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Effects of Collaborative Group Activities on Students' Interest, Course Participation, and Performance in an Online Physics Course

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EFFECTS OF COLLABORATIVE GROUP ACTIVITIES ON STUDENTS' INTEREST, COURSE PARTICIPATION, AND PERFORMANCE IN AN ONLINE PHYSICS COURSE

A Thesis by:

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December 2021

ABSTRACT

The purpose of this study was to investigate the impact of the use of collaborative work activities in online physics courses as perceived by students. Nearly identical surveys were administered at the beginning and end of two semesters to ascertain student perception on the impact of the utilization on their level of interest, participation, performance as well as teamwork skills. The results show that the majority of the population tested strongly agree that collaborative work had significant effect on all core areas tested, and they support the notion that it should be further utilized in both lecture and lab portions of the course. Testing on the data suggests that the group impacted the most were those deemed “low achieving”.

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INTRODUCTIONS AND EXPLANATION

The premise is a question that is commonly asked amongst instructors hoping to have positive impacts on their students: how can we create an environment in which students will be more willing to participate in their own learning? It is especially prevalent in an online setting: students may remain silent if there is nothing forcing them to give input, with an occasional question getting something out of them if they choose to respond to it. Getting students to be active in their courses is imperative if we are to increase their chances of being successful and getting something out of it. As such, one method that is currently being used in physics lab courses may be the answer to this problem. In the lab courses in the online format, collaborative work is being used for students to do work together in groups throughout the semester. While it is only being used for the grade aspect, what if it encompassed more?

If collaborative work were used in more courses, and even the lecture portions, would this have a positive effect on the students, in areas concerning their interest in the subject, willingness to participate, ability to work in teams, and ability to perform well in the course? This study will aim towards getting a consensus on student opinion of this method, and whether or not it warrants more extensive usage in the physics courses. In addition to student perception, the impact of collaborative work will be measured and compared, and the significance of its utilization will provide more evidence to support or discredit it.

BEGINNING THE STUDY

Studying Student Perceptions and their Importance

Viewing this study from an outside perspective can only take us so far when it comes to finding what is best for students within these online courses. Various factors must be considered, and the relationships that the students have between the instructor and themselves can provide insight into their ability to perform, participate, and improve. By looking into their perspective, certain aspects that instructors may miss at a glance are noticed, and common ground can be found between what the instructors and students think is best for the course regarding the usage of collaborative work.

In their work entitled *Exploring student perceptions of group interaction and class satisfaction in the web-enhanced classroom*, Michaela Driver dove into different interactions that take place in the web-based environment, and how they effected student perception and outlook of the courses they were in. References are made to a study by Moore and Kearsley in 1996, and in that study three interactions were found in the class setting, with them being " the student's engagement with the course materials … the student's engagement with the instructor … the student's engagement with other students in the class" (Driver). With the student-instructor relationship being the focus of most studies, it was found that neglecting the other interactions may be the reason behind student perception not matching what was expected, and so it was theorized that there must be some equilibrium between the three. If reached, student satisfaction and perceptions will have notable increases, and these findings are key to our own study.

Driver's research was carried out with teaching methods akin to active learning, much like our own study. With students split into groups and working together with an emphasis on their interactions rather than the student-instructor interaction, it was found that "nearly all students logged on and contributed on a regular basis" with "avid participation of all members and rotating leadership activities" (Driver). Data was collected for student perceptions via survey, with various questions utilizing a likert scale ranging from answers such as Strongly agree to Strongly disagree. Based on the findings, Driver concluded that while various factors could have been at play, the majority of her sample set had positive perceptions and high satisfaction of the course due to the teaching methods utilized (please see Excerpt A in APPENDIX B for specifics on her statement).

Physics is a subject that demands attention and participation. Losing track of imperative details can be done with the greatest of ease in an online setting, and the setting itself creates a disconnect between the students and the instructors. Collaborative work activities offer the benefit of multiple perspectives to the students, for they can bounce ideas, concerns, and various other topics at each other and build stronger foundations for retaining the material. To have them base the material solely on the view of the instructor would be a disservice to the students; because of this fact, the importance of getting our students to accept collaborative work cannot be understated. Their perceptions over the course of this study will be key for future studies.

The Work of Cindy A. Vartuli:

With evidence found for a connection between student perception of the course and engagement, making further conclusions for the other focuses of the study (student interest in particular) could prove to be a challenge due to the online environment bringing forth many

factors that could interfere with data collection. However, one such study that was found proved to be a superb reference and insightful. In her dissertation *INCREASING HIGH SCHOOL STUDENT INTEREST IN SCIENCE: AN ACTION RESEARCH STUDY*, Cindy A. Vartuli researched about how to enhance the interest of high school students in the subject of science, utilizing survey responses from both students and instructors alike, and creating a so called Career Project (also called an intervention) in response.

Vartuli's study differs from our own, in that an "intervention" was utilized in response to initial data on student interest. To meet that end, she split her data collection into two phases, with the first intending to "create a more accurate picture of student interest in learning and pursuing science", and the second intending create intervention methods in response and "test the effectiveness of the intervention in influencing student interest in learning and pursuing science" (Vartuli 102). Her intervention seemingly had a significant impact, for in the preliminary survey roughly 58.5% of the students (158 out of 270) expressed medium to high levels of interest in physics, and in the second phase it was found that "74.5% of students strongly agree or agree that as a result of the STEM Career Project they are interested in learning more about science" (Vartuli 112 and 160). This directly supports the claim that more active learning styles (such as collaborative work) can greatly foster student interest if done properly!

An important feature to note about this study is that its conclusion resonates with our own study and reinforces the notion that we are right to be considering methods such as collaborative work. In her final pages, Vartuli came to the conclusion that:

> Classroom opportunities that offer students creative ways to obtain and demonstrate knowledge, such as the STEM Career Project, can go a long way in developing student interest in science. Providing

> new ways for students to experience science learning that demonstrate direct applicability to their lives and even future career goals is critical to creating student interest in science. Additionally, providing formal and informal opportunities for student feedback can provide insights into creating an atmosphere in which interest can develop and thrive.
>
> Vartuli 209

These three ideas that she proposes all fall within the boundaries of what collaborative work can accomplish. However certain challenges must be overcome in order to be successful. Student interest must be considered and worked on if they are to engage and have meaningful learning and interactions.

A Direct Comparison between Traditional and Active Learning

The relative ease of the traditional teaching methods have made them a staple in the classroom to this very day. From the earliest education level to the last, they can be found in some way or form throughout the entirety of one's educational journey. Due to these various factors advocating for their usage, there are those who may still be on the fence between traditional learning and active learning. It is my hope that this next study further proves that we are correct in testing collaborative work rather than more traditional methods. In his study, entitled *Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses*, Richard Hake utilized surveys and distributed them across over 60 introductory physics courses. These actions were able to showcase a direct comparison between active learning and traditional methods of teaching (which are more passive in nature).

Hake's methods of comparison focused on determining the learning gains of students across multiple courses. Fourteen courses were taught in the traditional manner, while forty-eight utilized active learning in what Hake dubbed "interactive engagement" methods. In his findings, Hake found that for the traditional courses, the learning gain was roughly 23%, with the IE (interactive engagement) courses having roughly 48% gains. In addition, he concluded that "IE courses generally show both higher FCI averages and higher MB averages than traditional courses… it would appear that problem-solving capability is actually *enhanced*… " (Hake).

With his findings showing potential for active learning to be superior to traditional learning, I believe that this directly supports our claim and hopes for collaborative work in that it will enhance our students in various aspects. Though this study only looked at learning gains, our study is out to observe the impact on more than just performance, making our findings rather unique overall.

Will Students Accept Active Learning?

Active learning can come in many different forms, though the majority focus on placing emphasis on the student role rather than instructor. Though it has been shown that active learning has greater potential for growth over traditional methods, this is a moot point of the general student populous is not accepting of this learning style. The following study utilized active learning through the form of using PDAs (Personal Digital Assistant), and gathered data on the impact it had on students as well as their perception of it (similarly to what we have done). In their paper entitled *The Use of a Web-Based Classroom Interaction System in Introductory Physics Classes*, Dr. Edgar Corpuz, along with Ms. Ma Aileen Corpuz and Rolando Rosalez

found evidence to show students will not only be significantly impacted by this learning style, but will ultimately support it.

