Non-Cognitive Skills and the Performance of Macro Principles Students*

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December, 2013

1 Introduction

Principles of economics has a reputation as being a challenging course. Further, it seems that most students tend to have difficulty retaining ideas and concepts from it and other other economics courses (Walstad and Allgood, 1999). As a result, increasing student understanding would seem to be an important priority for economics educators. In recent years there has been considerable research on the importance of non-cognitive skills on labor market success—suggesting that these skills are important in college and perhaps in economics courses as well. In some cases, student views of these skills and thus actual academic performance can be shaped by instruction (Yeager and Dweck, 2012). An intervention that could be used to increase learning in their classes would be particularly helpful for economics educators.

In this study, three widely used instruments that measure non-cognitive skills were given to approximately 900 Penn State macro principles students in the Fall of 2012. They were the Grit Scale (Duckworth and Quinn, 2009), the Self-Control Scale (Tangney et al., 2004), and the Need for Cognition (Cacioppo et al., 1984). In addition, students were asked about their "mindset" (Dweck, 2006). While it may not be understood as a non-cognitive skill, "mindset" is sufficiently related to student academic performance that it merits inclusion in this study. The results are described below.

2 Importance of Non-Cognitive Skills

In general, the development of cognitive skills have been the primary focus of education to prepare students for the labor market. However, recent studies have led to greater emphasis and attention on the effect of non-cognitive skills for life outcomes in addition to cognitive skills. Cognitive skills can be defined as skills such as problem solving, critical thinking, study skills, and meta-cognitive skills. On the other hand, non-cognitive skills are interpersonal and intrapersonal skills such as social intelligence, persistence, time management, and work ethic.

Friedman et al. (2006) described how life achievements are the results of persistence, reliability, and self-discipline rather than high IQs, which challenge the convention of associating cognitive skills with success. Early intervention

*We would like to thank Tisha Emerson, Mark Maier, KimMarie McGoldrick, and Scott Simkins for initial discussion regarding this project. Bart Pursel and Yanping Liu provided excellent assistance with data collection. All errors are the authors'.

studies have revealed that non-cognitive skills can be improved, affecting education, earning, employment, and crime despite a lack of improvement in IQ (Heckman et al., 2010).

From an economics perspective, non-cognitive skills are not only highly valued in the labor market, but they are also predictors of academic achievement and success (Postlewaite and Silverman, 2006). Bowles et al. (2001) found that eighty percent of the benefit from years of schooling when predicting labor market outcomes is due to non-cognitive skills. Regarding educational outcomes, Carneiro et al. (2007) found that non-cognitive skill is a significant predictor for the following outcomes: school retention, degree attainment, employment status, work experience, wages, smoking, truancy before age sixteen, exclusion from school, teenage pregnancy, involvement with crime, and health. Lastly, Heckman and Rubinstein (2001) found that even though individuals with GEDs have the same level of cognitive skills as high school graduates, the GED holders had worse labor market outcomes.

Given the importance of non-cognitive skills in these domains, one might wonder if these skills influence outcomes in economics principles courses. With this in mind, three different survey instruments and a question on "mindset" were given to three sections of macro principles at Penn State in the Fall of 2012. The question and instruments are next described.

3 Non-Cognitive Skills Measures

According to Carol Dweck, the mindset of an individual is the link between ability and achievement (Dweck, 2006). With regards to ability, individuals explicitly or implicitly believe that intelligence is either innately fixed or that it has potential to grow. Such beliefs lead to two types of mindsets: a fixed mindset or a growth mindset. In a fixed mindset, individuals believe that their ability is innately fixed so they may fear failure and become more stressed when facing challenges. On the other hand, students with growth mindset are more likely to work through difficulties and succeed because they believe that their abilities can be developed through effort, persistence, and quality instruction.

Particularly in classrooms, a fixed or growth mindset influence students' academic achievements and learning outcomes. When students with fixed mindsets encounter particularly challenging material, they may become more stressed and perhaps even exert less effort in fear of failure. Any performance or outcome less than "perfect" is a negative reflection on their fixed ability which may discourage continuing efforts to learn and hinder further academic achievement and success; these students even dread "looking bad" to others (Dweck, 2012). In contrast, students with growth mindsets are more likely to be persistent and give forth effort regardless of how difficult they find course materials; these students believe that there is possibility for growth for everyone irrespective of their current levels of abilities. Therefore, Dweck argues that students with growth mindset have a higher likeliness of success due to their resilience.

