

Participation in STEAM activities and grit proficiency

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Objective

Steven E. Gross has completed a two-year study to identify variances in Angela Duckworth's grit scale scores between elementary school students who have completed design process focused Science, Technology, Engineering, Art, and Math (STEAM) projects and similar students who have not completed design process focused STEAM projects. The study's goal is to identify if learning about the design process in STEAM environments translates to student's learning perseverance and grit. Much research has been done to identify grit as an important non-cognitive skill. Zimmerman and Brogan's (2015) work suggest that gritty students are more successful academically because grittier students have more perseverance and passion for their long-term goals (Zimmerman & Brogan 2015). However, how students learn to be gritty remains unknown. Students in this study's experimental group participate in a STEAM club at a local elementary school. These students participate in inquiry-based projects where their designs often fail. After this failure students refine their projects until success is reached. An underlying belief of the researcher is that curricular focus on the iterative process of design and student's understating that failure is part of that process may result in students learning the virtues of being gritty.

Purpose of the Study

The purpose of this study is to determine whether or not there is a correlation between student's participation in design-focused STEAM activities and change in their level of grit as a student.

Theoretical Framework

STEAM education is an interdisciplinary approach. In order to allow students space and flexibility to own and control their own projects, combining STEAM education with the iterative process of design education is a good idea. Learning through exploration, failure, and revision allow educators to use design education to STEAM power learning. (Gross & Gross 2016.) These same processes have the chance to impact a student's level of perseverance, or grit.

An investigation of grit and attempts to quantify grit were undertaken in preparation of this study. Brackett & Rivers (2014) along with Duckworth (2007) define grit as non-cognitive and related to persistence. Defining grit in non-cognitive terms makes it a difficult thing to quantify. Much work has been done on cognitive ability, but non-cognitive research has a hard time defining what non-cognitive ability is (Duckworth et al., 2007). A unique and quoted explanation of non-cognitive ability arrives from Easton (2013) "Everybody hates the term but knows roughly what you mean when you use it" (Easton 2013 p. 7).

A study done at Sakarya University in Turkey used a Revised Turkish Version of the Duckworth's Grit Scale to examine the relationship between grit and metacognition of 352 college students (Arslan, S. et al., 2013). Their results showed a positive correlation between grit and metacognition.

A study conducted by Dubey (1982) found that there is a connection between grit and academic success. Another study found that National Spelling Bee competitors routinely score higher on Duckworth's Grit Scale (Duckworth et al., 2011). Yet another study by Pace Law Review looked at declining law school applications and determined that gritty law school candidates would do well as lawyers (Zimmerman et al., 2015). Wolters and Hussain used the Duckworth Grit Scale to find a correlation between grit and self-regulated learning (Wolters et al., 2014).

According to Duckworth and Quinn (2009), students with higher rates of grit exhibit greater levels of persistence and chasing of their goals. In the National Spelling Bee study, the findings demonstrated that grittier spellers performed better (Duckworth et al., 2011). Duckworth's research is extremely important to my study because it establishes a way to measure grit. Duckworth's methods were used in the University of Turkey study, Dubey study, National spelling bee study, and a study of military students. The Duckworth grit scale has proven to be the most valid grit assessment commonly available.

These different studies show the validity of grit as an important characteristic for successful students. Grit is a dynamic persistence within individuals to keep driving them towards a goal

(Duckworth et al., 2011). Yet, explaining exactly how to teach Grit to others is something that remains a mystery. Design process focused STEAM curriculum teaches students that when their ideas do not solve the problem they should look at different ways to continue towards the objective. My study aims to isolate if design process focused STEAM curriculum teaches students to be grittier.