To begin, the interactive learning with the PDAs involved short lectures where students would be grouped together, and answer questions provided by the instructor. With the students tackling the issues head on and allowed to question the instructor through the PDA as the lecture progressed, student engagement was ever present and enhanced. Using pre and post test data obtained, along with surveys to obtain student perceptions, the study concluded that "overall, all the groups of students had a favorable perception on the usefulness of the PDA system in engaging students and had a positive attitude towards the interactive teaching approach with at least 70% of the students either agreeing or strongly agreeing with the survey statements" (Corpuz). With a good majority in support of the usage of the PDAs (and in extension active learning), I believe extensive collaborative work usage would also generate similar support.

Instructors and Active Learning

Having found support from students on this matter, another potential hurdle to be considered comes from the instructors themselves. Many instructors may be inclined to heed the numbers and consider active learning, while many others will lean towards the traditional style that has been the norm. In a similar study utilizing PDAs, researchers Edgar Corpuz, Ma Aileen Corpuz, and Mary Moriarty sought to obtain the perception of instructors in their paper entitled *The Use Of PDAs As Classroom Interaction System: Instructors' Perspective*.

In a twist from their previous study, feedback from multiple instructors utilizing PDAs was also gathered, in an attempt to observe any changes in opinion over this teaching style after their experience with the PDAs. Four instructors took part in the study, and it was found that "improved student engagement and achievement were reported by all four faculty members",

and they were exposed to certain weaknesses of the traditional methods, such as “teaching classes in a traditional manner (prior to using PDAs) did not allow them to know what students understood, especially at the individual student level” (Corpuz).

With instructors able to recognize key weaknesses in traditional learning after utilizing active learning, the evidence is clear that instructors can come to support and use active learning, as they are aware of the benefits it brings. Collaborative work has potential support from both ends of the classroom spectrum. With all this support and evidence found for its potential impact, the time has come to apply it to our own study and see how our students are impacted.

METHODOLOGY

To be able to accurately gauge student perception as well as the impact of collaborative work, an apparatus that protected the students through anonymity was required. Surveys were the clear choice in this regard, with their flexibility and ease of creation allowing for various methods of distribution to be considered. Ultimately, choices were narrowed down to distributing the surveys through means of a Google Form, which offers universal accessibility, and through the Blackboard software, utilized by the University of Texas Rio Grande Valley in handling its courses and students.

With methods of sending out surveys for the students sorted out, determining the points of significance was pivotal towards the study. For this preliminary study, it was decided that two points of significance for students would be at the beginning and end of the semesters; specifically, around the time when students were given their pre and posttests for the online courses. These two points in time were chosen because of their potential for data analysis. Direct comparison between the two could showcase changes that student perception goes through, and the impact of collaborative work would be easier to determine.

Acquiring data for this study posed several challenges due to the online environment we found ourselves in. Without the physical presence accompanied in standard in-person classrooms, gathering feedback was limited. To that end, the surveys were structured to be nearly identical to each other if possible, to guarantee more accurate data comparison potential (please see APPENDIX A for the surveys used). Student perception of collaborative work, as well as their views on their levels of interest, participation, performance, and their teamwork skills

(which stands to be impacted the most due to collaborative work) are all items of interest, and the surveys have questioned tailored towards gathering data for each.

The questions utilize the likert scale, in which multiple answers are presented and students select the option that best fits their opinion, going down from strongly agree, agree, neither agree or disagree, disagree, to strongly disagree. The survey questions targeted our items of interest in the following manner:

Demographics: These questions gathered pivotal information on our student's current degree paths and their level of interest in the physics field, as well as their future career. There are little to no differences in this section between the surveys, which works to our advantage since we will be able to clearly see any changes made to student's perception of their interest in the subject as well as whether their future career paths have changed due to their change in perspective.

View on Collaborative Work: This section intended to find out student's initial and final opinions of collaborative work. After questioning them on where they were experiencing this learning style (if at all), they were asked about where they believed it belongs, as well as any benefits its usage could bring. These questions were altered slightly between the surveys in order to better show any changes in opinion. This combined with the last questions of the surveys would reveal whether or not students believe collaborative work belongs in the online setting.

View on Participation: Participation is something most consider necessary to engage and take in the material most effectively, but in an online setting this is easier said than done. With the usage of collaborative work putting students in groups for coursework, this has implications on their level of participation, so these questions will gather their input on their opinion of participation, situations in which they see themselves doing so, and ways to enhance it.

Self-Assessment on Teamwork Skills: Collaborative work is an excellent precursor towards getting students ready for future careers where they may be placed in groups to achieve some goal. This section of the survey will have the students consider six qualities (leadership, direction following, communication, efficiency, ability to give and receive feedback, level of personal responsibility) and rate themselves based on a different likert scale, ranging from strong to weak. This section is identical between the surveys, which means any changes will become immediately apparent. The anonymous nature of the surveys means students have little reason to lie for this section, so improved answers between the first and second survey are expected.

In addition, at the end of each survey is a final question which accepts longer answers, and asks the students for any comments and opinions they would like to share on collaborative work as a whole. Due to the anonymous nature of the surveys, this last question serves as the final keystone of information, the feedback the question can gather is vital to this study for we will see their reasoning on why they have certain opinions about collaborative work, and the answers can be used to further develop future plans for this learning style.

For the Summer II semester, we had a larger pool of students to send data to, as permission was granted to ask all students within certain online physics courses for their time and consideration. Because of this, the two surveys were distributed via Google Forms, for greater accessibility for the students (please see Survey #1 and Survey #2 within APPENDIX A for their structure). Thirty-three students responded to the initial survey and thirty-five responded to the second, with the majority of students having answered both. Bringing the summer data set to sixty-eight students, this set was hampered due to the students being pulled from multiple courses. That very fact made performance harder to track since we had little access to their pre and posttest values, so a t-test was done to determine the significance of collaborative work.

The Fall Semester of 2021 proved easier to gather statistical data, for while data was pulled from students in courses supervised by a singular instructor, we had access to pre and post data values, enabling more accurate significance values for the impact of collaborative work. While the initial survey was sent out as a Google Form (and drawing in 21 students), our apparatus was further refined in order to gather more meaningful and clear data on students and their views on collaborative work and its impact on them (please see Survey #3 and Survey #4 within APPENDIX A for their structure). This meant our second survey did not match the first as closely as was the case in the Summer II, though I believe this would prove to be insignificant towards data comparison, as the questions still served the same purpose despite some being altered. With the second survey being distributed through the Blackboard software itself, the students of the course had immediate access to it, and 43 students submitted responses, the largest data set between both semesters. With access to pre and post data values, regression tests were done in order to obtain correlation coefficient values and p-values, and the significance of collaborative work could be viewed.

SUMMER II BEGINNING DATA

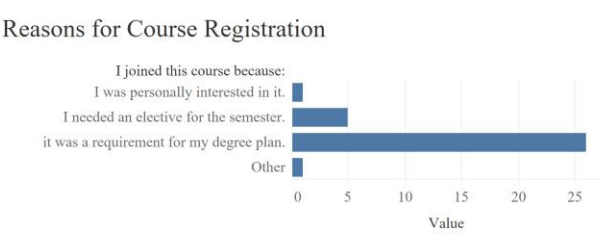
The following data on the next pages contains the summation of student opinion at the beginning of the Summer II semester, and the data collected has been ordered by their category. The data itself was extracted from the Google Form and turned into a more visual form via use of the Tableau software. Once all data was converted to a presentable form, the excel sheet provided by the Google Form extraction was again utilized to perform t-tests on the data to determine if collaborative work had significant impact.