Dweck explains that people's mindset serves as a framework to guide their behavior. Even though some students' may have fixed mindsets, Dweck emphasizes that mindsets are not permanent. Yeager and Dweck (2012) found that students showed higher academic achievement in challenging math courses as well as school transitions when they were taught that intellectual abilities can be developed. As instructors strive to guide students to learn new material to help them achieve their individual goals, they can encourage their students with an intervention to increase student learning. Especially for students with fixed mindsets, encouragement and praise can be effective in fostering resilience.

3.1 Grit Scale

The Grit scale is a self-reported measure of individual capacity to maintain both perseverance of effort and consistency of interest in projects that take months or longer to complete. While controlling for individuals' levels of intelligence, grit is independent from need for achievement and conscientiousness (including self-control) (Duckworth and Quinn, 2009).

The original grit scale has 17 items on a 5-point likert scale ranging from 1 (Not like me at all) to 5 (Very much like me) in which 7 items are reverse scored as 1 (Very much like me) to 5 (Not like me at all). Sample items include "I have overcome setbacks to conquer an important challenge" and "My interests change from year to year." After a common factor analysis of the 17-item Grit scale with promax rotation (allowing the two factors to correlate), Duckworth and Quinn (2009) found a two-factor solution resulting in 12 items for the overall grit scale. Therefore, the Grit scale is composed of two factors: Perseverance of Effort and Consistency of Interests. Based on the positive

correlations between individual items and the total score, the overall 12-item grit scale has a high internal consistency which indicates that set of 12 items are highly related as one group to measure the grit factor($\alpha = .85$). For each of the Perseverance of Effort and Consistency of Interest subscales, they both also demonstrated high internal consistency of $\alpha = .78$ for the former and $\alpha = .84$ for the latter. Duckworth et al. (2007) used the grit scale to predict the educational attainment among adults, grade point average among Ivy League undergraduates, retention at West Point, and ranking in the National Spelling Bee. On average, grit explained an average of 4% of the variances in the these achievement outcomes.

3.2 Need for Cognition Scale (Short Form)

The short form of the Need for Cognition Scale (NFC) assesses individual differences in their tendencies to engage in and enjoy effortful cognitive endeavors (Cacioppo and Petty, 1982). The original NFC consists of 34 items. Cacioppo et al. (1984) constructed a more efficient NFC by retaining 18 items. 37% of the variance of NFC was accounted for by the 18-item shorter form whereas only 27% of variance was accounted for by the 34-item longer form. As a set of 18-items in the short form of the NFC, Cronbach's alpha is .90 which demonstrates a high internal consistency, or how closely the set of items are related as one group. For each of the 18 items, there were 5 response options: 1 (extremely uncharacteristic), 2 (somewhat uncharacteristic), 3 (uncertain), 4 (somewhat characteristic), and 5 (extremely characteristic). 9 items were reverse scored. Sample items are "I would prefer complex to simple problems" and "It's enough for me that something gets the job done; I don't care how or why it works." NFC was one of thirteen scales used in the 2006-2007 Wabash National Study of Liberal Arts Education to measure student learning outcomes both inside and outside of classrooms in 17 institutions in the United States. After a slight drop from the beginning of post-secondary education and students' first years, the average NFC scores increased over the span of 4 years. Also, Tuten and Bosnjak (2001) examined the relationship between individuals' need for cognition and web usage for learning and educational purposes. From a sample of 400 students at three colleges in the Southeast United States, researchers found a positive and significant correlation between individuals' NFC and web usage for learning and education.

3.3 Self-Control Scale (Short Form)

The self-control scale measures the ability to regulate one's self by exerting self-control when it is necessary and restraining self-control when it is appropriate for optimal performance (Tangney et al., 2004). The self-control scale relates to control over thought, emotional control, impulse control, performance regulation, and habit breaking. Respondents are asked to indicate how each statement typically reflects them. Items have a 5-point likert scale ranging from 1 (Not at all like me) to 5 (Very much like me). 9 out of 13 items are reverse scored. Sample items include "I am good at resisting temptation" and "I often act without thinking through all the alternatives." Self-control scale reliability estimates of using both internal consistency and test-retest method demonstrated an alpha of .89. The 36 items all correlated highly to measure self-control. In addition, test-retest reliability of .89 was established by administering the self-control scale twice to 233 participants within a 3 week period. From the original self-control scale consisting of 36 items, they constructed a short form of the self control-scale.