Methodology

This study will look for a relationship between elementary school student's grit score using the Duckworth grit scale (Child Adapted Version 4) and enrollment in a design process focused STEAM club. This experimental study will compare the scores of students enrolled in a design process focused STEAM club with a comparison group of similar students not enrolled in a design process focused STEAM club. The school that has been chosen for this study is an elementary school in west suburban Illinois. This school has been chosen, because it has a design process focused STEAM club and a staff committed to finding ways to teach social and emotional learning skills such as grit. This study has spanned two school years. As part of this study STEAM club participants and comparison group students take the Duckworth grit scale in the fall and spring. The measurable dependent variable in this study will be the study's participant's score on the Angela Duckworth grit scale in the fall of the school year, and then again in the spring of the school year. The grit scale uses a Likert scale of 1-5, where 5 is extremely gritty and 1 is not at all gritty (Arslan, S. et al., 2013). A comparison group of similar students not enrolled in the STEAM club will take the grit scale at the same time intervals as students in the STEAM club. This study has collected data for 29 STEAM club students (14 from the 2016-2017 school year and 15 from the 2017-2018 school year.) This study has collected data for 11 comparison group students (7 from the 2016-2017 school year and 4 from the 2017-2018 school year.) The independent variable in this study will be the design process focused STEAM club curriculum. Students in the STEAM club will receive this independent variable, and comparison group students will not.

The research methodology applied in this study is experimental. In experimental research, an independent variable is manipulated, other variables stay constant, and the influence of the dependent variable is measured (Fraenkel & Wallen, 2015). This methodology is suitable for this study because the design process focused STEAM curriculum is present for only the STEAM club students and can be controlled by including similar students outside the STEAM club in the study. The Duckworth grit scale can be used to measure grit in both groups in the fall and spring of the school year.

The participants in this study are elementary school students in grades one, two, three, four and five. The sampling technique is purposive sampling. Purposive sampling is when the researcher picks the subjects to be involved in the study. (<http://dissertation.laerd.com>) In my study the purposeful sample represents students who selected to enroll in a STEAM club. STEAM club had an open enrollment period in the fall of a school year, and accepts twenty students on a first come, first serve basis. The researcher tried to find experimental and comparison students of similar grade level and gender. In year one all students in the comparison group were from the same elementary school of the experimental group. In year two one student attended a different elementary school within the same school district.

Purposive sampling is appropriate because this study needs an especially qualified group of students (Fraenkel & Wallen, 2015). Students must receive a design focused STEAM curriculum. The STEAM students and the comparison group will be compared using the Duckworth grit scale. This survey style assessment is administered in the fall and again in the spring.

The variables under examination in this study are the student's experiences with the design process and STEAM education and the results of the student's grit survey. Student's experience with the design process and STEAM education is the independent variable. The dependent variable is the student's grit survey results. Assessment of student's grit level will be obtained by using Duckworth's grit scale (Child Adapted Version 4) (2009). The grit scale produces a Likert scale score from 0-5. Both students using a design process focused STEAM curriculum and a comparison group of similar students without design process focused STEAM curriculum

completed the survey. Students in both groups took a pretest in the fall and a posttest in the spring. Results from each student were reviewed. Positive, negative, or neutral changes in pre and post-tests were evaluated for the entire test and each question for each participant.

The Duckworth grit scale has proven to be a reliable and valid instrument. Between 2005 and 2009 a study was completed using a long grit scale in order to develop a shorter scale (Duckworth et al., 2009). 1,218 Cadets from the West Point class of 2008, 1,308 from the class of 2010, 175 National Spelling Bee final round contestants from 2005 and 139 Ivy League undergraduates grit scale results were used to identify a shorter grit scale that would use elements of interest and effort to measure grit (Duckworth et al.,). The study showed that gender did not factor into the score of the shorter grit scale (Duckworth et al.). Another study was conducted using a sample of 1,554 individuals and online survey links (Duckworth et al.). The results of the online study continued to help create the short grit scale. Studies one and two validated a short grit scale (Duckworth et al.). Four more studies were completed to validate the short grit scale (Duckworth et al.). Previously in this proposal, three other studies using the Duckworth Grit Scale have been identified. Using the Duckworth grit scale in a pre-test and post-test environment has not been found. On her own website, Duckworth does warn the grit scale is designed to "assess individual differences rather than subtle within-individual changes in behavior over time." (www.angeladuckworth.com) Concern about this study using the Duckworth Grit Scale in a pre and post capacity is valid. However, at this time the researcher has been unable to identify another method of accurately assessing grit. The principal at the elementary school where our study took place has used the Duckworth grit scale in a pre/post capacity as well, due to lack of a different easily identifiable tool. Additionally, our study has at least seven months between pre and posttest. This extended time reduces the chance students remember things about the survey.