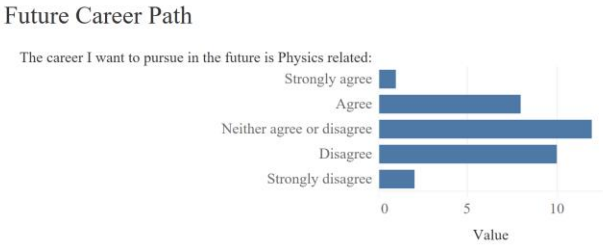
Student Gender and Majors

	What is your current Major?						
	Biology	Chemistry	Computer Engineering	Exercise Science	Manufacturing Engineering	Mathematics/ Computer Science	Mechanical Engineering
What is your gender?	Students	Students	Students	Students	Students	Students	Students
Female	13.00		1.00	2.00			2.00
Male	5.00	1.00	2.00		1.00	1.00	2.00
Prefer not to say	1.00						

Student Courses

Please select the PHYS course(s) you are currently in:	Students
PHYS 1402	22.00
PHYS 2426	11.00





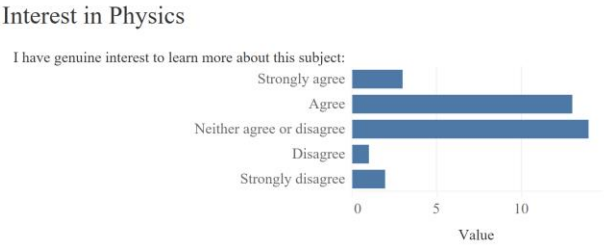
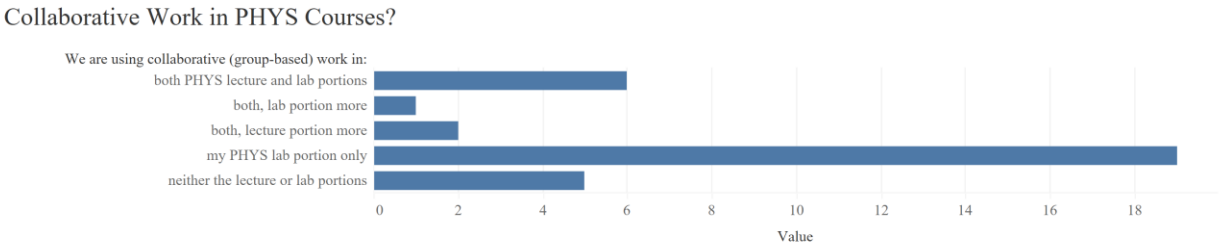


Figure 1 - Summer II Beginning Demographics

Figure 1 obtained demographic information on the students as well as questioned them briefly on their interest to pursue physics. According to the data from this survey, 58% of participants were female students, 38% were male and the remainder chose not to say. While only 3% joined the courses out of personal interest, roughly 48.5% expressed they agreed or strongly agreed to having genuine interest to learn more of physics, compared to the estimated 9.1% that disagreed or strongly disagreed to having that drive. In addition, despite no student answering with physics as their chosen major, roughly 27% had agreed or strongly agreed that their desired career in the future was physics related.



I believe that collaborative work is better suited for the lecture portion than individual work:	Students
Strongly agree	10.00
Agree	13.00
Neither agree or disagree	6.00
Disagree	3.00
Strongly disagree	1.00

I believe that collaborative work is better suited for the lab portion than individual work:	Students
Strongly agree	16.00
Agree	14.00
Neither agree or disagree	2.00
Disagree	1.00

I believe that collaborative work should be utilized in both the lecture and lab portions.	Students
Strongly agree	15.00
Agree	13.00
Neither agree or disagree	4.00
Disagree	1.00

I believe that collaborative work should NOT be utilized in neither the lecture or lab portions.	Students
Neither agree or disagree	3.00
Disagree	16.00
Strongly disagree	14.00

Figure 2 - Summer II Beginning Perceptions on Collaborative Work

Figure 2 obtained statistics on where students observed they were using collaborative work, as well as their perceptions of it compared to individualistic methods more commonly associated with traditional learning. 57.6% of students recorded they used collaborative work solely in the lab portion of the course, while 27% found they were using it in both lecture and lab portions, with the remaining having no collaborative work. Initial impressions from the students showed that 69.7% believed it would be superior to individual work for the lecture portion, 91% believing the same for the lab portion, and roughly 85% were in full support of its utilization in both portions.

I believe collaborative work can help me understand the material more efficiently than if I were to do it alone:	Students
Strongly agree	15.00
Agree	14.00
Neither agree or disagree	2.00
Disagree	2.00

I believe collaborative work can potentially make the course more enjoyable:	Students
Strongly agree	19.000
Agree	14.000

I believe collaborative work could result in higher grades than individual work:	Students
Strongly agree	17.00
Agree	11.00
Neither agree or disagree	5.00

Figure 3 - Summer II Beginning Perceptions continued

Figure 3 is the continuation of Figure 2, with the questions intending to gather student perceptions on collaborative work and its potential impact on their performance and satisfaction of the course. An estimated 88% believed the use of collaborative work would make understanding the material easier to manage, and all students agreed or strongly agreed that its use would make the course more enjoyable. In addition, roughly 85% believed it would have positive impact on their grades.

Student Views on Participation

Participation is something I consider necessary in order to pass the course:	Students
Strongly agree	14.000
Agree	10.000
Neither agree or disagree	9.000

My willingness to be active and participate is dependent on my understanding of the material:	Students
Strongly agree	16.00
Agree	8.00
Neither agree or disagree	7.00
Disagree	2.00

My willingness to be active and participate is dependent on whether others are doing so:	Students
Strongly agree	4.00
Agree	8.00
Neither agree or disagree	13.00
Disagree	7.00
Strongly disagree	1.00

I believe I would participate more if it could be done as a group rather than by myself:	Students
Strongly agree	6.00
Agree	17.00
Neither agree or disagree	8.00
Disagree	2.00

Figure 4 - Summer II Beginning Participation

Figure 4 contains the questions targeting student perception of participation and what may impact it. It was found that 72.3% of students considered participation a necessity for course success, with the same percent believing their ability to participate was dependent on their understanding and knowledge. However, though roughly 69.7% of students believed they would participate more in groups than individually, only 36.4% actually believed their participation level was dependent on if others were participating.

Student Views on Potential Impact

I believe collaborative work could allow me to perform better in the courses than if it was individual work:	Students
Strongly agree	10.00
Agree	16.00
Neither agree or disagree	5.00
Disagree	2.00

In courses done collaboratively, if I get higher grades it means I work well in teams:	Students
Strongly agree	9.000
Agree	12.000
Neither agree or disagree	12.000

I believe collaborative work can enhance my social skills:	Students
Strongly agree	15.00
Agree	17.00
Neither agree or disagree	1.00

Figure 5 - Summer II Beginning Performance

Figure 5 targeted student perceptions on how they would perform in the course, as well as questioned them on potential enhancement of social skills. With 78.8% of students agreeing or strongly agreeing that collaborative work would allow them to perform at a higher level, 63.6% believing they could correlate high grades with their ability to work in teams, and 97% convinced that collaborative work would impact their social skills, this category gives high hopes for collaborative work's reception with the students.

Figure 6 - Summer II Beginning Teamwork

Figure 6 contains the results of the questions in which students rated their own teamwork skills at the beginning of the semester. The results were promising, with students rating their initial skill strength in the following fashion: 84.8% believing their work efficiency as good or stronger, 81.8% rating their communication as good or stronger, 69.7% rating their leadership skills as good or stronger, 84.8% rating their ability to follow directions as good or stronger, 97% believing their ability to bear personal responsibility was good or stronger, and roughly 91% believing their ability to give and receive feedback and criticism as good or stronger.

SUMMER II END DATA

The following data on the next pages contains the summation of student opinion at the end of the Summer II semester, and the data collected has been ordered by their category. The data itself was extracted from the Google Form and turned into a more visual form via use of the Tableau software. Once all data was converted to a presentable form, the excel sheet provided by the Google Form extraction was again utilized to perform a t-test on the data to determine if collaborative work had significant impact.

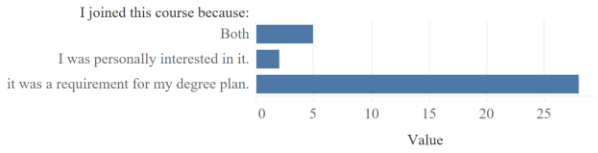
Student Gender and Majors

What is your gender?		What is your current Major?								
		Biology	civil engineering	Computer engineering	Electrical Engineering	Engineering	Exercise Science	Math/Computer Science	Mechanical Engineering	Physics
Female	Students	8.000	2.000	2.000		1.000	4.000			
Male	Students	8.000	1.000	3.000	1.000		1.000	1.000	2.000	1.000

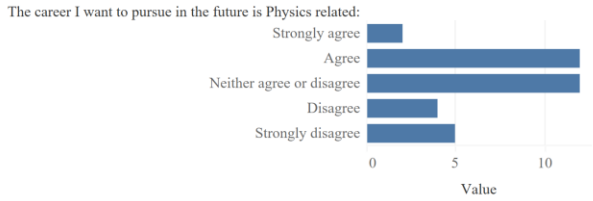
Student Courses

Please select the PHYS course(s) you are currently in:	Students
PHYS 1401	1.00
PHYS 1402	19.00
PHYS 2425	1.00
PHYS 2426	14.00

