Results

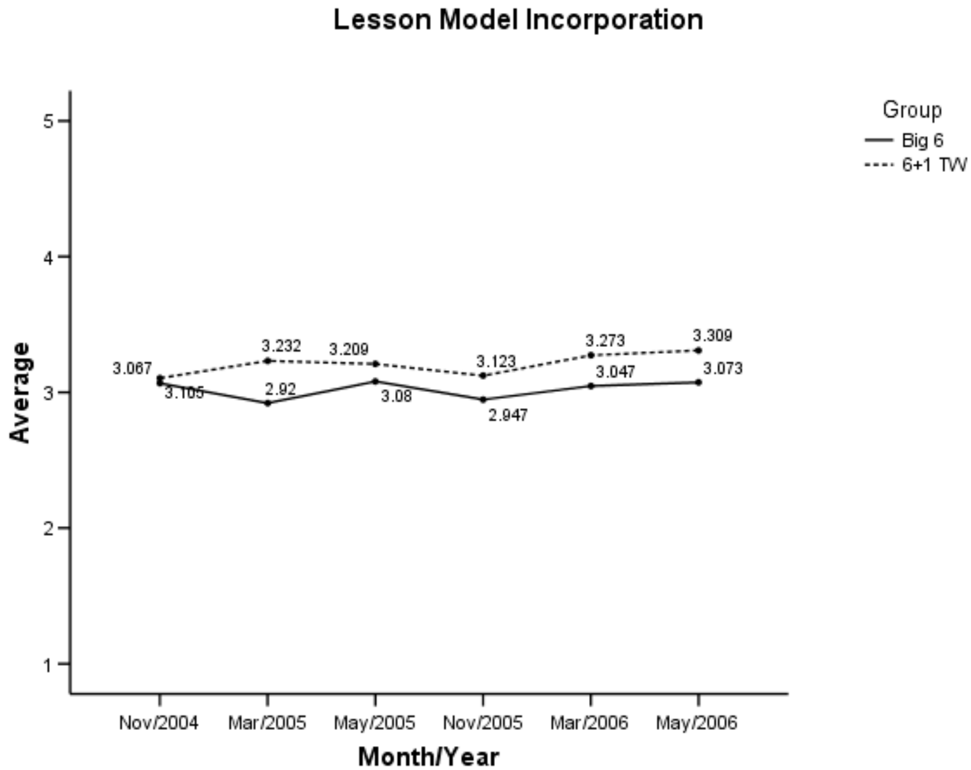
This section presents a summary of the results of the teacher questionnaires, student questionnaire, classroom observations that examined technology use and model fidelity, and measures of achievement that include the student work samples and standardized achievement tests. The findings are amalgamated to address the research questions posed for this study. Note that all significant results are significant at an $\alpha = 0.05$.

Research Question	Data Sources					
	Long Teacher Questionnaire	Short Teacher Questionnaire	Student Questionnaire	Student Work Samples	Classroom Observations	Achievement Test Scores
1. What is the extent that either treatment model, the *Big6™* or *6+1 Trait Writing® method*, is incorporated within teaching practices and classroom instruction?		✓	✓		✓	

Short teacher questionnaire

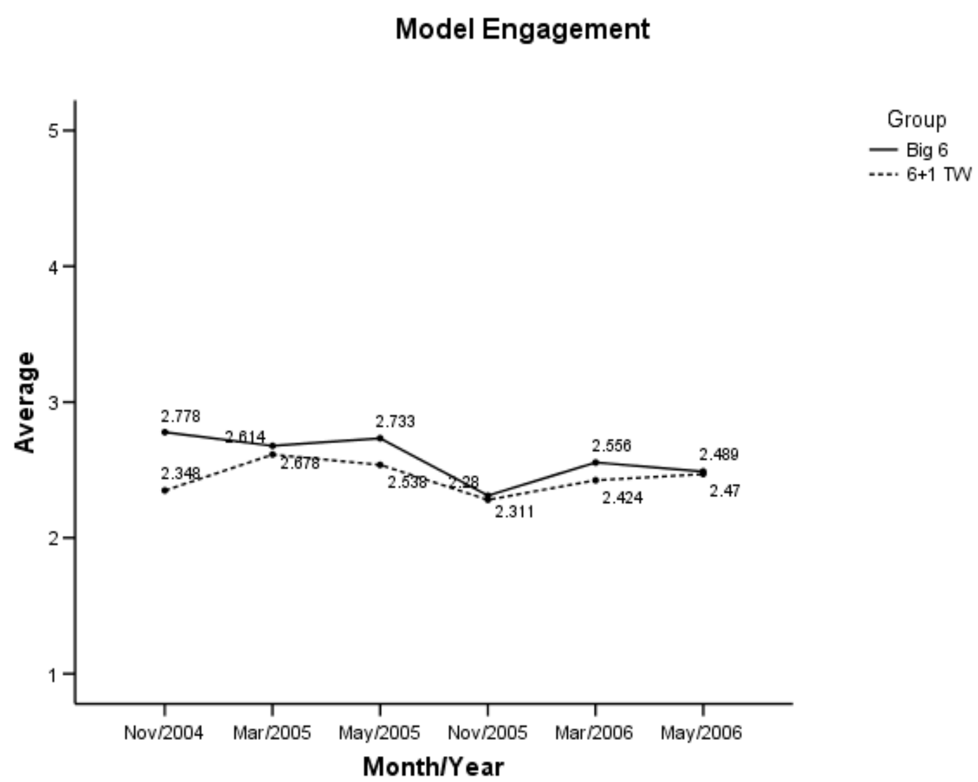
Lesson model incorporation. The split-plot ANOVA for lesson model incorporation revealed no statistically significant results for both the within- and between-subjects main effects. Thus, there was no significant changes from 2004 to 2006 for either of the treatment groups, nor were there any significant differences between the treatment groups (see Figure 1; 1=never, 2=rarely, 3=1-3 times every month, 4=1-3 times every week, 5=almost every day). On average, teachers from both *Big6™ and 6+1 Trait Writing®* groups reportedly incorporated the model approximately 1-3 times every month.