The Duckworth grit scale (Child Adapted Version 4) is an eight-question survey (2009). Each of the eight questions have the same possible five answer choices. The answer choices use a Likert scale and range from "very much like me" to "not like me at all." Four of the questions receive a five-point Likert scale result for "very much like me" and a one-point Likert scale score result for "not like me at all." The other four questions are reversed, where "very much like me" is

worth one point and "not like me at all" is worth five points. After scoring all questions the total points between the fall and spring assessments were compared.

This study compares each student's pretest in the fall compared to their posttest in the spring. Both years of the study began with 20 students in the experimental group. Comparison groups for both years were found from volunteers of the same age and grade level as experimental groups. 10 of the 11 students in the comparison group were from the same school as the experimental group. One comparison participant was from a neighboring school within the same school district. Having a smaller size comparison group than experimental group reduces the validity of this study. The researcher tried many methods to try to get a larger comparison group. The researcher asked teachers at the school to help find comparison participants. The researcher passed out fliers to perspective comparison parents at school events. The researcher personally reached out to parents at community events. The researcher made social media postings on the school social media feed trying to recruit prospective comparison parents.

In the fall students were read the Duckworth grit scale and marked their results on a paper form. This activity was repeated in the spring. Experimental students completed the task in a group setting, with a STEAM Club instructor reading the test questions. Comparison group students completed the task individually. Parents of comparison group students were asked to read the survey to their child. Differences in the pre and post tests for both years have been recorded for all students, those enrolled in design-focused STEAM curriculum and those in the comparison group without design focused STEAM curriculum. The STEAM club allows twenty students to enroll at a time.

The STEAM club has existed since January two thousand and fifteen and has had one hundred and fifteen members. Forty-five percent have been female, and fifty-five percent have been male. The STEAM club typically meets every other week during the school year.

Data

In both years the experimental group began with 20 students. The mortality in year one was 6 students, who left the study because they moved away, became too busy to attend class, or dropped out. Those 6 results were not used to calculate final results. The mortality in year two was 5 students, who left the study because they dropped out, or they were not present during either the fall or spring testing periods. Those 5 results were not used to calculate final results.

Comparison group students were found by an announcement on the school PTA social media account, by contacting school teachers, and by outreach at school events. During year one seven students were identified for the comparison group. During year two, four students were identified for the comparison group. During both years all comparison students completed both the fall and spring results and were used to calculate final results. Experimental group surveys were read aloud as a group in both the fall and the spring. Comparison group parents were asked to read aloud surveys to comparison group students.