Reasons for Course Registration



Future Career Path



Interest in Physics

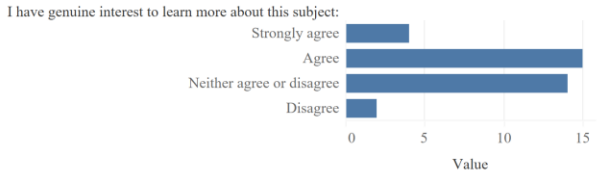
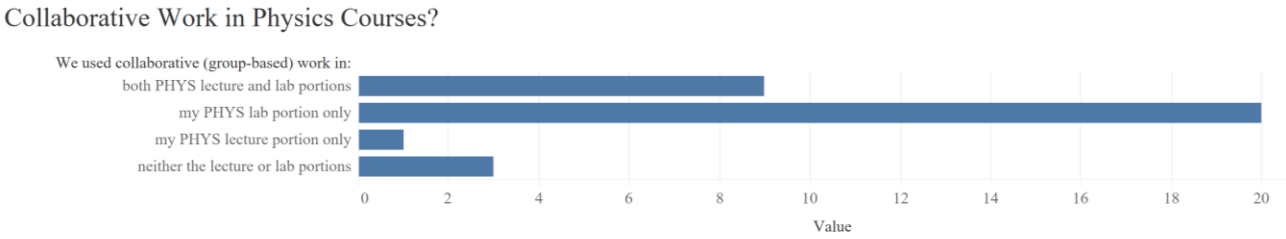


Figure 7 - Summer II End Demographics

The composition of students for the ending survey was more evenly split, with 51.4% being male students and 48.6% being female (this data set also had 35 students rather than 33 unlike the beginning survey). Unlike the initial survey, 40% of students agree or strongly agree that their future career lies in physics, while 54.3% expressed interest to learn more at the semesters end (with only 5.7% disagreeing that they had interest to learn more).



I believe that collaborative work is better suited for the lecture portion than individual work:	Students
Strongly agree	8.00
Agree	11.00
Neither agree or disagree	12.00
Disagree	3.00
Strongly disagree	1.00

I believe that collaborative work is better suited for the lab portion than individual work:	Students
Strongly agree	16.00
Agree	11.00
Neither agree or disagree	6.00
Disagree	1.00
Strongly disagree	1.00

I believe that collaborative work should be utilized in both the lecture and lab portions.	Students
Strongly agree	14.00
Agree	13.00
Neither agree or disagree	5.00
Disagree	3.00

I believe that collaborative work should NOT be utilized in neither the lecture or lab portions.	Students
Strongly agree	2.00
Agree	3.00
Neither agree or disagree	4.00
Disagree	11.00
Strongly disagree	15.00

Figure 8 - Summer II End Perceptions on Collaborative Work

Figure 8 showcases that support for collaborative work and student perception of it remained high, for 54.3% believed it was suitable for the lecture portion while roughly 77% believed the same for the lab portion. 77% ultimately believed that they would like to see collaborative work utilized in both portions, the final question for this figure confirming that 74.3% disagreeing with the idea that it has no place in their courses at all.

I believe collaborative work has, or could have, helped me understand the material more efficiently than if I had done it alone	Students
Strongly agree	11.00
Agree	17.00
Neither agree or disagree	3.00
Disagree	4.00

I believe collaborative work has, or could have, made the course more enjoyable:	Students
Strongly agree	15.00
Agree	8.00
Neither agree or disagree	9.00
Disagree	3.00

Figure 9 - Summer II End Perceptions continued

Figure 9 is the continuation of Figure 8, and shows more impact that students felt collaborative work had on them throughout the semester. With 80% of the mind that it had aided in their understanding of the material, and 65.7% believing its utilization succeeded in making the course more enjoyable, this data suggests that collaborative work is generally well received by the majority of students, and the potential it has is recognized even by them.

Figure 10 showcased results that were remarkably similar to that of Figure 4, showing that student views on participation were roughly stable. 71.4% of students agreed or strongly agreed that participation was a necessity for the course. 65.7% believe their ability to participate was dependent on their knowledge and understanding. 57.1% believed being in groups allowed them to participate more, yet only 40% agreed or disagreed that their ability to participate was dependent on if others were doing so.

Student Views on Participation

Participation is something I consider necessary in order to pass the course:	Students
Strongly agree	11.00
Agree	14.00
Neither agree or disagree	6.00
Disagree	2.00
Strongly disagree	2.00

My willingness to be active and participate was dependent on my understanding of the material:	Students
Strongly agree	10.00
Agree	13.00
Neither agree or disagree	9.00
Disagree	3.00

My willingness to be active and participate was dependent on whether others were doing so:	Students
Strongly agree	5.00
Agree	9.00
Neither agree or disagree	14.00
Disagree	4.00
Strongly disagree	3.00

I believe I would have participated more if it could have been done as a group rather than by myself:	Students
Strongly agree	9.000
Agree	11.000
Neither agree or disagree	9.000
Disagree	6.000

Figure 10 - Summer II End Participation

Data from the ending summer survey provided a similar picture of student perceptions about collaborative work and their performance and social skills when compared to the beginning of the semester. 68.6% of students (see Figure 11) believed that collaborative work had an impact on their performance in the course. However, it seems over the semester their perception of a correlation between grades and teamwork ability slightly shifted, for only 51.4% believed higher grades meant better teamwork ability. Social skill enhancement remained true to initial hopes and perception, for 85.7% of students believed their social skills were enhanced by collaborative work.

Student Views on Potential Impact

I believe collaborative work has, or would have, allowed me to perform better in the courses than if it was individual work:	Students
Strongly agree	10.00
Agree	14.00
Neither agree or disagree	8.00
Disagree	3.00

In courses done collaboratively, if I got higher grades it means I work well in teams:	Students
Strongly agree	7.00
Agree	11.00
Neither agree or disagree	14.00
Disagree	2.00
Strongly disagree	1.00

I believe collaborative work has, or would have, enhanced my social skills:	Students
Strongly agree	11.00
Agree	19.00
Neither agree or disagree	5.00

Figure 11 - Summer II End Performance

Figure 12 reveals that there were slight shifts in student teamwork skill scoring from the beginning to the end of the semester. 88.6% of students believed their work efficiency, ability to follow directions as well as their ability to give and receive feedback and criticism were good or stronger. Meanwhile, 77.1% rated their communication skills as good or stronger, 68.6% rated their leadership as good or stronger, and 91.4% believed their ability to bear personal responsibility to be good or stronger.

Figure 12 - Summer II End Teamwork

Summer II Data Analysis

With the arduous nature of collecting meaningful data for the summer semester due to the numerous courses used, statistical data was found through direct comparison, and t-tests were done to determine the significance of collaborative work on the students (please see Data Set #1 within APPENDIX B for the t-tests and their results). The t-tests results were disheartening to see at first, for the values obtained suggested that there was no real significance that collaborative work brought, despite the students mean scores increasing from the initial to final survey.

Nonetheless, the summer data had more to tell, and looking at the data showed that student perceptions did improve as was expected. For student interest, 54.3% of students expressed that they have genuine interest to learn about the subject of physics, compared to the prior 48.5% noted at the beginning of the semester. 68.5% of the students answered that they felt their performance was better due to the use of collaborative work and would have been less if they worked individually. Data on the students' teamwork skills showed stability or increases, most notably in their work efficiency and ability to follow directions.

As to whether collaborative work has a place in the online physics courses, the students offered majority support for it to be within both the lecture and lab portions, with roughly 77% answering in that manner. In addition, 80% felt their understanding of the course material was significantly impacted by collaborative work, with 65.7% believing its utilization made the course more enjoyable. Despite these promising values, we must entertain the possibility that the increases and stability of student perception from beginning to end could have been attributed to other factors. Nonetheless these results are promising for future studies.

The students had much to say when they arrived at the final question of the survey, and many of their answers express support for collaborative work and why they think it should continue to be utilized. Five such responses can be found below:

Student #1: The ability to work in groups and discuss in groups and discuss the lab is nice when there are people willing to participate in the group. You are able to communicate as well absorb knowledge from your group which you can take and apply to your report. Grades were individual which I really liked as there was no dependence on others but being groups helps dissolve those questions that need further discussion.

Student #2: I think collaborative work allows students to bounce ideas off each other and reinforce concepts from the course. This allows them to process the information and retain it more effectively.