Figure 1



Model Engagement. The split-plot ANOVA for model engagement evaluated by within-subjects analysis revealed a statistically significant main effect across time, $F_{(5, 31)} = 3.65$, $p = 0.010$, $\eta_p^2 = 0.370$. In general, the results of teachers' report indicated a slight decline in model engagement with no significant differences between the treatment groups (Figure 2; 1=almost none of the class time, 2=less than half of the class time, 3=roughly half of the class time, 4=most of the class time, 5=almost all of the class time). Examining the pairwise comparisons revealed that the *6+1 Trait Writing*® group significantly dropped in their model engagement, but was only a mean reduction of about .3 points from 2004 to 2006. Qualitatively speaking, the *6+1 Trait Writing*® remained fairly consistent in spending approximately half the class time engaging students in activities related to the *6+1 Trait Writing*® model. The *Big6™* teachers remained relatively consistent as well in spending about half the class time engaging students in activities related to the *Big6™* model.

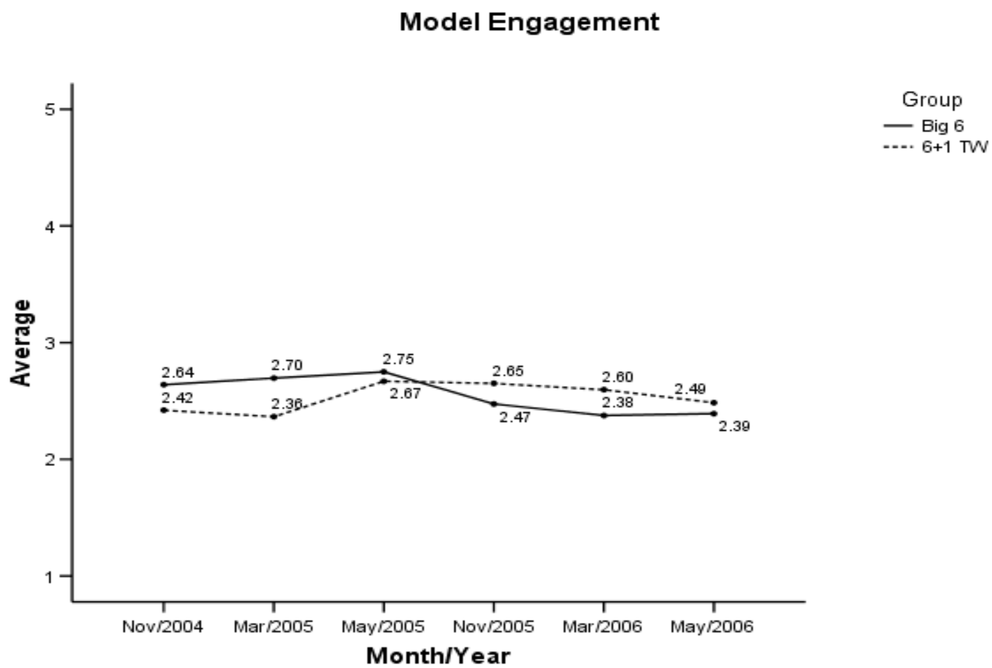
Figure 2



Student Questionnaire

Model engagement. As indicated by the means displayed in Figure 3, students in general, reported that they rarely learned about their experimental model in class (1=never, 2=rarely, 3=1-3 times every month, 4=1-3 times every week, 5=almost every day). The main and interaction effects of time, model and time by model are all statistically significant, $F_{(5,767)} = 11.07$, $p < 0.001$, $\eta_p^{\,2} = 0.067$; $F_{(5,767)} = 13.05$, $p < 0.001$, $\eta_p^{\,2} = 0.078$; again are small indicating a lack of practical significance (see Cohen, 1988). The mean differences for each group displayed across time and across groups in the pairwise comparison also showed small mean effect sizes. The pairwise comparisons between the six time points within each of the three groups showed the mean differences to be significant over many of the time points. Again, from a practical standpoint the mean differences were not meaningfully significant because the effect sizes were small, with virtually no differences between the groups at the endpoint in May, 2006.

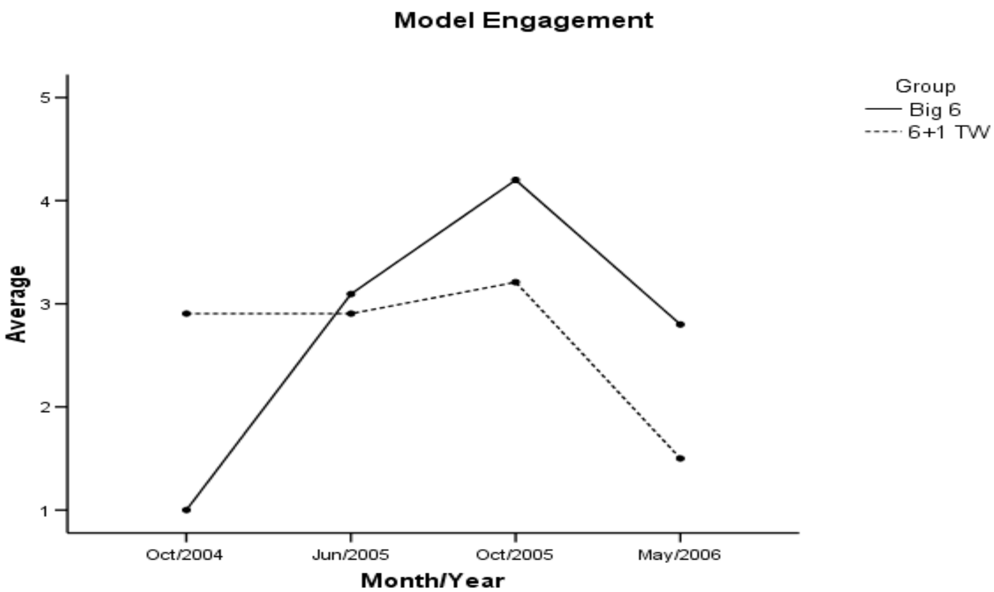
Figure 3



Classroom Observations

The split-plot ANOVA considering modeling engagement indicated that there were no significant differences between the groups nor was there any significant growth over time. In general, there were wide fluctuations in model use between groups and in progression over time (Figure 4). Though, the model engagement for June, 2006 yielded results similar to teachers' reports on the short questionnaire and students' reports on the student questionnaire. That is, teachers engaged students in the 6+1 Trait Writing® or Big6™ models a small to moderate amount of time. The observation results need to be interpreted cautiously because of the small sample size and lack of statistical power.