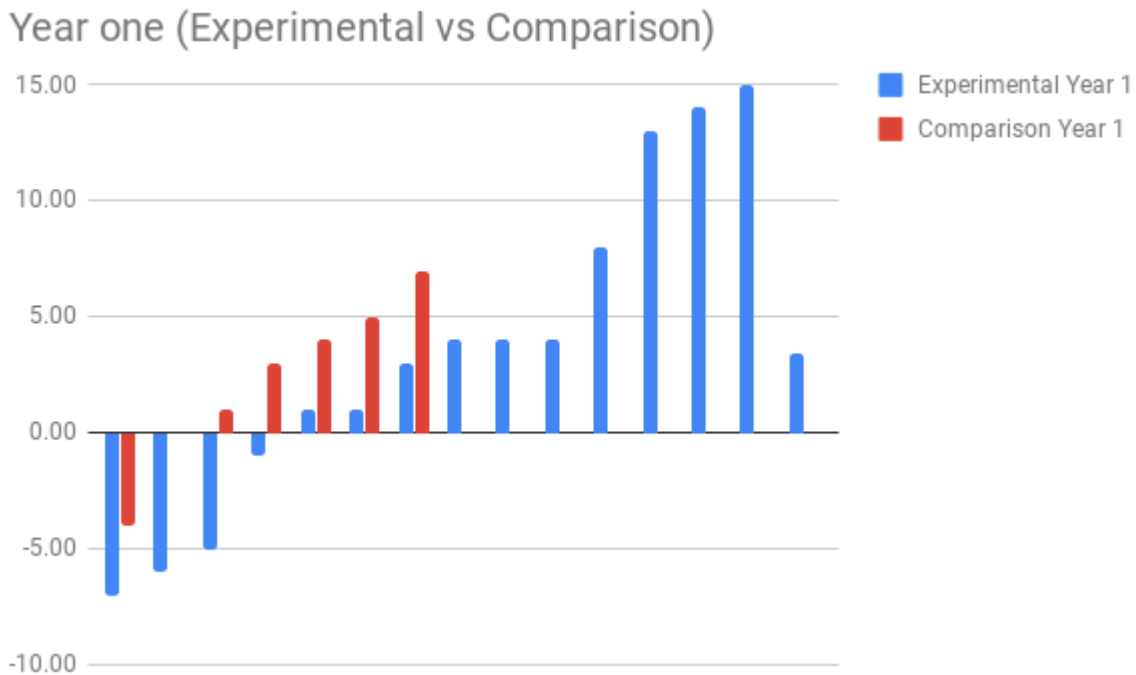
Both fall and spring survey results have been tabulated and scored for both years. Results show some trends. The mean change of total survey points for year one experimental group was +3.43. The mean change of total survey points for year one comparison group was +2.29. The year one experimental group gained on average 1.14 points more than the comparison group in year one. The mean change of total survey points for year two experimental group was +0.47. The mean change of total survey points for year two comparison group was -2.25. The experimental group changed on average +2.72 points more than the comparison group in year two.

Combined the year one and year two experimental group mean change was +1.90. The combined year one and two comparison change was +.64. The experimental group changed +1.26 more than the comparison group for years one and two combined.

After noticing that the second year results were across the board lower than the first year the researcher consulted with the school principal. The researcher pointed out the dip in overall scores from year one to year two. The school principal mentioned that she had seen an overall dip

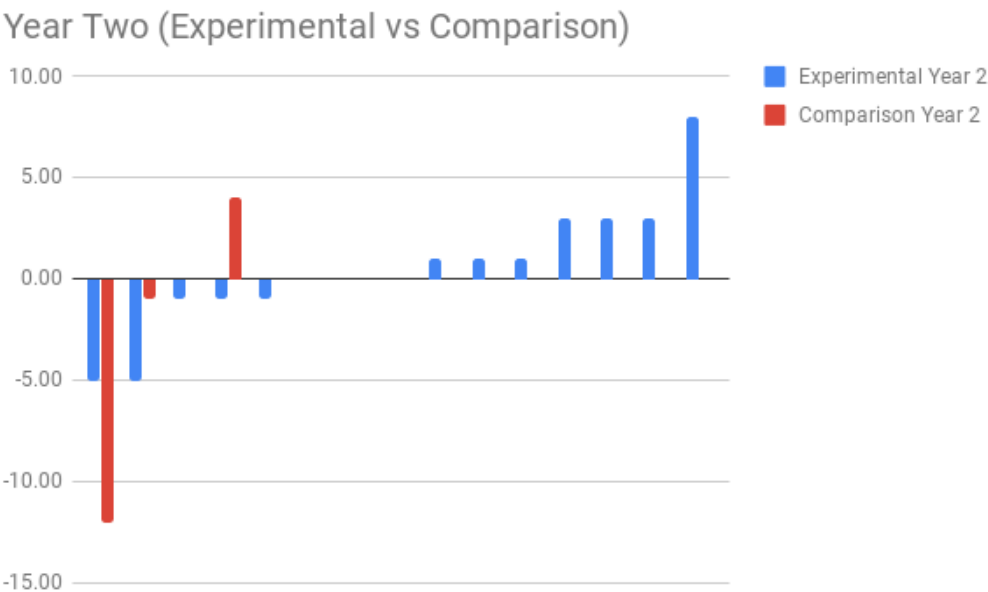
in school achievement scores from year one to year two. This demonstrates that data from this study correlates with data from the school indicating lower test scores year over year.

