

The statistical and anova analysis of the growth mindset concept

[Psychology](#), [Child Development](#)



Statistical Analysis: Final Paper

Variables

Dependent variable The dependent variable is z scores of growth mindset.

Independent variable The independent variable is time in relation to a year long intervention to improve growth mindset.

- Time 1: Control before mindset intervention.
- Time 2: Six months into mindset intervention
- Time 3: Directly after mindset intervention is completed.
- Time 4: One year after mindset intervention is completed.

Introduction

Growth mindset is a useful concept that measures whether a person believes that intelligence is fixed or if it can be grown (Dweck, 2000). Studies indicate that students with a higher growth mindset tend to do better in math and science than those with a more fixed view of intelligence (Blackwell, Trzesniewski, & Dweck, 2007). Interventions to change mindset have shown some promise (Cutts, Cutts, Draper, O'Donnell, & Saffrey, 2010), but the evidence is not conclusive.

This study aims to study the effectiveness of a growth mindset intervention program. A cost effective method of improving math and science scores would be useful in any educational context. If we can raise student's growth mindset this could be a fairly simple way to do this. Our study would provide proof of concept for a larger program hopefully providing the impetus for a public policy initiative at the city level.

As such we hope and hypothesize that there will be a significant increase in growth mindset among the 400 students that participated in the intervention once the intervention is fully completed and that this gain would not significantly decrease one year after the intervention is completed.

Method

The data was collected from three high schools in the Greater Pittsburgh Area. All students in the three schools were sent home with a permission form to opt out of the study. Out of the 3489 students four percent returned permission forms denying participation in the study for a total N= 3349. Out of 3349 students that consented to participate in the study 400 students were selected at random to participate in the intervention. Before the intervention began each student filled out a forty question survey. Five of the questions formed a scale measuring growth mindset. The questions were on a five-point Likert scale ordered left to right from strongly disagree to strongly agree. The five questions ($\alpha = .89$) were then compiled into a scale by representing a higher growth mindset with a five and a low growth mindset with a one for each question then averaging the scores. Finally the scale was normed. The growth mindset normed scores collected were recorded, but not shared with the researchers conducting the intervention to prevent any differential treatment based on the scores.

The intervention consisted of a one hour per week workshop where students learned about how the brain adapted to information and the modern understanding of intelligence as well as general study strategies. At the six month mark they were once again given the 40 question survey to complete

and the growth mindset normed scores were once again recorded. After the year mark the intervention was complete and the same 40 question survey was used to assess growth mindset. Finally a year after the end of the intervention was completed we followed up with all 400 students and had them once again take the survey. Descriptive statistics for each time point's normed growth mindset scores are shown in Table 1.

Analysis & Results

Justification

The ANOVA statistical technique in general makes several key assumptions about the data analyzed. However, our data was collected from the same subjects tested at different time points and as such are clearly not independent. Therefore we cannot use a regular one-way ANOVA and need to instead use a repeated measures one-way ANOVA which instead assumes that there is sphericity rather than independence. This means that the assumptions for the repeated measures ANOVA are: sphericity, identical variances between and within groups, and random sampling. Sphericity is where no two categories are more correlated than any other two categories. This assumption appears not to be met for the data collected. Mauchly's test for non-sphericity, $\chi^2(5) = 68.07, p = .00$, indicates that the assumption of sphericity has been violated most likely due to the fact that we would expect the times that are closer to be more highly correlated than times that are further apart. To compensate for this we will use the Green-house Geisser correction to counteract the violation.

The assumption of normality is that the dependent variable in question, in this case the growth mindset z scores follows a normal distribution. This assumption had to be tested because there wasn't a clear theoretical reason that growth mindset scores would be normally distributed. Therefore using QQ Plots normality was tested and it was determined that the z-scores of growth mindset followed a generally normal distribution for all four time points.

Similarly the assumptions that there was identical variances between and within groups needed to be tested as it is always possible that the data set has irregularities. For the repeated measures ANOVA the test for sphericity if met would indicate that the growth mindset scores at different time points have equal variances. As discussed above our data violates this assumption and it is compensated for by applying the Green-house Geisser correction. Additionally, there is an equal sample size for each group and the sample size is not particularly small and the groups should have equal variances as the same subjects are in each group. Unfortunately, there is no way to directly test whether the within group variance assumption is met, but since the F ratio is greater than one we assume that this is the case.

The random sampling assumption is that the data set was obtained by taking a completely random sample of the population of interest in order to obtain a representative sample. This assumption was not fulfilled as the schools that data was collected from were not randomly selected. However we did take a random sample of the 3349 students that indicated that they were willing to participate in the study. Therefore the generalizability of the study is limited,

but should reflect the three high schools well. Since the main purpose of this study is to provide the basis for a city-wide initiative the minor violation of the random sampling assumption should have a limited effect for our purposes.

ANOVA Results

The repeated measure ANOVA analysis with Green-house Geisser correction showed that growth mindset differed significantly at the different time points, $F(2.06, 203.47) = 2351.8, p < .001$. Using a paired t-test the planned contrast between the pre-intervention time and the immediate post-intervention time, $t(99) = -66.08, p < .001$, showed that there was a large 5.87 significant increase between the pre-intervention time and the immediate post-intervention time. There was not a significant difference between the planned contrast between the immediate post-intervention time point and the time point taken a year after the intervention, $t(99) = -.607, p = .545$.

Discussion

As expected the analysis revealed that the four different time points were statistically significantly different in their growth mindset scores. This demonstrates that the intervention most likely had some effect on growth mindset. Our planned contrasts indicated that the intervention had a fairly large positive effect on growth mindset and that this effect persisted even after a year.

These findings make a strong case for our intervention. Not only was there a large increase in growth mindset, but this increase persisted after the intervention was over for at least a year. While a developmental effect

cannot be ruled out because we did not test a control group there is no theoretical reason to believe that growth mindset would change so drastically during high school naturally. We also failed to determine if the change in growth mindset resulted in a commensurate increase in academic achievement. Prior research has not established directionality between growth mindset and achievement so it could be that we only changed mindset but did not have the intended effect of increasing academic achievement. Regardless of these limitations our study did show that growth mindset is not a fixed attribute and can be changed with a non-intensive intervention. Not only does this provide a useful proof of concept for a program at the high school level it also indicates that growth mindset could be changed at earlier developmental stages possibly with a greater effect.

In future research it might be useful to isolate what parts of our intervention were most effective in improving growth mindset as well as determine the exact mechanisms through which the change occurred. This would allow the construction of interventions that are tailored to specific schools and situations. It would also be interesting to investigate the effect of the intervention on specific races and socio-economic classes.