Figure 4



Summary of Model Engagement and Fidelity

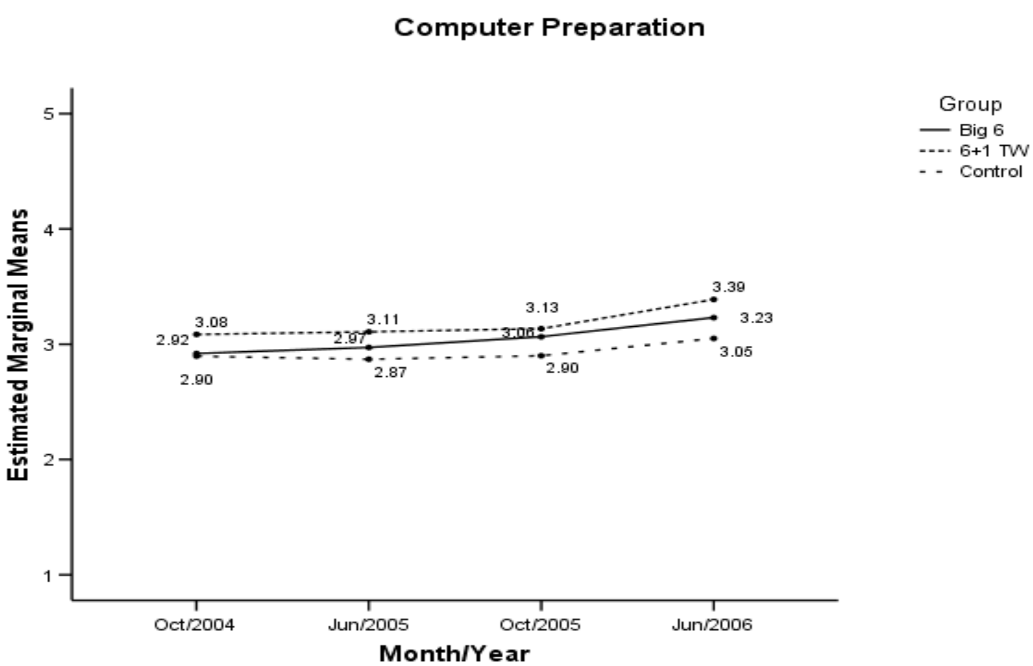
Overall, teachers reported teaching their respective treatment model to their classes somewhat more than what students reported learning about the model. Observational results corroborate with teacher and student reports. However, despite similar results across data sources, the models were not taught on a regular basis, which raise questions as to the influence of students' application of the models as measured by their school achievement.

Research Question	Data Sources					
	Long Teacher Questionnaire	Short Teacher Questionnaire	Student Questionnaire	Student Work Samples	Classroom Observations	Achievement Test Scores
2a. What is the extent that technology is incorporated within teachers' instructional practices? 2b. What is the extent that technology is incorporated with the instruction of either treatment model, *Big6*™ or *6+1 Trait Writing*® *method?*	✓	✓	✓	✓	✓	

Long teacher questionnaire

Computer preparation. The split-plot ANOVA results for integration of computer use into the classroom curriculum revealed statistically significant within-subjects main effects, $F_{(3, 54)} = 8.9$, $p<.001$, $\eta_p^{\ 2} = 0.33$; thus there was significant growth in how prepared the teachers felt implementing computer use within the classroom. As indicated in Figure 5 (1=none, 2=low, 3=medium, 4=high, 5=don't know) both the Big6™ and 6+1 Trait Writing® groups showed significant growth over from 2004 to 2006, with the *6+1 Trait Writing®* exhibiting the largest growth in computer preparation. The pairwise comparisons revealed that the *6+1 Trait Writing®* had significantly higher computer preparation in June, 2006 than the control group (mean difference=.34).

