The Effect on Grit from a Computer Science Workshop

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Abstract

This study uses Duckworth’s grit scale to investigate factors that contribute to a student’s grit score, specifically exposure to Computer Science (CS). While limited with a small sample size, my findings suggest Middle School girls’ grit scores may have benefitted from participation in a CS workshop. However, further study with a larger sample size is needed to show a statistically significant impact of exposure to CS on a student’s grit score.

Keywords: Grit, Computer Science Education
The Effect on Grit from a Computer Science Workshop

This study investigates the link between Computer Science and grit- specifically how participation in a CS workshop affects a student’s grit.

**Literature Review**

Grit is a person’s perseverance and passion for long term goals. A gritty person has stamina when faced with setbacks and plateaus in their progress towards a goal. Grit also corresponds with a dedication to stick with a long term interest (Duckworth, Peterson, Matthews, & Kelly, 2007). “So, grit is not just having resilience in the face of failure, but also having deep commitments that you remain loyal to over many years” (Perkins-Gough, 2013, p. 14).

Grit has been shown to correlate with many positive traits and to be a predictor of success in several different areas. Duckworth *et al* found grit to be associated with lifetime education attainment, academic achievement at competitive universities, higher GPA even if a student had a low SAT, rank in the National Spelling Bee, and retention after the first summer of Cadet Basic Training at West Point (Duckworth *et al.*, 2007). Grit was also found to be linked to the long term performance of cadets in the four year program at West Point (Maddi, 2012; Kelly, 2014), to teacher effectiveness (Duckworth, Quinn, & Seligman, 2009; Robertson-Kraft & Duckworth, 2012), to success in online education programs (Milman, 2015), to a higher work ethic (Mericac, 2015), to GPA, hours spent studying, and to overall success of non-traditional doctoral students (Cross, 2014), to an increased intensity of exercise (Reed, Pritschet, & Cutton, 2013), to reduced suicide ideation (Kleiman, Adams, Kashdan, & Riskind, 2013), to higher life satisfaction (MacCann & Roberts, 2010), to increase in student’s self regulated learning, and to less procrastination (Wolters, 2015). Overall, “when you consider individuals of equal talent, the grittier ones do better” (Perkins-Gough, 2013, p. 14).
Recently Stokas criticized that “grit has served as a tool for convincing society that achievement occurs through heroic individual effort despite inadequate social supports” thus allowing society to justify social and economic inequality (2015). Grit has had so much exposure and has been a buzzword in education for quite some time; it is good to question and think critically about it. The studies conducted on grit to this point have focused on academic challenges occurring inside the classroom, and not on how grit relates to the challenges of social and economic injustice in the world. There is of course a need for more efforts to address these issues for students, alongside with what teachers can do in their classrooms. “In an academic environment that teaches grit and fosters growth, students can learn to persist” (Hoschanadel, 2015, p. 47) and possibly to carry some of these lessons to meet the challenges they face outside of the classroom.

Because grit has been shown to correlate with so many positive attributes, the factors that teachers can change within their classrooms to help increase grit and determination in their students when faced with challenges is worth study. Ricci (2013) surveyed kindergarten, first-, second-, and third-grade students on their beliefs about intelligence. While 100 percent of the kindergarteners had a growth mindset believing they could learn, a dramatic shift in mindset took place over the first 4 years of schooling. By fourth grade, 42 percent of the students demonstrated a fixed mindset suggesting a belief that intelligence is not malleable. The data indicate that traditional educational practices curtail curiosity for learning in almost half of our students before the end of elementary school. Efforts to curtail this decline in student mindset are in need of further investigation.

A growth mindset is particularly important for gifted and talented students because they are at risk for both under achievement and perfectionism, which may hinder them from reaching
their potential (Esparaza, 2014). In studying the mindsets of gifted students in China, Chan (2012) categorized students to be healthy perfectionists, unhealthy perfectionists, or non-perfectionists. Unhealthy perfectionists scored significantly higher on the measure of a fixed mindset, suggesting that targeting mindset change could be an effective intervention for unhealthy perfectionists.