Student #3: I believe that on top of the homework for lecture, there could be some questions during class, very brief questions in which you are partnered up and work on it as a group. Then, the professor get a chance to go over the problems and perhaps give credit to the groups who answered correctly. As for the lab portion, we were allowed to work in groups which is great. I believe at least for labs this should always be the case. My perspectives on labs is that it is a fun and hands-on version of lecture. With that being said, working in groups creates a fun working environment where you can learn and discuss what you may not be able to really talk about during lecture. In conclusion, I believe that group work should be implemented into both lab and lecture. However lecture should be more in moderation and more of an extra credit or checkpoint, while the lab should be very collaborative work.

Student #4: If it is gonna be used, we need to make sure that everyone speaks up and is not afraid to voice their concerns.

Student #5: i enjoyed the collaboration aspect of my lab portion a lot, especially because my group and i were effective communicators and were able to split the work well and ask questions when necessary.

FALL 2021 DATA AND ANALYSIS

With the Fall 2021 semester data comprised of students from courses taught by a single instructor rather than the multitude for the summer semester, an opportunity for more statistical data presented itself, and a more accurate attempt to study the impact of collaborative work was made. The surveys used for this semester had slight modifications from their predecessors, however due to the end survey being altered more heavily than its beginning counterpart, we were not be able to put forth the data into the Tableau software for visual comparison as the two surveys no longer match up to the degree that the two Summer II surveys possessed.

Regardless, the statistical data collected was more than worth the sacrifice. With access to pre and post test data, regression tests could be done, with the values obtained painting a clearer picture than what could be obtained from the summer data. Setting the post scores as the dependent variable and changing the independent to the total scores of the student responses for our categories, the following tables on the next pages were created to showcase the obtained correlation coefficients and p-values:

Table 1 - Fall 2021 Interest Data

Correlation Coefficients and P-values for Fall 2021 Student Interest Data				
	All Students	**Low Achieving**	**Male Students**	**Female Students**
Multiple R	0.257132	0.316639	0.254795	0.232978
R Square	0.066117	0.10026	0.06492	0.054279
Adjusted R Square	0.043339	0.075943	-0.00701	0.017905
P-value	0.509013	**0.049537**	0.359424	0.232829

Table 1 shows that the correlation coefficients hint at no real significance from collaborative work on our student groups. P-values show significant positive impact on the Low Achieving category. Male students seem to have been impacted less than female students.

Table 2 - Fall 2021 Participation Data

Correlation Coefficients and P-values for Fall 2021 Student Participation Data				
	All Students	**Low Achieving**	**Male Students**	**Female Students**
Multiple R	0.0881	0.214564	0.075346	0.178066
R Square	0.007762	0.046038	0.005677	0.031707
Adjusted R Square	-0.01644	0.019539	-0.07081	-0.00553
P-value	0.574264	0.195801	0.789565	0.364643

Table 2 shows that the correlation coefficients and p-values hint at no real significance from collaborative work on our student groups. Male students seem to have been impacted less than female students.

Table 3 - Fall 2021 Performance Data

Correlation Coefficients and P-values for Fall 2021 Student Performance Data				
	All Students	**Low Achieving**	**Male Students**	**Female Students**
Multiple R	0.218833	0.386849	0.147873	0.30314
R Square	0.047888	0.149652	0.021866	0.091894
Adjusted R Square	0.024666	0.126032	-0.05337	0.056967
P-value	0.158583	**0.016427**	0.598937	0.11686

Table 3 shows that the correlation coefficients hint at no real significance from collaborative work on our student groups. P-values show significant positive impact on the Low Achieving category. Male students seem to have been impacted less than female students.

Table 4 - Fall 2021 Teamwork Data

Correlation Coefficients and P-values for Fall 2021 Student Teamwork Data				
	All Students	**Low Achieving**	**Male Students**	**Female Students**
Multiple R	0.342944	0.400748	0.390127	0.297713
R Square	0.117611	0.160599	0.152199	0.088633
Adjusted R Square	0.095551	0.137282	0.086984	0.053581
P-value	**0.026191**	**0.012655**	0.150552	0.123888

Table 4 shows that the correlation coefficients hint at no real significance from collaborative work on our student groups. P-values show significant positive impact on both the Low Achieving and All Student categories. Male students seem to have been impacted less than female students.

The implications of this data were somewhat unique and unexpected. Rather than broad impact as was expected, it appeared that there was negligible or no real impact from collaborative work on our students. The correlation coefficients consistently hinted that was the case, with no real significance found from the values. Our male students had higher p-values all around compared to our female students, suggesting female students were impacted more. Despite these findings however, our regression tests did bring forth one fact: that of our four student groups, only one showed significant impact by using collaborative work (for more details on the other values obtained, please see Data Set #2 in APPENDIX B). This category, as shown by bolded values within the previous tables, was our Low Achieving students.

The results were clear from the p-values. The Low Achieving category saw significant positive impact from collaborative work in our regression tests for Student Interest, Performance, and Teamwork. Although the p-value was too high to hint at significance for Participation, we can observe that our Low Achieving group still had the lowest p-value for it compared to the other categories. This revelation could hint at the possibility that there was in fact real significant impact for the other student groups tested. There is good news however! Of the four categories tested, Teamwork saw the greatest significance for our student groups, for it sports the lowest p-values among the four categories, and our values show that collaborative work impact was significant for the All Students category as well as the Low Achieving!

With our surveys showing that most of the students across the semester are in support of this teaching style, and the data only shows significant impact in one category (two if you consider Teamwork showed impact on two categories), this hints at the possibility that the current apparatus used to gather data could use further improvement. The responses of the students revealed that their perceptions are at levels similarly viewed in the prior summer

semester data, and they would suggest nearly all considered the group work impactful, so our data collecting methods must be refined in such a way to account for it.

The free write responses of the students for the Fall semester echo those of the prior semester, in that the majority of the responses support collaborative work and would like to see it utilized further. Six such responses have been included below:

Student 1: It should be incorporated because it allows for a better understanding of the subject with peers.

Student 2: Collaborative work allowed me to learn more my discussing concepts of the course with those in my academic level. We understand each other and support each other to make sure we understand the material to the best of our abilities.

Student 3: I believe collaborative work should be utilized in various courses so students are able to further develop their skills of sharing ideas, coming to a mutual understanding with a partner, and being able to take constructive criticism to learn from their mistakes or any concepts they may have difficulty in.

Student 4: I think that the amount of collaborate work we have done is good as we do both collaborate but also get to work individual and test our own knowledge too. But it is good to have a group to get help where needed and to talk thorugh the problems I don't understand.

Student 5: Personally for my lecture having a group was amazing because I did struggle a bit, and I could ask my group mates. However, in my lab out of the three group mates I had only one actually helped and the other two we kind of had to drag along, because we would ask for their opinions and they never answered us so it would take us very long to complete the lab.

Therefore, I am half for and half against because it is only helpful when everyone contributes or at the very minimum follows along.

Student 6: I believe collaborative work should be used within any STEM course that is intensive. My professor allows us to complete individual quizzes, and then we have group quizzes with our group partners to work out the same questions from the individual quiz. It is really helpful to go over my mistakes in this form of collaborative group work.

CLOSING THOUGHTS AND CONCLUSIONS

The results of this study made it clear that collaborative work has a place in online physics courses, and our students are advocating for further implementation. The surveys utilized showcased the students' perceptions of their own performance and skills, which saw improvement as the semesters went on, and they listed their own opinions and ideas about the experience.

The summer and fall data sets each brought staggering facts to the table, with the summer set displaying that while the majority of the data population fully support collaborative work in their online courses, the significance of it appears negligible. student interest saw increases from the beginning to the end of the Summer II semester, with 54.3% of students expressing that they have genuine interest to learn about the subject of physics, compared to 48.5% from beforehand. 68.5% of the students answered that they felt their performance was impacted due to collaborative work, and the other tested categories saw stability or similar increases in student perceptions across the semester.

However, with the refined questioning brought in the fall semester, the significance of collaborative work's impact was found to have mostly affected students deemed "low achieving". This contrast, between the majority believing collaborative work enhanced all tested aspects and increased their enjoyment of the course, while simultaneously impacting only one student group, hints that the data collection and testing must be revised. If the students believe that the impact is real, perhaps we should not disregard it merely because the significance from the testing does not seem to match.

In addition, looking at their answers in the free written sections, a consensus arose that collaborative work is effective, and that it should not be exclusive to the lab section. However, a decent portion of the students seem to be on the fence about having it in the lecture section. This suggests that for the lecture portion, they do not want collaborative work implemented in a way that is identical to the lab section. Further study would be required to see potential impact of collaborative work if its usage differed across the lecture and lab portions of the physics courses.