Figure 5

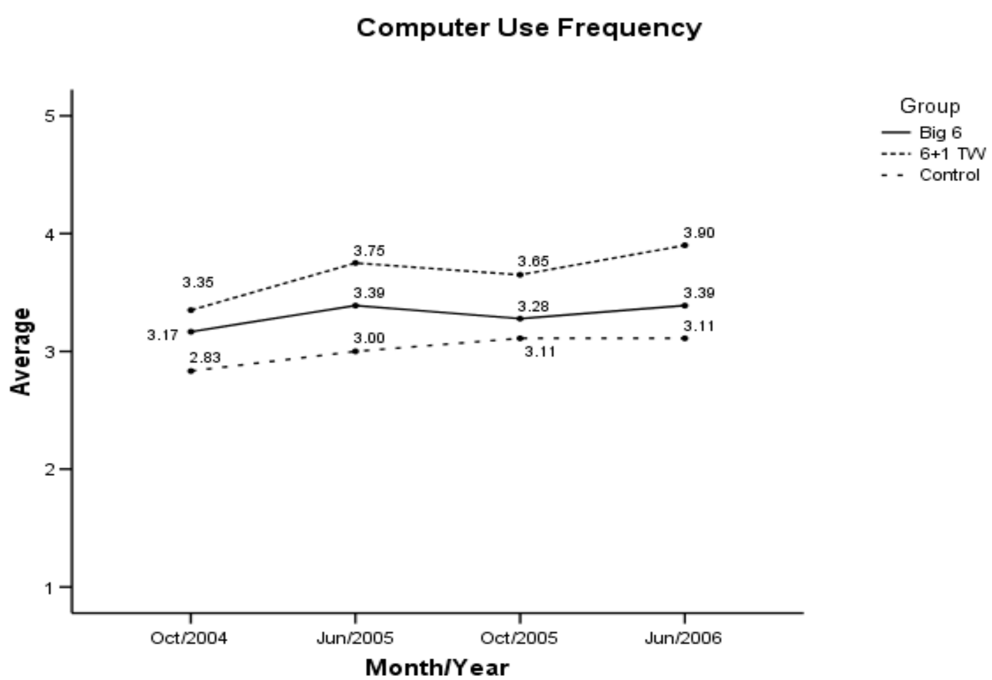


REPORTED FREQUENCY OF COMPUTER USE

Long teacher questionnaire

The split-plot ANOVA results of the within-subjects analysis of teacher reported computer use revealed a statistically significant main effect across time, $F_{(3, 51)} = 6.14$, $p = 0.001$, $\eta_p^{\ 2} = 0.27$. The 6+1 Trait Writing® teachers consistently reported more computer use than the Big6™ or control group teachers. Figure 6 reports the mean average scores for classroom computer use for each of the models across time [1=never, 2=rarely, 3=monthly (at least every few weeks), 4=weekly (at least once/week), 5=almost daily (3 or more days/week)]. The level of reported computer use increased significantly for each of the treatment groups over the two-year study period (2004 to 2006). Examination of the pairwise comparisons revealed that the 6+1 Trait Writing® teachers were the only group that showed a significant increase in computer use (mean difference=0.55). Neither the Big6™ nor the control teachers showed significant growth in computer use. By June of 2006, the 6+1 Trait Writing® group indicated they used computers at least once a week, which was an increase from originally reported use of only every few weeks. Both the Big6™ and the control groups remained relatively consistent in their frequency of computer use (only every few weeks). Differences in the frequency of computer use in the teacher's long questionnaire also revealed significant results for between-subjects effects, $F_{(2, 53)} = 7.08$, $p = 0.02$, $\eta_p^2 = 0.21$. Examination of the pairwise comparisons revealed that at each of the four time points, the 6+1 Trait Writing® Traits reported significantly more computer use than both the Big6™ and control groups, with the largest difference occurring in June of 2006. This was a generalized increase in their computer usage from 2004 to 2006.

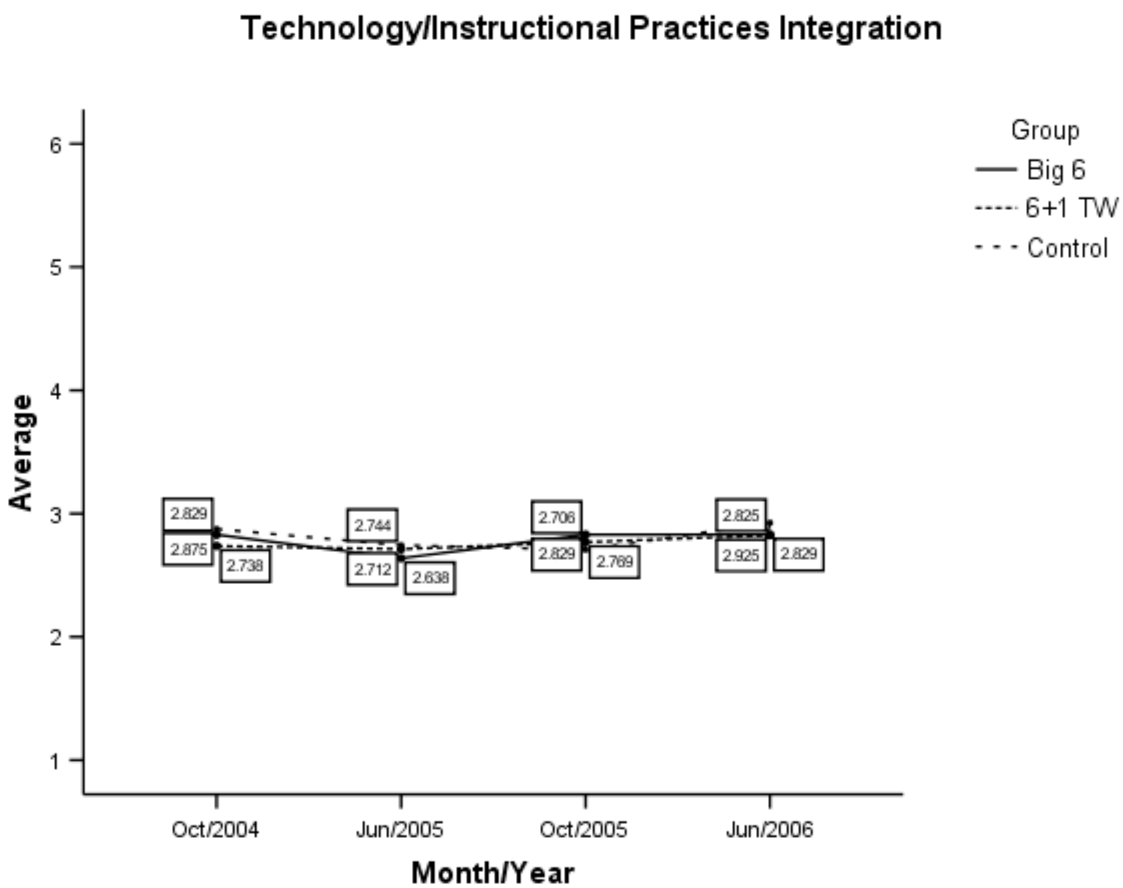
Figure 6



Long teacher questionnaire

The split-plot ANOVA considering technology/instructional practices integration indicated that there were no significant differences between the groups nor was there any significant growth over time. In general, the Big6™, 6+1 Trait Writing® and the control teachers showed no differences in their report of technology/instructional practices integration in the classroom (Figure 7). On average, all three groups of teachers slightly agreed with statements (1=strongly disagree, 2=moderately disagree, 3=slightly disagree, 4=slightly agree, 5=moderately agree, 6=strongly agree) pertaining to technology/instructional practices integration in the classroom.