Below is a chart for each year of our research. The first chart is year one, the second chart is year two, and the third chart is year one and two combined. The charts show the difference from pretest to posttest for the experimental and comparison students. Below the charts are each student's difference from pretest to posttest for each student on the grit scale.

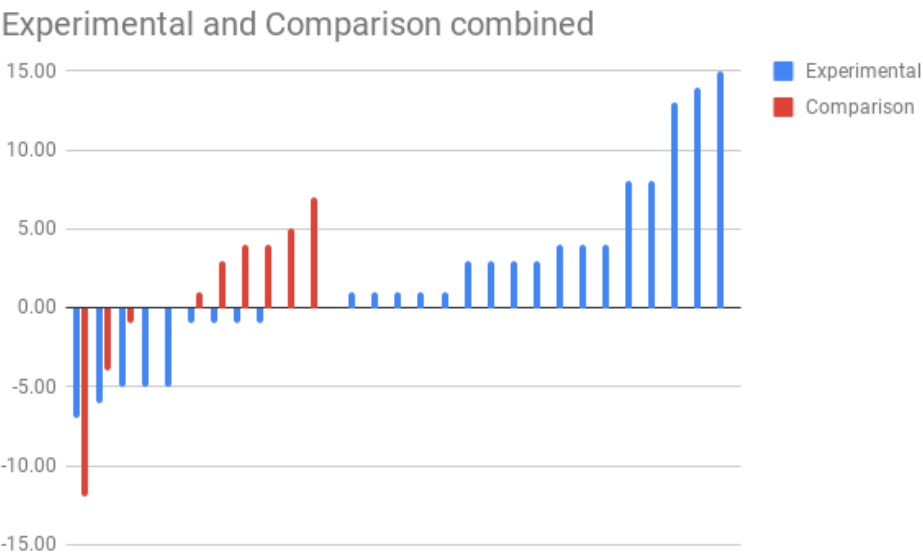


Experimental difference year 1: -7,-6,-5,-1,1,1,3,4,4,4,8,13,14,15

Comparison difference year 1: -4,0,1,3,4,5,7



Experimental difference year 2:-5,-5,-1,-1,-1,0,0,0,1,1,1,3,3,3,8
Comparison difference year 2: -12,-1,0,4



Experimental difference combined: -7,-6,-5,-5,-5,-1,-1,-1,-1,0,0,0,1,1,1,1,3,3,3,3,4,4,4,8,8,13,14,15
Comparison difference combined: -12,-4,-1,0,0, 1,3,4,4,5,7

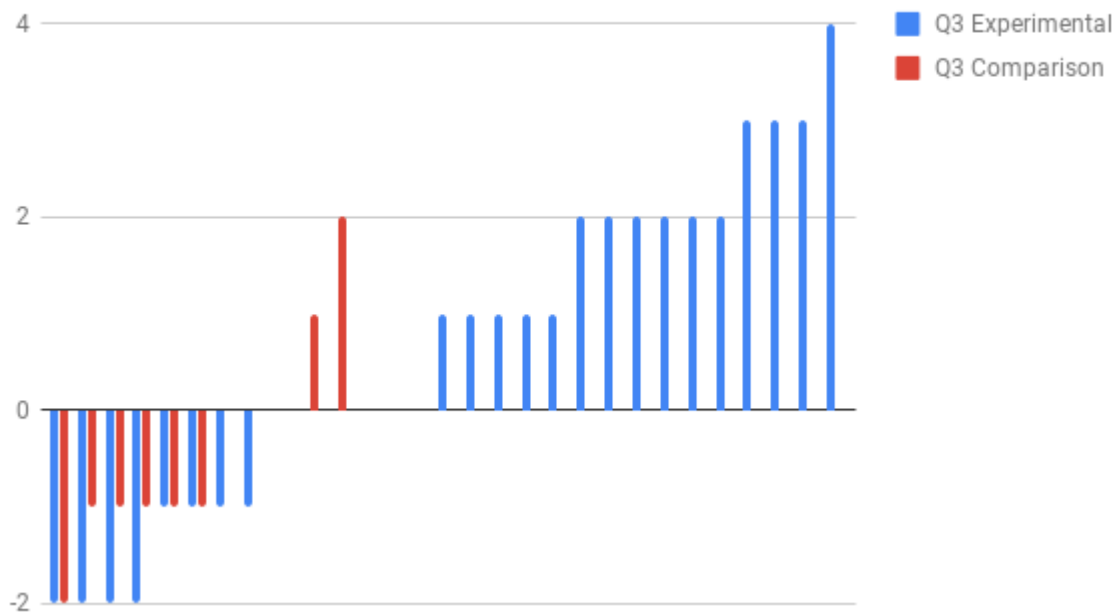
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Next, the researcher used the IBM statistical software package SPSS to run an analysis of the data. The researcher used the combined year one and year two results. T-Tests were run on the overall results, as well as for each question in the grit survey. In order to be statistically significant a confidence level of 95% is expected. For a T-Test, this means the significance must be below .05. Below are the outputs from SPSS. (PrePostDifference is the overall test results.)