Many factors exist that could have interfered with the data gathered during the two semesters. As our apparatus continues to be refined we move closer towards being able to gather concrete and utterly clear data, but even then there are hurdles for studies of this nature. We must ensure that we are truly using collaborative work in a way that is aligned with active learning, as well as properly assess the impact through the students' achievements. We could possibly even consider gathering data at more than two points during the semester, to better gauge student progression as the semester moves along. This study is preliminary in nature, and it is my hope that future research in this subject carefully consider what should be done to ensure the success of it, for the implications of collaborative work and its utilization in these online physics courses are promising as we have come to see here.

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APPENDIX A

APPENDIX A

Survey #1:

Survey #1 was utilized at the beginning of the Summer II semester in order to initiate the exploratory phase of the study and begin gathering initial student perceptions on collaborative work and potential impacts it could have.

Summer II Student Views on Interest and Collaborative Work (Beginning)

For the following sets of questions, please give the answer that matches your opinion the closest based on the scale and options provided.

* Required

Upon reading the email for this survey, I understand that this survey is not mandatory and that my answers will remain anonymous. I am above the age of 18 and I agree to answers the content of this survey to the best of my ability. *

I agree and will take this survey.

I disagree and will not take this survey.

If you would like to be entered into the raffle, please leave your university email down below. Thank you for your participation!

Your answer

What is your gender?

Female

Male

Prefer not to say

Other:

What is your current Major?

Your answer

Please select the PHYS course(s) you are currently in: *

PHYS 1401

PHYS 1402

PHYS 2425

PHYS 2426

Other

If your PHYS course was not in the choices above, please put it down below:

Your answer

I joined this course because:

it was a requirement for my degree plan.

I needed an elective for the semester.

I was personally interested in it.

Other

The career I want to pursue in the future is Physics related:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I have genuine interest to learn more about this subject:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

We are using collaborative (group-based) work in: *

my PHYS lecture portion only

my PHYS lab portion only

both PHYS lecture and lab portions

neither the lecture or lab portions

I believe that collaborative work is better suited for the lecture portion than individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe that collaborative work is better suited for the lab portion than individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe that collaborative work should be utilized in both the lecture and lab portions.

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe that collaborative work should NOT be utilized in neither the lecture or lab portions.

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work can help me understand the material more efficiently than if I were to do it alone:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work can potentially make the course more enjoyable:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work could result in higher grades than individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

Participation is something I consider necessary in order to pass the course:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

My willingness to be active and participate is dependent on my understanding of the material:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

My willingness to be active and participate is dependent on whether others are doing so:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe I would participate more if it could be done as a group rather than by myself:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work could allow me to perform better in the courses than if it was individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

In courses done collaboratively, if I get higher grades it means I work well in teams:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work can enhance my social skills:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

My ability to work effectively with others is:

Strong

Good

Average

Decent

Weak

My ability to communicate effectively with others is:

Strong

Good

Average

Decent

Weak

My ability to be a leader is:

Strong

Good

Average

Decent

Weak

My ability to follow the directions of others is:

Strong

Good

Average

Decent

Weak

My ability to accept the consequences of my actions is:

Strong

Good

Average

Decent

Weak

My ability to give constructive criticism and feedback, as well as receive it, is:

Strong

Good

Average

Decent

Weak

If you have any comments on whether collaborative work should or should not be used within PHYS courses and why, you may put them down below:

Survey #2:

Survey #2 was utilized towards the end of the Summer II semester.

Summer II Student Views on Interest and Collaborative Work (End)

For the following set of questions, please give the answer that matches your opinion the closest based on the scale and options provided.

* Required

Upon reading the email for this survey, I understand that this survey is not mandatory and that my answers will remain anonymous. I am above the age of 18 and I agree to answers the content of this survey to the best of my ability. *

I agree and will take this survey.

I disagree and will not take this survey.

If you would like to be entered into the raffle, please leave your university email down below:

Your answer

What is your gender?

Female

Male

Prefer not to say

Other:

What is your current Major?

Your answer

Please select the PHYS course(s) you are currently in: *

PHYS 1401

PHYS 1402

PHYS 2425

PHYS 2426

Other

I joined this course because:

it was a requirement for my degree plan.

I needed an elective for the semester

I was personally interested in it.

Other

The career I want to pursue in the future is Physics related:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I have genuine interest to learn more about this subject:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

We used collaborative (group-based) work in: *

my PHYS lecture portion only

my PHYS lab portion only

both PHYS lecture and lab portions

neither the lecture or lab portions

I believe that collaborative work is better suited for the lecture portion than individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe that collaborative work is better suited for the lab portion than individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe that collaborative work should be utilized in both the lecture and lab portions.

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe that collaborative work should NOT be utilized in neither the lecture or lab portions.

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work has, or could have, helped me understand the material more efficiently than if I had done it alone:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work has, or could have, made the course more enjoyable:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

Participation is something I consider necessary in order to pass the course:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

My willingness to be active and participate was dependent on my understanding of the material:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

My willingness to be active and participate was dependent on whether others were doing so:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe I would have participated more if it could have been done as a group rather than by myself:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work has, or would have, allowed me to perform better in the courses than if it was individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

In courses done collaboratively, if I got higher grades it means I work well in teams:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work has, or would have, enhanced my social skills:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

My ability to work effectively with others is:

Strong

Good

Average

Decent

Weak

My ability to communicate effectively with others is:

Strong

Good

Average

Decent

Weak

My ability to be a leader is:

Strong

Good

Average

Decent

Weak

My ability to follow the directions of others is:

Strong

Good

Average

Decent

Weak

My ability to accept the consequences of my actions is:

Strong

Good

Average

Decent

Weak

My ability to give constructive criticism and feedback, as well as receive it, is:

Strong

Good

Average

Decent

Weak

If you have any comments on whether collaborative work should or should not have been used within PHYS courses and why, you may put them down below. Please be encouraged to also put your own input on what you think would have been best for the class:

Survey #3:

Survey #3 was utilized at the beginning of the Fall 2021 semester, and received slight changes that set it apart from the surveys given out in the prior semester.

Fall 2021 Student Views on Interest and Collaborative Work (Beginning)

For the following sets of questions, please give the answer that matches your opinion the closest based on the scale and options provided.

* Required

Upon reading the email for this survey, I understand that this survey is not mandatory and that my answers will remain anonymous. I am above the age of 18 and I agree to answers the content of this survey to the best of my ability. *

I agree and will take this survey.

I disagree and will not take this survey.

If you would like to be entered into the raffle, please leave your university email down below. Thank you for your participation!

Your answer

What is your gender?

Female

Male

Prefer not to say

Other:

What is your current Major?

Your answer

Please select the PHYS course(s) you are currently in: *

PHYS 1401

PHYS 1402

PHYS 2425

PHYS 2426

Other

If your PHYS course was not in the choices above, please put it down below:

Your answer

I joined this course because:

it was a requirement for my degree plan.

I needed an elective for the semester.

I was personally interested in it.

Other

The career I want to pursue in the future is Physics related:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I have genuine interest to learn more about this subject:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

We are using collaborative (group-based) work in: *

my PHYS lecture portion only

my PHYS lab portion only

both PHYS lecture and lab portions

neither the lecture or lab portions

I believe that collaborative work is better suited for the lecture portion than individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe that collaborative work is better suited for the lab portion than individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe that collaborative work should be utilized in both the lecture and lab portions.

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe that collaborative work should NOT be utilized in neither the lecture or lab portions.

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work can help me understand the material more efficiently than if I were to do it alone:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work can potentially make the course more enjoyable:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work could result in higher grades than individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

Participation is something I consider necessary in order to pass the course:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

My willingness to be active and participate is dependent on my understanding of the material:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

My willingness to be active and participate is dependent on whether others are doing so:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe I would participate more if it could be done as a group rather than by myself:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work could allow me to perform better in the courses than if it was individual work:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

In courses done collaboratively, if I get higher grades it means I work well in teams:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

I believe collaborative work can enhance my social skills:

Strongly agree

Agree

Neither agree or disagree

Disagree

Strongly disagree

My ability to work effectively with others is:

Strong

Good

Average

Decent

Weak

My ability to communicate effectively with others is:

Strong

Good

Average

Decent

Weak

My ability to be a leader is:

Strong

Good

Average

Decent

Weak

My ability to follow the directions of others is:

Strong

Good

Average

Decent

Weak

My ability to accept the consequences of my actions is:

Strong

Good

Average

Decent

Weak

My ability to give constructive criticism and feedback, as well as receive it, is:

Strong

Good

Average

Decent

Weak

If you have any comments on whether collaborative work should or should not be used within PHYS courses and why, you may put them down below:

Survey #4:

Survey #4 is a modified version of Survey #3 that aimed towards more concrete and clear data on the impact of collaborative work on students. It is also the only one of the surveys to be

Upon reading the description, I understand that this survey is not mandatory and that my answers will remain anonymous. I am above the age of 18 and I agree to answer the content of this survey to the best of my ability.