Are mindsets things people can learn? Yes, says Carol Dweck: by teaching students that they get smarter as they challenge themselves, through teachers presenting themselves as mentors for learning, not as judges of student intellect, in giving strategy oriented feedback that focuses on progress, and by teachers having a growth mindset about their students (interview, 2013). “In theory, the work that Carol has done to show that you can change your mindset would also be relevant to changing your grit… I say ‘in theory’ because we haven’t shown it yet“ (Perkins-Gough, 2013, p. 14). Snipes, Fanscsali, and Stoker (2012) noted that a growth mindset is possibly one of the strongest contributors to the development of grit. The most fundamental practice in promoting a growth mindset is acknowledging and praising students for the efforts they put into learning-- not for ability.

“Schools need to provide intentional experiences for students to develop non cognitive skills such as grit” (Laursen, 2015, p. 20). Csikszentmihalyi (1990) described learning as the intrinsic reward of hard work that is essential to successful human development. In order to prepare students for adult success, education should help them to seek out challenging and engaging activities that set them on the path to mastery. "Challenge gives children vision and direction, focus and perseverance. Support gives the serenity that allows them freedom from worry and fear" (Csikszentmihalyi, 1990, p.17). Csikszentmihalyi may have identified the factors that increase grit before the term grit had yet been coined.
Esparza’s work showed a strong teacher effect on growth mindset of students in the general population, and that a 6 week intervention had a large effect on gifted students’ mindset (Esparza, 2014). Pride (2014) suggests that “working through challenges is a given in STEM, but if students are not explicitly presented with examples of narratives from people who persisted through challenges, they may never realize that “even geniuses had to work hard” (Dweck, 2010)”(p. 43). Thus, learning stories are another way to help students to foster a growth mindset. Pawlina (2011) backed up the importance of teachers in students’ development of a growth mindset, reporting that responding to difficult situations can teach children a sense of self efficacy, especially when supported by and given confidence from their teachers.

Intelligent females who would be the likely candidates to enter the computer science field are in danger of having a low sense of self efficacy. Highly intelligent female MENSA members’ self estimated intelligence (SEI) scores were found to be lower than males (Storek & Furnham, 2012). Furthermore, it was found that in a broader population an increase in intelligence correlated with an increase in SEI scores in males, but a decrease in SEI scores in females. Compared to boys, girls do not perform as well with problem solving using computers, have less general computer literacy, and less confidence in their computer competency (Volman & van Eck, 2001).

Strategies shown to effectively increase female participation in STEM fields include student centered learning, positive messages about their competence, being given the opportunity to problem solve with support from their instructors, and hearing stories and case studies about other females in the sciences (Baker, 2013). Women are more likely to enter computer science because of encouragement from a teacher, family member, or friend (Cohoon, 2006). The National Science Foundation calls for early science instruction, relevant curriculum, greater
emphasis on the use of computers, integrating reading and writing into science, careful attention
to how groups are formed, activities that build self-efficacy, appropriate role models, messages
that science is for everyone, and student centered teaching to help increase female participation
in science (2003).

These strategies that work to increase female participation in STEM fields overlap with
the strategies that have been shown to change student mindsets and sense of self efficacy, and
possibly to increase their grit. This study aims to further the research in this area, specifically on
how participation in a Computer Science workshop can influence the grit scores of elementary
and middle school female participants.

**Methodology**

**Research Questions, Hypotheses, and Variables**

Research question: Does participation in a Computer Science (CS) workshop affect a
student’s grit score? The hypothesis is that participation in a computer science workshop will
increase a student’s grit score. The variables of interest are the *grit score*, the dependent
variable, and *exposure to a CS workshop*, which is the independent variable. A grit score is
calculated using a twelve question self assessment that determines the resilience of and how
likely a participant is to complete a challenge, even in the face of setbacks. The independent
variable has two levels: the *treatment group* that participated in the workshop, and a *comparison
group* that did not participate.

**Experimental Design**

The study is a quasi-experimental design; the participants are not assigned to groups
randomly. Specifically, this is a nonequivalent comparison group design, because the
comparison group and the treatment groups are not composed of similar populations. The
difference in the groups is that the treatment group self selected to participate in the Computer Science workshop while the comparison group did not.