Independent Samples Test					
		Levene's Test for Equality of Variances		t-test for Equality of Means	
		F	Sig.	t	df
PrePostDifference	Equal variances assumed	.104	.749	.650	38
	Equal variances not assumed			.669	19.199
Q1DifferenceFinal	Equal variances assumed	1.599	.214	-.914	38
	Equal variances not assumed			-.855	16.039
Q2DifferenceFinal	Equal variances assumed	.102	.751	1.596	38
	Equal variances not assumed			1.554	17.195
Q3DifferenceFinal	Equal variances assumed	3.552	.067	1.773	38
	Equal variances not assumed			2.130	27.572
Q4DifferenceFinal	Equal variances assumed	1.369	.249	.452	38
	Equal variances not assumed			.504	22.918
Q5DifferenceFinal	Equal variances assumed	1.574	.217	-.317	38
	Equal variances not assumed			-.369	25.544
Q6DifferenceFinal	Equal variances assumed	.002	.967	-.338	38
	Equal variances not assumed			-.357	20.260
Q7DifferenceFinal	Equal variances assumed	.000	.986	.109	38
	Equal variances not assumed			.101	15.943
Q8DifferenceFinal	Equal variances assumed	.094	.761	-.242	38
	Equal variances not assumed			-.259	21.007

The SPSS results show that while the grit survey results were greater for the experimental group than the comparison group, these overall study results are not statistically significant. None of the individual question results are significant either. Question three results are the closest to being significant. Question three significance results were .067, or 93.3%. Below is a chart of question three combined results from year one and year two.

Question 3 Combined years



Experimental: -2,-2,-2,-2,-1,-1,-1,-1,0,0,0,0,0,0,1,1,1,1,1,2,2,2,2,2,3,3,3,4

Comparison: -2,-1,-1,-1,-1,-1,0,0,0,1,2

Interpretation

While the difference between the overall pre and post tests is larger for the experimental group than the comparison group, the difference is not statistically significant. After these findings, the researcher looked closer at question three, which was the closest individual question to having statistically significant results. Question three is about the ability to persist with a project for a long period of time (Angela Duckworth Grit Scale).

Over time the STEAM club used in this research has been reducing the number of projects students work on each year. This has been done purposely to allow students to fully immerse themselves in their projects. In his book An Ethic of Excellence, Ron Berger talks about this concept when comparing American and Japanese schools. "The average eighth-grade Japanese science textbook has just eight topics, compared to the sixty-five found in the average U.S. textbook. By covering less and learning it more deeply students have plenty of time for hands on exploration" (Berger 2003). The STEAM club used in this research has slowed down the speed of its curriculum so that units now last 16 weeks. During those 16 weeks, the STEAM club covers just a hand full of topics. Perhaps this contributes to the experimental study participant's growth on question 3 compared to the comparison group. 93.3% is very close to being statistically significant. With such a small sample size in this study, the researcher believes a larger study is warranted to see if these results continue with a larger sample size.

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Angela Duckworth Grit Scale (Child Adapted Version 4)

<https://upenn.app.box.com/v/8itemgritchild>

<http://angeladuckworth.com/>