I agree and will take this survey.

I disagree and will not take this survey.

What is your gender?

Female

Male

Prefer not to say

Other

What is your current Major?

The career I want to pursue in the future is Physics related:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

Please select the PHYS course(s) you are currently in:

PHYS 1401

PHYS 1402

PHYS 2425

PHYS 2426

Other

I joined this course because:

it was a requirement for my degree plan.

I needed an elective for the semester.

I was personally interested in it.

Other

We are using collaborative (group-based) work in:

my PHYS lecture portion only

my PHYS lab portion only

both PHYS lecture and lab portions

neither the lecture or lab portions

I believe that collaborative work is better suited for the lecture portion than individual work:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

I believe that collaborative work is better suited for the lab portion than individual work:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

I believe collaborative work has, or could have, helped me understand the material more efficiently than if I had done it alone:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

I believe collaborative work has, or could have, made the course more enjoyable:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

Participation is something I consider necessary in order to pass the course:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

My willingness to be active and participate was dependent on my understanding of the material:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

My willingness to be active and participate was dependent on whether others were doing so:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

I believe the use of collaborative work has, or would have, allowed me to participate more in the course:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

I believe collaborative work has, or would have, allowed me to perform better in the courses than if it was individual work:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

I believe the use of collaborative work had a positive impact on my grades:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

I believe my performance in other STEM courses will improve if they utilized collaborative work.

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

I believe collaborative work has, or would have, enhanced my social and teamwork skills:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

The use of collaborative work in the course greatly improved my ability to work effectively with others.

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

The use of collaborative work in the course greatly improved my ability to communicate effectively with others.

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

The use of collaborative work in the course greatly improved my ability to be a leader.

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

The use of collaborative work in the course greatly improved my ability to follow the directions of others.

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

The use of collaborative work in the course greatly improved my ability to accept the consequences of my actions.

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

The use of collaborative work in the course greatly improved my ability to give and receive constructive criticism and feedback.

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

I believe learning and applying the material of the course through collaborative work has caused my interest in physics to increase:

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

The use of collaborative work greatly helped sustain my interest in the physics course throughout the semester.

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

I would be more interested in taking physics courses that utilize collaborative work than those that do not.

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

The use of collaborative work allowed me to become more actively engaged in my learning.

1. Strongly agree

2. Agree

3. Neither agree or disagree

4. Disagree

5. Strongly disagree

If you have any comments on whether collaborative work should or should not have been used within physics courses and why, you may put them down below. Please be encouraged to also put your own input on what you think would have been best for the class.

APPENDIX B

APPENDIX B

Excerpt A:

Excerpt A is from a small section of Michaela Driver's results found in their study. The results in said section imply that the perception of the students was strongly affected by their satisfaction of the course as well as the level of engagement within it. This strengthens the notion that collaborative work can potentially lead to greater student engagement and satisfaction. Excerpt A is as follows:

> The following results relate to assessments of overall class interaction. Sixty-three percent of students strongly agreed that there was a lot of interaction among all participants in the class. Fifty-six percent of respondents strongly agreed that they felt part of a learning community in the class and were happy with the quality of exchanges that occurred in the class. Forty-eight percent strongly agreed that they were satisfied with the level of class interaction.
>
> Michaela Driver

Data Set #1:

Data Set #1 is a set of t-tests done on the Teamwork category of the Summer II data set. Due to concerns over the lack of statistical data due to the pool of students from multiple courses, these tests were done by converting student responses to numerical values ranging from 1 to 5 (one being the weakest answer and 5 being the strongest). By tallying up the results and comparing across both surveys, it was found that while the mean scores were overall higher for the majority of students at the end of the semester than at the beginning, the impact of collaborative work was not significant and therefore it would appear other factors caused the mean scores to increase.

Teamwork Skill: Work Efficiency

	Before	*After*
Mean	4.212121	4.428571
Variance	0.484848	0.487395
Observations	33	35
Hypothesized Mean Difference	0	
df	66	
t Stat	-1.2795	
P(T<=t) one-tail	0.102601	
t Critical one-tail	1.668271	
P(T<=t) two-tail	0.205202	
t Critical two-tail	1.996564	

Teamwork Skill: Communication

	Before	*After*
Mean	4.060606	4.285714
Variance	0.558712	0.680672
Observations	33	35
Hypothesized Mean Difference	0	
df	66	
t Stat	-1.18024	
P(T<=t) one-tail	0.121071	
t Critical one-tail	1.668271	

P(T<=t) two-tail	0.242142	
t Critical two-tail	1.996564	

Teamwork Skill: Leadership Ability

	Before	*After*
Mean	3.787879	3.942857
Variance	0.859848	0.820168
Observations	33	35
Hypothesized Mean Difference	0	
df	66	
t Stat	-0.69665	
P(T<=t) one-tail	0.244234	
t Critical one-tail	1.668271	
P(T<=t) two-tail	0.488468	
t Critical two-tail	1.996564	

Teamwork Skill: Ability to Follow Directions

	Before	*After*
Mean	4.181818	4.342857
Variance	0.465909	0.467227
Observations	33	35
Hypothesized Mean Difference	0	
df	66	
t Stat	-0.971671	
P(T<=t) one-tail	0.167381	
t Critical one-tail	1.668271	
P(T<=t) two-tail	0.334762	
t Critical two-tail	1.996564	

Teamwork Skill: Personal Responsibility

	Before	*After*
Mean	4.454545	4.314286
Variance	0.318182	0.515966
Observations	33	35
Hypothesized Mean Difference	0	
df	64	
t Stat	0.89822	

P(T<=t) one-tail	0.186218
t Critical one-tail	1.669013
P(T<=t) two-tail	0.372435
t Critical two-tail	1.99773

Teamwork Skill: Criticism and Feedback Ability

	Before	*After*
Mean	4.242424	4.305556
Variance	0.376894	0.446825
Observations	33	36
Hypothesized Mean Difference	0	
df	67	
t Stat	-0.40894	
P(T<=t) one-tail	0.341945	
t Critical one-tail	1.667916	
P(T<=t) two-tail	0.68389	
t Critical two-tail	1.996008	

Data Set #2:

Data Set #2 is composed of the results of the regression tests done for the Fall 2021 data. Interest, Participation, Performance and Teamwork Skills were emphasized, and four regression tests were done in an attempt to find the impact of collaborative work on students in four groups. These groups were composed of the following: All Students, Low Achieving (those who scored less than 80% on their Pre-Tests), Male Students and Female Students. Converting student responses to numerical values as done with the Summer II data, we were able to obtain p-values that suggest that out of the four student groups, the Low Achieving were impacted the most by the utilization of collaborative work. The data from the tests was then used to create Tables 1-4 of the Fall 2021 data. The regression tests can be found on the following pages.