**Sample**

The target population is grade school and middle school female students. The study population is female middle school students in the Boise School District who were invited to participate in the *CS Code for Fun* workshop. A sample of 23 females signed up; their ages ranged from 7-12, and their ethnicity was a mix of Asian and Caucasian students.

The CS workshop was advertised to families with either an email from the classroom teacher to the parents of female students, or a visit from the leader of the workshop to the girls’ classrooms along with a flyer sent home. Due to the non random sampling with participants self selecting to be in the workshop, this is a *convenience* sample. The comparison group consists of female students from a 5th grade classroom. A flowchart of the experimental design is shown in figure 1.
Measures

Grit is a construct given an operational definition using a 12-item scale. The grit scale measures two factors of high achieving individuals: perseverance of effort and consistency of interests. The scale has been shown to have an internal consistency of $\alpha=0.85$ (Duckworth et al., 2007). This high Cronbach's alpha value shows that the grit scale has an above acceptable level of consistency. Instructions ask each respondent to indicate how much the statements are like her, choosing response options on a 5 point Likert-type scale ranging from 5 (very much like me) to 1 (not like me at all). In this study the total grit score is the sum of the points assigned to
each of the 12 questions responses, resulting in a total grit score that could range from 0 to 60, with scores close to 60 representing higher grit scores, as shown in figure 2.

12- Item Grit Scale

Directions for taking the Grit Scale: Please respond to the following 12 items. Be honest—there are no right or wrong answers!

1. I have overcome setbacks to conquer an important challenge.
2. New ideas and projects sometimes distract me from previous ones.*
3. My interests change from year to year.*
4. Setbacks don’t discourage me.
5. I have been obsessed with a certain idea or project for a short time but later lost interest.
6. I am a hard worker.
7. I often set a goal but later choose to pursue a different one.*
8. I have difficulty maintaining my focus on projects that take more than a few months to complete.*
9. I finish whatever I begin.
10. I have achieved a goal that took years of work.
11. I become interested in new pursuits every few months.*
12. I am diligent.

Scoring:

For questions 1, 4, 6, 9, 10 and 12 assign the following points:
5 = Very much like me
4 = Mostly like me
3 = Somewhat like me
2 = Not much like me
1 = Not like me at all

For questions 2, 3, 5, 7, 8 and 11 assign the following points:
1 = Very much like me
2 = Mostly like me
3 = Somewhat like me
4 = Not much like me
5 = Not like me at all

Add up all the points and divide by 12.
The maximum score on this scale is 5 (extremely gritty), and the lowest score on this scale is 1 (not at all gritty).
Figure 2. The 12 Item Grit Scale (Duckworth et al., 2007).

Data & Analysis

The grit score for each participant’s pre and post test values was obtained by adding the 1-5 score earned from the response on each of the 12 questions. This allows for a maximum score of 60 (extremely gritty) and a minimum score of 12 (not at all gritty). An analysis of covariance (ANCOVA) was run to compare the pre and post test grit scores for the multiple groups. An ANCOVA is run to control for factors which cannot be randomized but which can be measured on an interval scale, and allows for the comparison of the treatment and comparison groups in spite of differing pre-test scores (Huang, n.d.).

Findings

The descriptive statistics for the treatment and comparison groups’ pretest results are shown in Table 1. The treatment group had an average pre test grit score of 35.4 while the comparison group had an average pretest grit score of 38. The treatment group had 17 participants that had both a pre and post test score; out of the 23 participants 4 were not present for the administration of either the pre or post test, and two did not complete the form correctly. The comparison group had 13 participants. Figure 3 shows a histogram comparing the treatment and comparison group’s pretest scores.
Table 1.
Total Pre-Test Grit Score

