instrument is showed adequate reliability.

Results

To address the first research question, we conducted multiple linear regression to test if different academic motivation components significantly related to group work skills (*YLS_Group_Post*). The results of the regression indicated the model explained 26% percent of the variance. Based on the result from Table 2, some academic motivation components significantly relate to group work skills. We found that students' self-perceptions of success (*MUSIC_SUCCESS*), interest (*MUSIC_INTEREST*), empowerment (*MUSIC_EMPOWERMENT*), and caring (*MUSIC_CARING*) significantly related to group work skills. However, the usefulness (*MUSIC_UTILITY*) construct did not statistically relate to the outcome variable. In the next model, we conducted the multiple regression to test if different academic motivation components significantly related to students' communication skills. Based on Table 2, academic motivation components accounted for 25% of the explained variability in the communication skills (*YLA_Comm_Post*). We found that success, interest, caring, and usefulness significantly related to communication skills. Conversely, empowerment did not relate to communication skills in this model.

For addressing the third research question, we used multiple regression to test if different components of academic motivation relate to team processes. Based on Table 2, academic

motivation constructs explained 25% of the variability in the model. Results indicated that empowerment, success, interest, and caring significantly relate to team processes, and usefulness does not at the P<.01 level.

Table 2

Summary of multiple regression	for academic	motivation	explaining	group	work skill
communication skills, and team	processes				

	Unstandardized		Standardized		
	Coefficients		Coefficients		
Variables	В	Std. Error	Beta	t	Sig.
Group Work Skills	1.728	.053		32.628	.000
MUSIC_EMPOWERMENT	.044	.015	.089	2.858	.004
MUSIC_UTILITY	.016	.016	.034	.972	.331
MUSIC_SUCCESS	.105	.016	.198	6.402	.000
MUSIC_INTEREST	.104	.017	.226	6.087	.000
MUSIC_CARING	.059	.018	.118	3.354	.001
Communication Skills					
MUSIC_EMPOWERMENT	.025	.017	.046	1.462	.144
MUSIC_UTILITY	.040	.018	.078	2.194	.028
MUSIC_SUCCESS	.179	.018	.302	9.671	.000
MUSIC_INTEREST	.052	.019	.101	2.709	.007
MUSIC_CARING	.061	.020	.109	3.046	.002
Team Processes					
MUSIC_EMPOWERMENT	.060	.022	.088	2.727	.006
MUSIC_UTILITY	.046	.024	.072	1.960	.050
MUSIC_SUCCESS	.105	.023	.144	4.509	.000
MUSIC_INTEREST	.109	.024	.172	4.515	.000
MUSIC_CARING	.122	.025	.175	4.798	.000

Note. N=1095 Fore group work skills, R²=.26; N=1094 for communication skills, R²=.25; N=1048 for team processes, R²=.26, p<.001.

We also examined a partial correlation to test if there is a significant relationship between group work skills, communication skills, and team process skills whilst we control academic motivation components. The average score of all academic motivation components is used for this analysis. Based on Table 3, when we control for academic motivation, we find the following partial correlations. There was a moderate, positive correlation between communication skills $(2.61 \pm .38)$ and group work skills $(2.74 \pm .35)$ whilst controlling for academic motivation (3.07 $\pm .53$), which was statistically significant, r (1049) = .509, N=1052, p<.0010. However, zero-

order correlation showed that there was a statistically significant, moderate, positive correlation between communication skills and group work skills (r (1050) = .624, N=1052, p<.001) indicating that academic motivation had moderate influence in controlling for the relationship between communication skills and group work skills.

Further, there was a statistically significant low positive correlation between team processes $(2.33 \pm .47)$ and communication skills when we controlling for academic motivation r (1049) =.255, N=1052, p<.001. although, zero-order correlation indicated that there was statistically significant moderate correlation between team processes and communication skills (r (1050) = .428, N=1052, p<.001). This result indicating that academic motivation had influence in controlling the relationship between team processes and communication skills.

Furthermore, there was a significant low positive association between team processes and group work skills when we control for academic motivation r (1049) = .253, N=1052, p<.001. However, zero-order correlation indicates there was statistically significant moderate correlation between team processes and group work skills (r (1050) = .439, N=1052, p<.001). Based on the result we can see the effect of motivation in controlling association between team processes and group work skills.