Unlike the Grit scale which examines one's capacity to maintain both perseverance of effort and consistency of interest to long-term goals, the self-control scale assesses an individual's ability to manage and adapt oneself both internally and externally as the situation arises. By "[overriding] or [changing] one's inner responses" and exerting or restraining behavioral responses, an individual exercises self-control (Tangney et al., 2004). Beyond the scope of education, Finkenauer et al. (2005) used the self-control scale to investigate the relationship between parental efforts and adolescent adjustment in predicting emotional and behavioral problems into adulthood. This study found that low self-control scores was a risk factor for both behavioral and emotional problems.

4 Data

The data for this study comes from three sections of principles of macroeconomics taught at Penn State in the Fall of 2012 by the first author. Learning is assessed by the score on the comprehensive final as well as the macro TUCE (Walstad et al., 2007) which was administered to the students as a bonus with the final exam. Thus, only those students

who took the final are included in the analysis[a] resulting in a total sample size of 903 students. Other data includes the percent of clicker questions that students responded to during class. There was a clicker question almost every day of class so this is a reasonable measure of attendance.[b] Administrative data from university authorities allowed us to include critical indicators such as SAT scores, credits earned, and college GPAs (which necessarily excludes students who started their college careers that semester).

Second, a survey was conducted the first day of class (refer to a copy at the end of this paper). In this survey, question 19 asks students about their their mindset.[c] Also, in one section of the course, the macro TUCE was administered the first day. Finally, at various points during the semester, the following instruments were administered in all three sections: Grit, NFC, and Self-Control. By the end of the semester, there was some grumbling from students about the data collection and it was mentioned in student evaluations.

One significant challenge was the SAT data—the administrative dataset did not include scores for a significant number of students. Thus, if available, self-reported data was used as a substitute. [d] Even then, SAT data was missing for 109 students.

Another challenge was that no attempt was made to gather initial survey data from students who missed the first day of class. The first author did not then know that many students do significant shopping for classes during the first two weeks of the semester and there was considerable enrollment churn.[e] In addition, there was no attempt to administer the Grit, NFC, or Self-Control instruments to students who did not fill them out in class. Thus, as a result, there is a considerable number of "holes" in the completed dataset. Table 1 describes the number of observations for key variables. Most unfortunately, the specific missing values vary by student.

Table 1:

Variable	Number of Observations
Clicker	903
Final Exam	903
Post TUCE	901
Math SAT	784
Self-Control	727
NFC	729
Grit	729
Mindset	749
GPA	471
Pre TUCE	259

5 Analysis of the Data

This dataset has several limitations given the number of missing responses by many students on the various surveys. As more independent variables are added to a regression, more and more observations are necessarily excluded. Thus, this analysis uses a limited numbers of independent variables. This includes a core set of variables used in each equation and then examining non-cognitive measures one at a time (thus precluding the study of interactions). Tatum and Childers (2013) has an extensive review of significant variables in academic production functions for students in college economics classes. Their findings are used here for a core set of independent variables. They report that GPA, SAT scores, attendance, and math ability are typically found to be statistically significant. They report that more recent studies have found that gender is no longer significant.

[a] Thus, there is no correction for selection effects.

[b] While it varied slightly by section, approximately 140 clicker questions were asked during the semester. Clicker data may be more meaningful than standard attendance data as it potentially measures participation as opposed to physical attendance.

[c] Other responses will be used in future studies.

[d] Notably, since SAT data was available from both sources, they could be compared. Often, the values were not the same. The reason is unclear.

[e] It was his first semester teaching at Penn State.

However, GPA is difficult to use here as many students had no prior college experience that fall (Table 1 has the data). However, Math SAT scores are available for a very large majority of the students and clicker attendance data is available for all students. Thus, the following regressions were estimated:

$$learn = \beta_0 + \beta_1 math\_SAT + \beta_2 clicker + \beta_3 non - cognitive\ skill \tag{1}$$

where *learn* is the percentage score on the comprehensive final exam or the Post TUCE score (the number correct). The $non - cognitive\ skill$ variable is one of Self-Control, NFC, Grit, or Mindset.

Tables 2–5 show the results with the final exam score at the dependent variable and the Clicker and Math_SAT independent variables and one of Mindset, NFC, Grit, and Self-Control as the final $non - cognitive\ skill$ variable. In each regression Math_SAT and Clicker coefficients are highly significant and of the rest only NFC coefficient is statistically significant. Tables 6—9 have the same independent variables but the Post TUCE as the dependent variable. Again, the Math_SAT and Clicker coefficients are highly significant and the only non-cognitive skill variable that is significant is again NFC. While the NFC coefficient is statistically significant, the practical impact of the variable is small. The estimated value for this coefficient in Table 3 (the final exam score was the independent variable) was .091 while the largest reported NFC score was 84 and the minimum was 25, for a range of 59. Thus, at most, the NFC score leads to a variation of 5.31 in the final exam score.