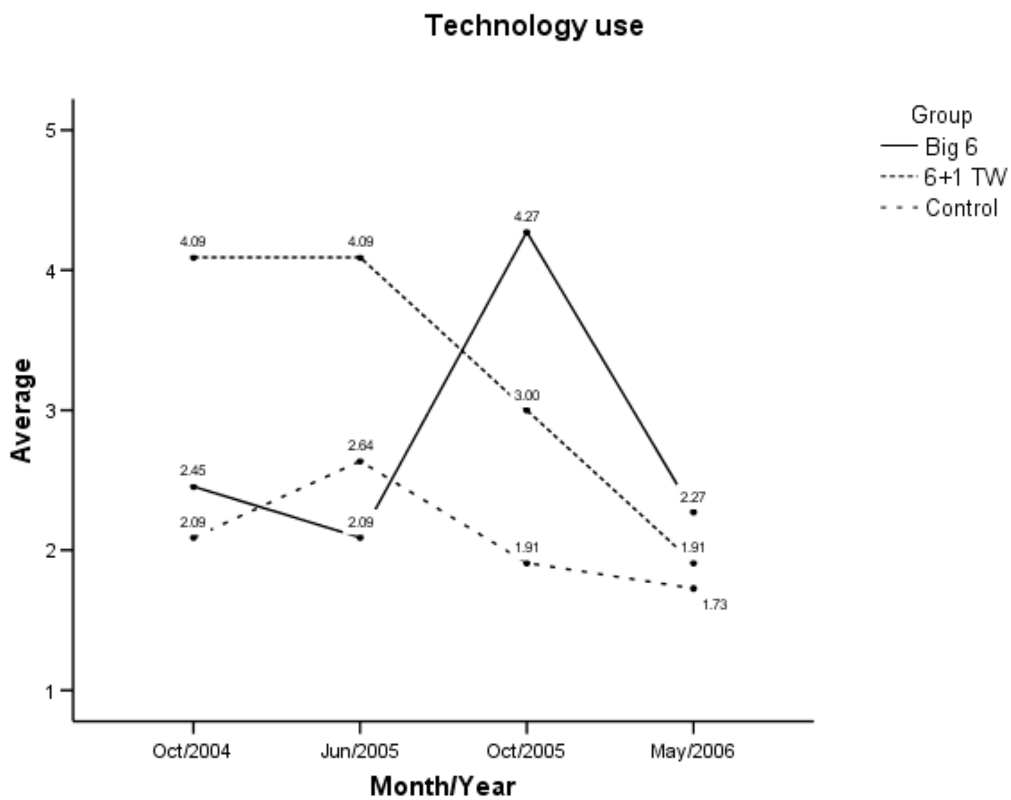
Figure 7



Classroom Observations

Technology use. The split-plot ANOVA considering technology use indicated that there were no significant differences between the groups nor was there any significant growth over time. Again, more power is needed to detect what seem to be rather large effect sizes. In general, use of technology varied greatly across the two year study. In summary, the Big6™ group used computers and technology more than 50% of the time during the first two semesters yet this level of use sharply decreased over the following two semesters. Figure 8 illustrates the inconsistency of technology use by both groups over the course of the study. Although, there is a lack in significance and these results should be interpreted cautiously.

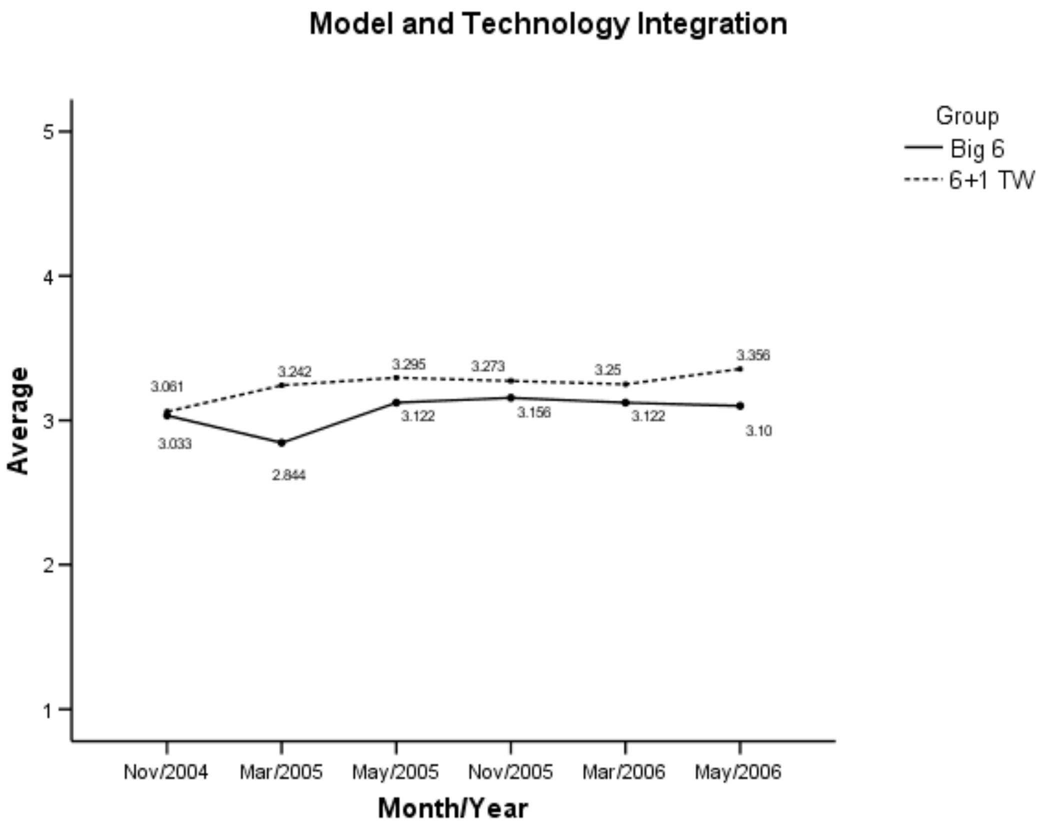
Figure 8



Short teacher questionnaire

The split-plot ANOVA considering model and technology integration indicated that there were no significant differences between the groups nor was there any significant growth over time. In general, the Big6™ and 6+1 Trait Writing® teachers showed no differences in their report of model technology integration in the classroom (Figure 9). On average, the two teacher treatment groups integrated the model and technology in the classroom 1-3 times every month (1=never, 2=rarely, 3=1-3 times every month, 4=1-3 times every week, 5=almost every day).