INTEREST REGRESSION DATA

All Students:

All Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.257132427
R Square	0.066117085
Adjusted R Square	0.043339453
Standard Error	7.968733935
Observations	43

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	184.3248026	184.325	2.90272	0.095999591
Residual	41	2603.529542	63.5007		
Total	42	2787.854344			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	80.89403344	5.414317225	14.9408	3.5E-18	69.95959798	91.828469	69.95959798	91.8284689
Interest Score	0.762399531	0.447486624	1.70374	0.096	-0.14131804	1.6661171	-0.14131804	1.6661171

Low Achieving:

Low Achieving

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.3166393
R Square	0.1002604
Adjusted R Square	0.0759431
Standard Error	7.7107518
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	245.1364393	245.136	4.123	0.049537404
Residual	37	2199.860668	59.4557		
Total	38	2444.997108			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	77.671067	5.705437827	13.6135	6E-16	66.11075172	89.231382	66.11075172	89.231382
Interest Score	0.9568512	0.471234615	2.03052	0.0495	0.002039153	1.9116632	0.002039153	1.9116632

Male Students:

Male Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.254795
R Square	0.064920492
Adjusted R Square	-0.007008701
Standard Error	8.901403996
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	71.51442306	71.5144	0.90256	0.359424664
Residual	13	1030.05491	79.235		
Total	14	1101.569333			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	78.99119086	12.87528828	6.1351	3.6E-05	51.17582162	106.80656	51.17582162	106.80656
Interest Score	0.935399674	0.984597903	0.95003	0.35942	-1.191694776	3.0624941	-1.19169478	3.06249412

Female Students:

Female Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.232978176
R Square	0.05427883
Adjusted R Square	0.017904939
Standard Error	7.761526175
Observations	28

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	89.89488304	89.8949	1.49225	0.232829122
Residual	26	1566.273503	60.2413		
Total	27	1656.168386			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	81.91096509	6.200781651	13.2098	4.8E-13	69.16507587	94.656854	69.16507587	94.6568543
Interest Score	0.656283368	0.537243338	1.22158	0.23283	-0.448036129	1.7606029	-0.44803613	1.76060286

PARTICIPATION REGRESSION DATA

All Students:

All Students
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.0881004
R Square	0.0077617
Adjusted R Square	-0.0164393
Standard Error	8.2139321
Observations	43

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	21.63842136	21.63842	0.320718	0.57426352
Residual	41	2766.215923	67.46868		
Total	42	2787.854344			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	85.513131	7.817714427	10.93838	9.89E-14	69.724936	101.30133	69.724936	101.301325
Participation Score	0.2202994	0.389001815	0.56632	0.574264	-0.56530571	1.0059045	-0.56530571	1.0059045

Low Achieving:

Low Achieving
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.2145643
R Square	0.0460378
Adjusted R Square	0.0195389
Standard Error	7.9582174
Observations	38

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	110.0316718	110.0317	1.737345	0.19580136
Residual	36	2279.996086	63.33322		
Total	37	2390.027758			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	76.352679	9.523023936	8.017693	1.59E-09	57.0390916	95.666267	57.0390916	95.6662671
Participation Score	0.6185578	0.46928563	1.318084	0.195801	-0.33319754	1.5703132	-0.33319754	1.5703132

Male Students:

Male Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.0753459
R Square	0.005677
Adjusted R Square	-0.0708094
Standard Error	9.1790553
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	6.253611684	6.253612	0.074222	0.78956464
Residual	13	1095.315722	84.25506		
Total	14	1101.569333			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	94.665722	13.56600507	6.978158	9.65E-06	65.3581495	123.97329	65.3581495	123.973294
Participation Score	-0.1738402	0.638091204	-0.27244	0.789565	-1.55235244	1.204672	-1.55235244	1.20467203

Female Students:

Female Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.1780659
R Square	0.0317075
Adjusted R Square	-0.0055345
Standard Error	7.8536015
Observations	28

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	52.51292604	52.51293	0.85139	0.3646434
Residual	26	1603.65546	61.67906		
Total	27	1656.168386			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	79.673052	10.50698087	7.582868	4.76E-08	58.0756431	101.27046	58.0756431	101.27046
Participation Score	0.4985799	0.540344208	0.922708	0.364643	-0.61211355	1.6092733	-0.61211355	1.60927331

PERFORMANCE REGRESSION DATA

All Students:

All Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.2188332
R Square	0.047888
Adjusted R Square	0.0246657
Standard Error	8.0461317
Observations	43

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	133.5046877	133.505	2.06216	0.158582522
Residual	41	2654.349656	64.7402		
Total	42	2787.854344			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	82.138645	5.530923787	14.8508	4.3E-18	70.96871744	93.308572	70.9687174	93.3085718
Performance Score	0.476421	0.331764397	1.43602	0.15858	-0.19359079	1.1464328	-0.1935908	1.1464328

Low Achieving:

Low Achieving

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.3868493
R Square	0.1496524
Adjusted R Square	0.1260316
Standard Error	7.5136069
Observations	38

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	357.6733885	357.673	6.33563	0.016427089
Residual	36	2032.354369	56.4543		
Total	37	2390.027758			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	72.049163	6.761281971	10.6561	1.1E-12	58.33664779	85.761679	58.3366478	85.7616786
Performance Score	1.0145324	0.403061264	2.51707	0.01643	0.197086242	1.8319785	0.19708624	1.83197851

Male Students:

Male Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.1478726
R Square	0.0218663
Adjusted R Square	-0.053375
Standard Error	9.1040231
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	24.08725463	24.0873	0.29062	0.598937017
Residual	13	1077.482079	82.8832		
Total	14	1101.569333			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	86.616168	8.512390608	10.1753	1.5E-07	68.2262658	105.00607	68.2262658	105.00607
Performance Score	0.2779726	0.515634218	0.53909	0.59894	-0.83598738	1.3919326	-0.8359874	1.39193263

Female Students:

Female Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.3031399
R Square	0.0918938
Adjusted R Square	0.0569667
Standard Error	7.6056071
Observations	28

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	152.1916446	152.192	2.63101	0.116860209
Residual	26	1503.976741	57.8453		
Total	27	1656.168386			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	76.976936	7.714292362	9.97848	2.2E-10	61.11998071	92.833891	61.1199807	92.8338908
Performance Score	0.7466937	0.460342394	1.62204	0.11686	-0.19955364	1.692941	-0.1995536	1.69294105

TEAMWORK REGRESSION DATA

All Students:

All Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.342944
R Square	0.1176106
Adjusted R Square	0.0955509
Standard Error	7.8358988
Observations	42

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	327.3586669	327.359	5.33146	0.026191073
Residual	40	2456.05239	61.4013		
Total	41	2783.411057			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	73.947577	7.027836434	10.5221	4.4E-13	59.74378999	88.151365	59.74378999	88.1513645
25	0.6518269	0.282298913	2.309	0.02619	0.08127956	1.2223743	0.08127956	1.22237433

Low Achieving:

Low Achieving

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.4007475
R Square	0.1605986
Adjusted R Square	0.1372819
Standard Error	7.4650903
Observations	38

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	383.8350983	383.835	6.88771	0.012654763
Residual	36	2006.19266	55.7276		
Total	37	2390.027758			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	68.964073	7.650387648	9.01445	9.2E-11	53.44836745	84.479778	53.44836745	84.479778
TeamScore	0.8083103	0.30799301	2.62444	0.01265	0.183671564	1.4329491	0.183671564	1.43294911

Male Students:

Male Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.390127
R Square	0.1521991
Adjusted R Square	0.0869836
Standard Error	8.4758095
Observations	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	167.6578241	167.658	2.33379	0.150552435
Residual	13	933.9115093	71.8393		
Total	14	1101.569333			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	68.120185	15.15321215	4.49543	0.0006	35.38366062	100.85671	35.38366062	100.85671
TeamScore	0.8810185	0.576705791	1.52767	0.15055	-0.364878595	2.1269156	-0.3648786	2.12691563

Female Students:

Female Students

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.2977132
R Square	0.0886331
Adjusted R Square	0.0535806
Standard Error	7.6192494
Observations	28

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	146.7913948	146.791	2.52858	0.12388833
Residual	26	1509.376991	58.053		
Total	27	1656.168386			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	76.469218	8.178252061	9.35031	8.4E-10	59.65857963	93.279855	59.65857963	93.2798554
TeamScore	0.5390104	0.338968255	1.59015	0.12389	-0.157748836	1.2357696	-0.15774884	1.23576962

BIBLIOGRAPHICAL SKETCH

MR. AIRIK R. SANCHEZ

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Educational Background:

- Highschool Diploma obtained from Weslaco High School in May 2014.
- Bachelor of Science in Physics obtained from the University of Texas Rio Grande Valley in May 2019.
- Master of Science in Interdisciplinary Studies obtained from the University of Texas Rio Grande Valley in December 2021.

Airik R. Sanchez was born on May 2nd, 1996 to Rene Sanchez Jr. and Erica Sanchez in his hometown of Weslaco, Texas. Together with his sisters Emerie and Samantha Sanchez, he grew up as a military child in base after base, slowly being instilled with great morals, manners, and the drive for constant improvement in all aspects of life. Learning early on that he had a passion for the sciences, he attended the University of Texas Rio Grande Valley with the intent to pursue this ambition, and it was found that he enjoyed tutoring others in areas such as Physics. With this in mind, Mr. Sanchez continues on his journey of self-improvement and fulfillment, in order to one day aid others in their quest to find themselves and where they belong.