As the TUCE was also given to one section at the start of the semester, it is possible to explore value added in the course (with the reminder that many observations are missing). Thus, the formulation is

$$post\_TUCE - pre\_TUCE = \beta_0 + \beta_1 math\_SAT + \beta_2 clicker + \beta_3 non - cognitive\ skill \tag{2}$$

The results are presented in Tables 10–13. Again, the coefficients on the Clicker and Math_SAT independent variables are significant, but instead of the NFC coefficient being significant, the Grit coefficient is. However, its sign is negative, which is inconsistent with expectations.

6 Discussion and Conclusion

Given the importance of non-cognitive skills in other domains, it seems surprising that they are largely statistically insignificant in this study. Although one non-cognitive skill, NFC, was found to be significant and of the expected sign, its practical significance is minor. Several possible reasons come to mind. Missing data may be a limitation of this study, as might an analysis of those who dropped the class. A more complete dataset with improvements in data collection processes may lead to different results. Another possibility is that this student population is quite a bit different from the typical subjects in non-cognitive skills studies—they are often younger students and sometimes from low SES backgrounds. Penn State students are fairly capable; the mean math SAT score of the students in the study was 624, which is at about the 80% percentile nationally (College Board, 2013).[f] Perhaps the relative importance of non-cognitive skills is lower with higher performing students.

More broadly, it seems that much of the performance variation of principles students is unexplained. A goal of this study was to gain more understanding of why some students perform well and others do not. Finally, one might have hoped that a classroom intervention, as in Yeager and Dweck (2012), might be possible. Unfortunately, "mindset" was not correlated with success in these classes.

[f] For a point of comparison, the pre TUCE mean was 10.6, which is at about the 68th percentile and the mean post TUCE score was 19.27, which is about the 83rd percentile nationally (Walstad et al., 2007) (both of these are for the "matched" sample).

Table 2:

	Dependent variable:
	final_exam
SAT_math	0.044***
	(0.004)
clicker	0.143***
	(0.018)
mindset	0.063
	(0.340)
Constant	35.199***
	(3.307)
Observations	692
R^2	0.206
Adjusted R^2	0.202
Residual Std. Error	8.916 (df = 688)
F Statistic	59.423*** (df = 3; 688)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 3:

	Dependent variable:
	final_exam
SAT_math	0.045***
	(0.004)
clicker	0.153***
	(0.019)
nfc	0.091**
	(0.035)
Constant	29.151***
	(3.404)
Observations	634
R^2	0.232
Adjusted R^2	0.228
Residual Std. Error	8.933 (df = 630)
F Statistic	63.455*** (df = 3; 630)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 4:

	Dependent variable:
	final_exam
SAT_math	0.046***
	(0.004)
clicker	0.117***
	(0.019)
grit	0.619
	(0.691)
Constant	34.562***
	(3.810)
Observations	631
R^2	0.207
Adjusted R^2	0.203
Residual Std. Error	8.681 (df = 627)
F Statistic	54.553*** (df = 3; 627)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 5:

	Dependent variable:
	final_exam
SAT_math	0.048***
	(0.004)
clicker	0.145***
	(0.019)
self_cont	0.031
	(0.046)
Constant	31.695***
	(3.583)
Observations	634
R^2	0.234
Adjusted R^2	0.230
Residual Std. Error	9.223 (df = 630)
F Statistic	63.981*** (df = 3; 630)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 6:

	Dependent variable:
	post_TUCE
SAT_math	0.020***
	(0.002)
clicker	0.042***
	(0.009)
mindset	0.073
	(0.165)
Constant	3.322**
	(1.622)
Observations	691
R^2	0.149
Adjusted R^2	0.145
Residual Std. Error	4.327 (df = 687)
F Statistic	39.988*** (df = 3; 687)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 7:

	Dependent variable:
	post_TUCE
SAT_math	0.020***
	(0.002)
clicker	0.052***
	(0.009)
nfc	0.050***
	(0.016)
Constant	−0.312
	(1.581)
Observations	634
R^2	0.205
Adjusted R^2	0.201
Residual Std. Error	4.148 (df = 630)
F Statistic	54.007*** (df = 3; 630)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 8:

	Dependent variable:
	post_TUCE
SAT_math	0.022***
	(0.002)
clicker	0.036***
	(0.010)
grit	0.289
	(0.340)
Constant	1.709
	(1.877)
Observations	630
R^2	0.176
Adjusted R^2	0.172
Residual Std. Error	4.262 (df = 626)
F Statistic	44.457*** (df = 3; 626)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 9:

	Dependent variable:
	post_TUCE
SAT_math	0.021***
	(0.002)
clicker	0.044***
	(0.009)
self_cont	0.011
	(0.021)
Constant	2.358
	(1.654)
Observations	632
R^2	0.184
Adjusted R^2	0.180
Residual Std. Error	4.175 (df = 628)
F Statistic	47.247*** (df = 3; 628)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 10:

	Dependent variable:
	post_TUCE - pre_TUCE
SAT_math	0.011^{***}
	(0.004)
clicker	0.043^{**}
	(0.017)
mindset	-0.123
	(0.274)
Constant	-0.651
	(3.038)
Observations	225
R^2	0.064
Adjusted R^2	0.051
Residual Std. Error	4.166 (df = 221)
F Statistic	5.042^{***} (df = 3; 221)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 11:

	Dependent variable:
	post_TUCE - pre_TUCE
SAT_math	0.009^{**}
	(0.004)
clicker	0.049^{***}
	(0.017)
nfc	0.038
	(0.027)
Constant	-3.079
	(2.858)
Observations	189
R^2	0.090
Adjusted R^2	0.075
Residual Std. Error	3.729 (df = 185)
F Statistic	6.105^{***} (df = 3; 185)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 12:

	Dependent variable:
	post_TUCE - pre_TUCE
SAT_math	0.011^{***}
	(0.004)
clicker	0.061^{***}
	(0.020)
grit	-1.258^{**}
	(0.631)
Constant	1.487
	(3.780)
Observations	180
R^2	0.109
Adjusted R^2	0.094
Residual Std. Error	4.042 (df = 176)
F Statistic	7.200^{***} (df = 3; 176)
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 13:

	Dependent variable:
	post_TUCE - pre_TUCE
SAT_math	0.013^{***}
	(0.004)
clicker	0.044^{**}
	(0.020)
self_cont	0.004
	(0.040)
Constant	−2.721
	(3.497)
Observations	189
R^2	0.078
Adjusted R^2	0.063
Residual Std. Error	4.227 (df = 185)
F Statistic	5.224^{***} (df = 3; 185)
Note:	*p<0.1; **p<0.05; ***p<0.01

As part of the study I'm undertaking of student performance in this course, I would appreciate it if you would please answer the following questions.

1. Your name (please print): _____
2. Your PSU computer id (typically 3 letters followed by digits; mine is wlg13): _____
3. Your gender: M F
4. Number of AP credits you have brought to PSU: _____
5. Number of hours of college instruction (non-AP) that you have completed to date: _____
6. Have you passed a previous economics course in college: yes no
7. What other colleges did you apply to:_____
   _____
8. Are you a member of a fraternity or sorority or are you rushing this semester: yes no
9. Your rank in high school: ___ and the number of students in your graduating class: ___
10. Your combined SAT score: ___ and your math SAT score: ____.
11. Did your mother attend college: yes no
    Did she complete a bachelor's degree or higher: yes no
12. Did your father attend college: yes no
    Did he complete a bachelor's degree or higher: yes no
13. About how many hours a week do you spend on social networking sites: ____
14. About how many minutes a day, on average, do you spend viewing, reading, or listening to non-entertainment local, regional, national, and/or international news: ____
15. For how long do you think the contents of this course will be useful to you:
    A) until the end of this semester
    B) until the end of my college career
    C) until the end of my life
16. Speaking for yourself, how would you define success in this course:
    an A
    a B
    a C
    learning the material regardless of the grade
17. What do you think that your chance of success (as you defined above) is in this course? Please use a 100 point percentage scale. Thus, 100% would be that you're sure you'll succeed and 0% you're positive that you won't succeed. ____

Please turn the page over for 3 more questions.

18. Consider your most common study environment – which of the following apply (more than one answer is fine):
    A) you are on a computer or tablet and you're multitasking
    B) music is playing
    C) you're texting on a phone
    D) it is pretty quiet
19. There are basically two views of intelligence. One view is called “fixed mindset,” which says that throughout life you pretty much have the intelligence you were born with. The other view is called “flexible mindset,” and it says that you can add to your intelligence as you learn. Which best describes your views?
    A) fixed mindset
    B) more fixed then flexible mindset
    C) about equal parts fixed and flexible mindset
    D) more flexible than fixed mindset
    E) flexible mindset
20. College itself and the college experience in general benefit graduates in many ways. About what percent of those benefits come from courses that you take and the skills you gain from them: ____ This is opposed to other experiences, like extra-curricular activities, what you do with friends, and jobs you might have while in college.

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