<table>
<thead>
<tr>
<th></th>
<th>Pre-Treatment</th>
<th>Pre-Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>35.41</td>
<td>38.00</td>
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<tr>
<td>Standard Error</td>
<td>1.33</td>
<td>2.14</td>
</tr>
<tr>
<td>Median</td>
<td>36.00</td>
<td>38.00</td>
</tr>
<tr>
<td>Mode</td>
<td>30.00</td>
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<tr>
<td>Standard Deviation</td>
<td>5.47</td>
<td>7.70</td>
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<td>Sample Variance</td>
<td>29.88</td>
<td>59.33</td>
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<tr>
<td>Kurtosis</td>
<td>-1.19</td>
<td>-0.48</td>
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<tr>
<td>Skewness</td>
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<td>-0.40</td>
</tr>
<tr>
<td>Range</td>
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<td>26.00</td>
</tr>
<tr>
<td>Minimum</td>
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<td>24.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>44.00</td>
<td>50.00</td>
</tr>
<tr>
<td>Sum</td>
<td>602.00</td>
<td>494.00</td>
</tr>
<tr>
<td>Count</td>
<td>17.00</td>
<td>13.00</td>
</tr>
</tbody>
</table>

Figure 3.

Pre Test Grit Score Total Treatment and Comparison
The pre test grit scores were subtracted from the post test grit scores to obtain the diff value for each participant’s grit scores. The descriptive statistics for the treatment and comparison groups’ diff values are shown in Table 2. The mean value for the treatment’s diff was 5.29 with a standard deviation of 6.03 while the mean for the comparison’s diff score was 1.85 with a standard deviation of 7.23. A histogram comparing the treatment and comparison groups diff values is shown in Figure 4. The p value for the treatment group’s diff compared to the comparison group’s diff is 0.089, which shows no significance.

<table>
<thead>
<tr>
<th>Table 2. Post-Pre Difference (Diff)</th>
<th>Treatment Diff.</th>
<th>Control Diff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.29</td>
<td>1.85</td>
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<tr>
<td>Standard Error</td>
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<tr>
<td>Median</td>
<td>6.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Mode</td>
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<td>-2.00</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>6.04</td>
<td>7.23</td>
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<tr>
<td>Sample Variance</td>
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<td>52.31</td>
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<tr>
<td>Kurtosis</td>
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<td>-0.35</td>
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<td>24.00</td>
</tr>
<tr>
<td>Minimum</td>
<td>-6.00</td>
<td>-12.00</td>
</tr>
<tr>
<td>Maximum</td>
<td>20.00</td>
<td>12.00</td>
</tr>
<tr>
<td>Sum</td>
<td>90.00</td>
<td>24.00</td>
</tr>
<tr>
<td>Count</td>
<td>17.00</td>
<td>13.00</td>
</tr>
</tbody>
</table>
An ANCOVA controlling for the pretest grit score comparing treatment and comparison groups’ post test grit score was run. The ANCOVA results show the effect of the CS workshop on post test grit scores using an alpha value of 0.05 was not significant (p=0.319).

**Limitations**

The p value for both the T test on the difference between the pre and post test scores for the treatment and comparison, along with an ANCOVA run to compare the post test scores for each group controlling for the pretest grit scores showed no significant impact of the Code for Fun workshop on the treatment group’s post test grit score. While the mean diff score of the treatment group was 5.29 versus the comparison group’s 1.85, the large standard deviations combined with the low sample sizes created noise in the data that reduced the power of the treatment group’s increase in grit scores. If this study were to be replicated with a larger sample
of participants and with a matched treatment and comparison group, the power would likely increase.

Threats to the internal validity include history, or outside events at home or school that occur during the course of the workshop and may affect the responses to the grit scale. A confounding variable is that the CS workshop participants were signed up by their parents, and are more likely to have had prior exposure to coding, or to have participated in similar STEM activities previously.

A threat to the external validity of the study is that the sample is a convenience sample of students who chose to participate in the CS workshop; these students would presumably already possess the qualities, such as grit, that correlate with success in CS. Additionally, the demographics of the sample do not match the demographics of the target population, and the demographics of the comparison group do not match the demographics of the treatment group.

Conclusion

The aim of this research was to determine whether exposure to Computer Science could impact a student’s grit score. A pre and post grit test was given to middle school females before and after participation in a Computer Science workshop. The same pre and post test was given to 5th grade females as a comparison group.

The findings suggest that the treatment group may have benefitted from the CS workshop, and its use of teaching strategies such as problem solving with support, female role models and stories of how they became involved in CS, activities to increase self efficacy, and affirmations worded to focus on work and effort. Further study with larger sample sizes is needed to reduce the noise in the data and to show a statistically significant impact of exposure to Computer Science on a student’s grit score.
References