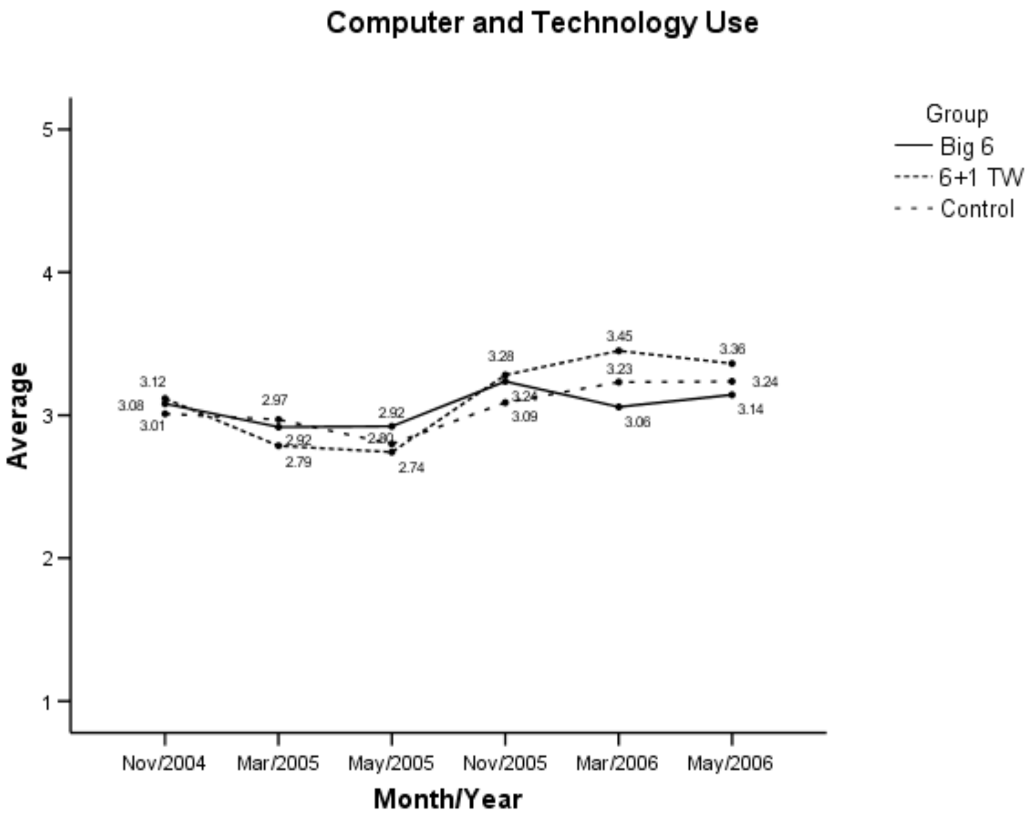
Figure 9



Student questionnaire

The split-plot ANOVA assessing students' reported computer and technology use indicated the within-subjects main effect was significant, $F_{(5,1263)} = 37.0178$, $p < 0.001$, $\eta_p^{\ 2} = 0.128$, as was the between-subjects main effect, $F_{(2,1267)} = 6.402$, $p = 0.002$, $\eta_p^{\ 2} = 0.010$. Again the effect sizes are small indicating a lack of practical significance. The respective means are displayed in Figure 10 (1=never, 2=rarely, 3=sometimes, 4=often, 5=very often). As before, the 6+1 Trait Writing® group used technology and computers more frequently than the Big6™ and control students with significant differences appearing in March and May of 2006. Both the *6+1 Trait Writing®* and the *Big6™* groups showed significant growth in computer and technology use from 2004 to 2006, while the control group did not exhibit significant growth.

Figure 10



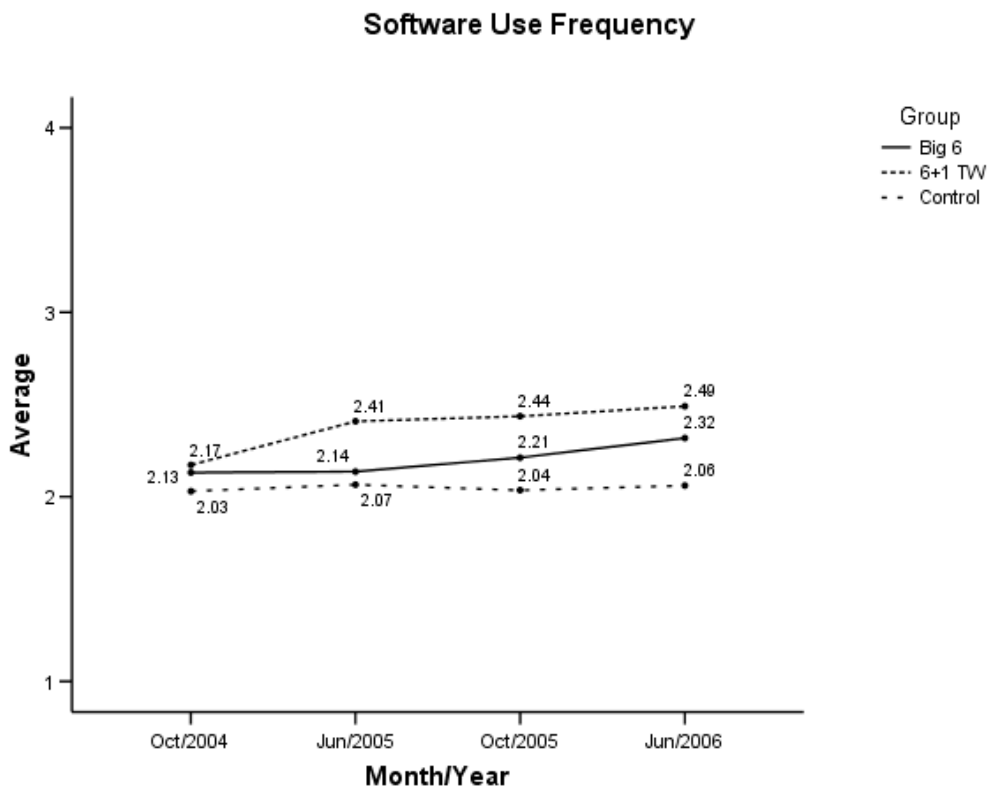
REPORTED SOFTWARE USE

Long Teacher Questionnaire

The split-plot ANOVA of the within-subjects analysis for teacher reported software use revealed a statistically significant main effect across time, $F_{(3, 51)} = 5.88$, $p = 0.002$, $\eta_p^2 = 0.25$. As illustrated in Figure 11 (1=none, 2=low, 3=medium, 4=high, 5=don't know), both the 6+1 Trait Writing® teachers (mean difference=0.32) and the Big6™ teachers (mean difference=0.19) showed a slight significant increase in their software use. The control teachers' did not exhibit a statistically significant increase.

Tests of between-subjects effects for computer use revealed significant results, $F_{(2, 53)} = 5.23$, $p = 0.008$, $\eta_p^2 = 0.16$. The 6+1 Trait Writing® reported more software use than the Big6™ or control groups at each time point from 2004 to 2006.