Table 3

Correlations

			YLS_Com	YLS_Grou		
Control Variables			m_Post	p_Post	TP	MUSIC
-none- ^a	YLS_Comm_	Correlation	1.000	.624	.428	.470
	Post	Significance (2-tailed)		.000	.000	.000
		df	0	1050	1050	1050
	YLS_Group_	Correlation	.624	1.000	.439	.501
	Post	Significance (2-tailed)	.000		.000	.000
		df	1050	0	1050	1050
	ТР	Correlation	.428	.439	1.000	.495
		Significance (2-tailed)	.000	.000		.000
		df	1050	1050	0	1050
	MUSIC	Correlation	.470	.501	.495	1.000
		Significance (2-tailed)	.000	.000	.000	
		df	1050	1050	1050	0
MUSIC	YLS_Comm_	Correlation	1.000	.509	.255	
	Post	Significance (2-tailed)		.000	.000	
		df	0	1049	1049	
	YLS_Group_	Correlation	.509	1.000	.253	
	Post	Significance (2-tailed)	.000		.000	
		df	1049	0	1049	

TP	Correlation	.255	.253	1.000	
	Significance (2-tailed)	.000	.000		
	df	1049	1049	0	

Discussion

Our study explored the relationship between motivation, group work skills, communication skills, and team processes. Based on the results, there is a significant relationship between most of motivation components including empowerment, success, interest, and caring and group work skills. These findings mirror other studies that students' academic motivation is related to their group work and team work skills (Filippatou & Kaldi, 2010; Pérez Martínez, García Martín, & Sierra Alonso, 2014). However, there is no significant association between usefulness and group work skills. We can suggest that students' perception of the course's value for their future is not related to how they work in a group.

The result of multiple regression indicates that most of academic motivation component can be used to predict communication skills. There is a statistically significant relationship between success, interest, caring, and usefulness and communication skills. These findings also align with previous studies; when students are motivated and have self-efficacy, they have better interactions and communication with peers (Yang, Tsai, Kim, Cho, & Laffey, 2006). However, there was no significant relationship between the success component of academic motivation and communication skills. The success component is based on their effort and expected outcome. Communication skills are more about how they engage in conversation with their peers. Based on the result, we could suggest that students' expectations are not related to how they communicate.

We also found significant relationships between various components of academic motivation and team processes. Based on the result, empowerment, success, interest, and caring can predict the level of team processes. This is consistent with previous research that academic motivation is associated with collaboration and team processes (Martin, 2005). However, the significance level of usefulness component of academic motivation was not statistically significant. It is interesting to notice that students' perception of the class's usefulness for their future is not related to how they collaborate in a group.

The result of partial correlation reported association between group work skills, communication skills, and team processes when we control for academic motivation. Previous research are also reported that team processes, communication skills and group work skills are important elements for engineering students (Pears & Daniels, 2010). Based on these results we can see the relationship and association between group work skills, communication skills, team processes and motivation, which provides more evidence of those relationships established in prior studies. A unique contribution of our sample is that it is comprised of predominantly racially minoritized elementary-aged children from around the country, and so the outcomes shown in this paper extends the presence of these relationships between constructs to this population. Also, the new findings show students' academic motivation is a necessary factor in how they communicate, collaborate, and work in a group.

The SEEK program used the PBL approach to provide an environment for students to work on an individual project each week. This program was designed around a series of several activities, such as making a drone, wind turbine, or gravity cruiser. Students know that they will present their module to their peers and mentors at the weekly competition at the end of each week., and mentors advised students to understand that working with their team and having strong communication skills would help them be successful in that weekly competition. Furthermore, their module each week focused on a different toy or common product that made engineering seem more real and useful. These factors in combination boosted their academic motivation to engage in learning and fostered more knowledge about STEM (Edwards et al., in press), which our results show also simultaneously linked to group skills and communication skills.

Conclusion

The PBL environment provided by SEEK promotes academic motivation, which in turn relates to higher group work skills, communication skills, and team processes. Furthermore, there is an association between groupwork skills, communication skills, and team processes whilst controlling for academic motivation. This research provides evidence that PBL strategy makes students more motivated by implementing their STEM knowledge. This approach also provides an excellent environment for students to learn while improving their life skills such as group work skills, team processes, and communication to complete their project.

Acknowledgement

This study is based upon a project supported by the National Science Foundation Engineering Education and Centers under Grant Number DRL-1614710, 1614739, and 1615143. Any ideas, findings, assumptions and conclusions or suggestions expressed in this study are those of the author(s) and do not reflect the views of the National Science Foundation.

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