Figure 11



EVIDENCE OF TECHNOLOGY

Student work samples

The between-subjects ANOVA for group membership interaction revealed statistically significant results, $F_{(2)} = 22.81$, $p < 0.001$, $\eta_p^2 = 0.045$; note, however, the small effect size. Between subjects effect sizes for group membership by date also revealed statistically significant results, $F_{(9)} = 7.198$, $p < 0.001$, $\eta_p^2 = 0.063$; and the interaction of group by date for technology, $F_{(18)} = 2.980$, $p < 0.001$, $\eta_p^2 = 0.053$; note that the work samples were evaluated as a between subjects design and changes considered over time should be interpreted with care. The between-group analyses were performed to consider linear growth because the same students were not considered from year-to-year. Despite this limitation there is reason to believe that there are important findings for the use of technology in Wisconsin's middle schools.

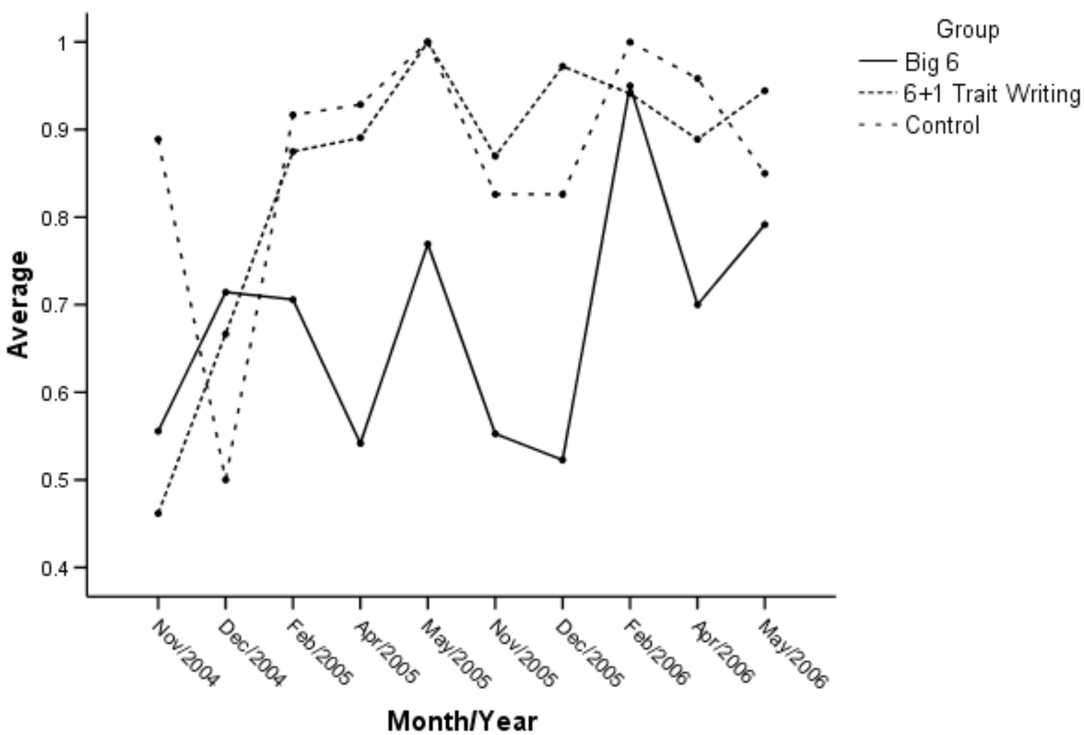
Further, the 6+1 Trait Writing® group displayed an increased use of technology over the first year and sustained use over the second year. The Big6™ group, aside from the December 2004 time point, showed consistent use of technology throughout both years. The control group, as may be expected, had lower technology use scores than both the instructional groups and the use of technology varied throughout the two years (see Figure 12). Pairwise comparisons over time for the control group finds that from December of 2004 to May of 2006 there was a significant increase in the use of technology by an average mean difference of .236.

Pairwise comparisons of technology use in the Big6™ group from November 2004 to December 2004 found a significant decrease with the mean difference being .389 with a *p*-value of .002. Time point two when compared over the next nine time points found a statistically significant increase at each time point, however changes over the year when compared to other time points did not reach significance as often as with the 6+1 Trait Writing®.

Closer evaluation of the second year's work samples revealed more inconsistent use of technology across the three groups. The control group's use of technology began the year (M = .5) then peaked in February (M = .95) and returned to just above baseline (M = .69) by May. The Big6™ group showed a similar trend; however, the use of technology was higher at the beginning of the year (M = .89) than the control group, therefore ending higher (M = .88). The 6+1 Trait Writing® group used technology consistently and with high frequency over the entire year (M = .92).

Figure 12

Technology Use



Summary of Technology use

Teacher and student questionnaire results corroborate technology use on a biweekly basis. Overall, the 6+1 Trait Writing® group used technology slightly more than the other two groups consistently over time.

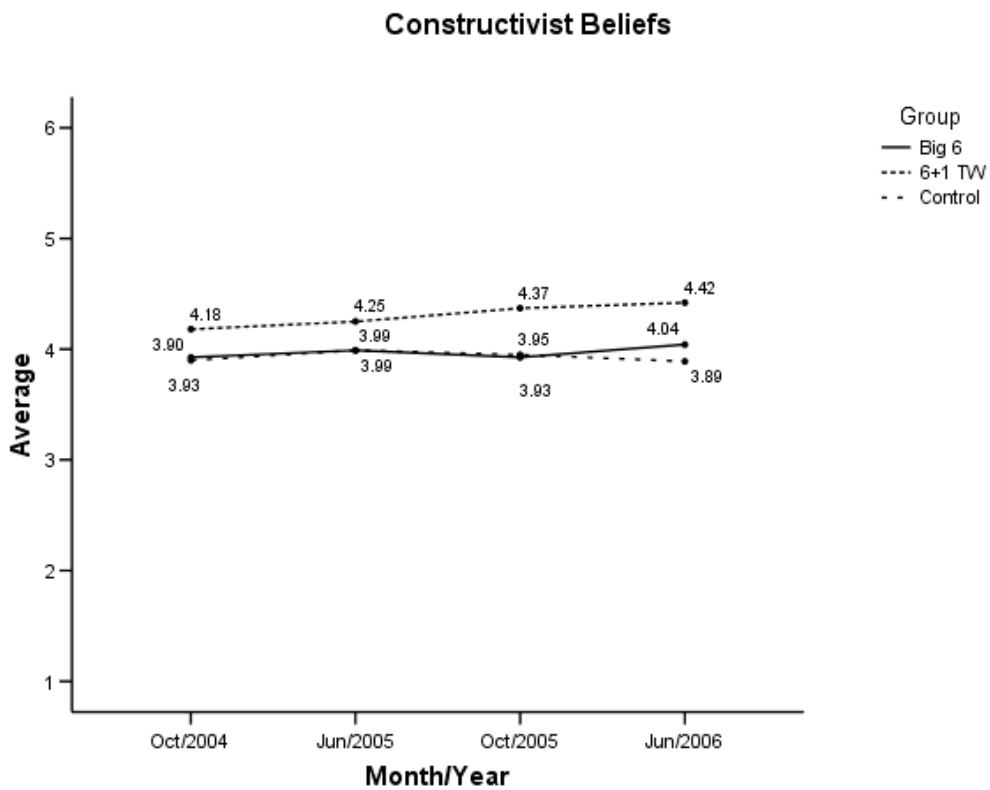
Research Question	Data Sources

	Long Teacher Questionnaire	Short Teach Questionnaire	Student Questionnaire	Student Work Samples	Classroom Observations	Achievement Test Scores
3. What is the relationship between the incorporation of the *Big6™* or *6+1 Trait Writing® method*, the integration of technology, and teachers' constructivist beliefs and practices in classroom instruction?	✓					

Long Teacher Questionnaire

A split-plot ANOVA of the teacher's long questionnaire revealed no significant main effect for within or between-subjects factors for constructive beliefs. For the three treatment groups, teachers' responses remained generally constant throughout the study as there were no significant gains in constructivist beliefs from October of 2004 to June of 2006. The mean average scores are presented in Figure 13 (1=strongly disagree, 2=moderately disagree, 3=slightly disagree, 4=slightly agree, 5=moderately agree, 6=strongly agree). Thus, on average, teachers slightly agreed with constructivist-based teaching practices. While not significant, the 6+1 Trait Writing® teachers tended to report higher constructivist expectations throughout the study than the Big6™ and the control group.

Figure 13



Summary of Constructivist Beliefs and Practices

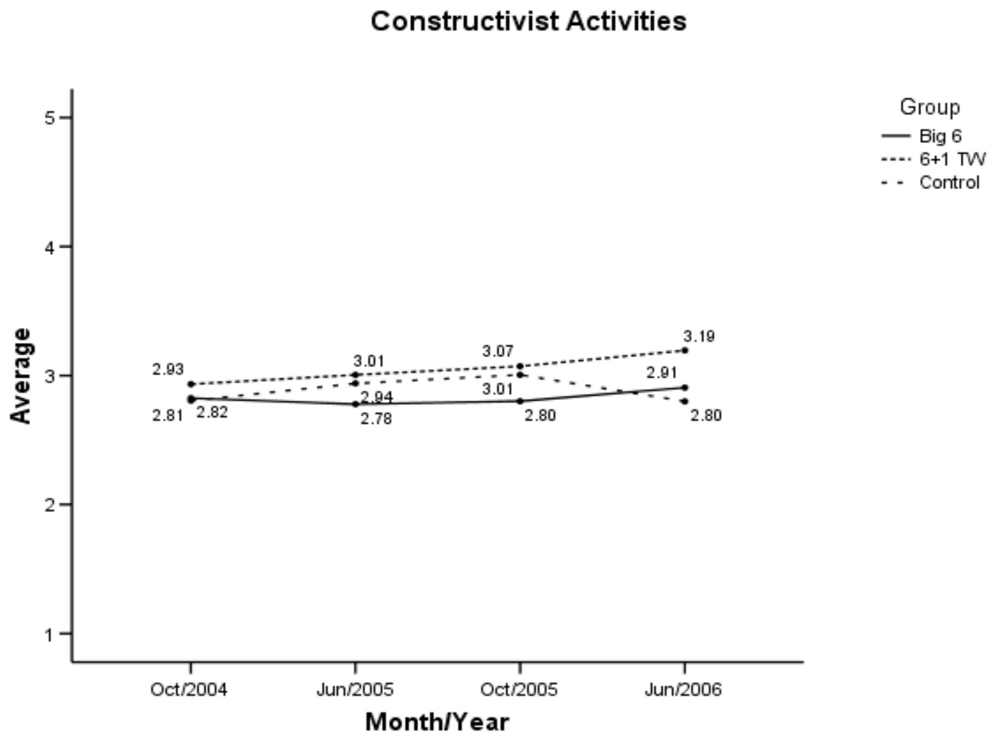
While teachers across groups slightly agreed with constructivist beliefs, there were no significant changes in teachers' reported beliefs from the beginning of 2004, to the end of May 2006. Additionally, teachers did not differ significantly in their constructivist beliefs regardless of the treatment group to which they were assigned.

Research Question	Data Sources					
	Long Teacher Questionnaire	Short Teach Questionnaire	Student Questionnaire	Student Work Samples	Classroom Observations	Achievement Test Scores
4. What is the relationship between the incorporation of the *Big6™* or *6+1 Trait Writing® method*, the integration of technology, and constructivist instructional activities in the classroom?	✓	✓	✓		✓	

Long teacher questionnaire

The split-plot ANOVA indicated that the group within-subjects main effect was significant, $F_{(3, 54)} = 2.89$, $p=0.04$, $\eta_p^2 = 0.14$; thus there was a difference between instructional model groups. Analysis of pairwise comparisons revealed the 6+1 Trait Writing® group reported significantly higher constructivist activities in June of 2006, than both the Big6™ and the control group, $F_{(2, 56)} = 4.53$, $p = 0.04$. Thus, the 6+1 Trait Writing® teachers had higher expectations in constructivist learning at the conclusion of the study than did the Big6™ or the control groups (see Figure 14; 1=never, 2=rarely, 3=1-3 times every month, 4=1-3 times every week, 5=almost every day). In general, the Big6™ teachers showed minimal increases in their constructivist activities while the 6+1 Trait Writing® group showed a slight increase in constructivist activities from 2004 to 2006. The control group followed a similar pattern with a subsequent decrease towards the end of the second year. However, there were no statistically significant differences between groups. Overall, the three groups indicated that they used constructivist activities 1-3 times every month.

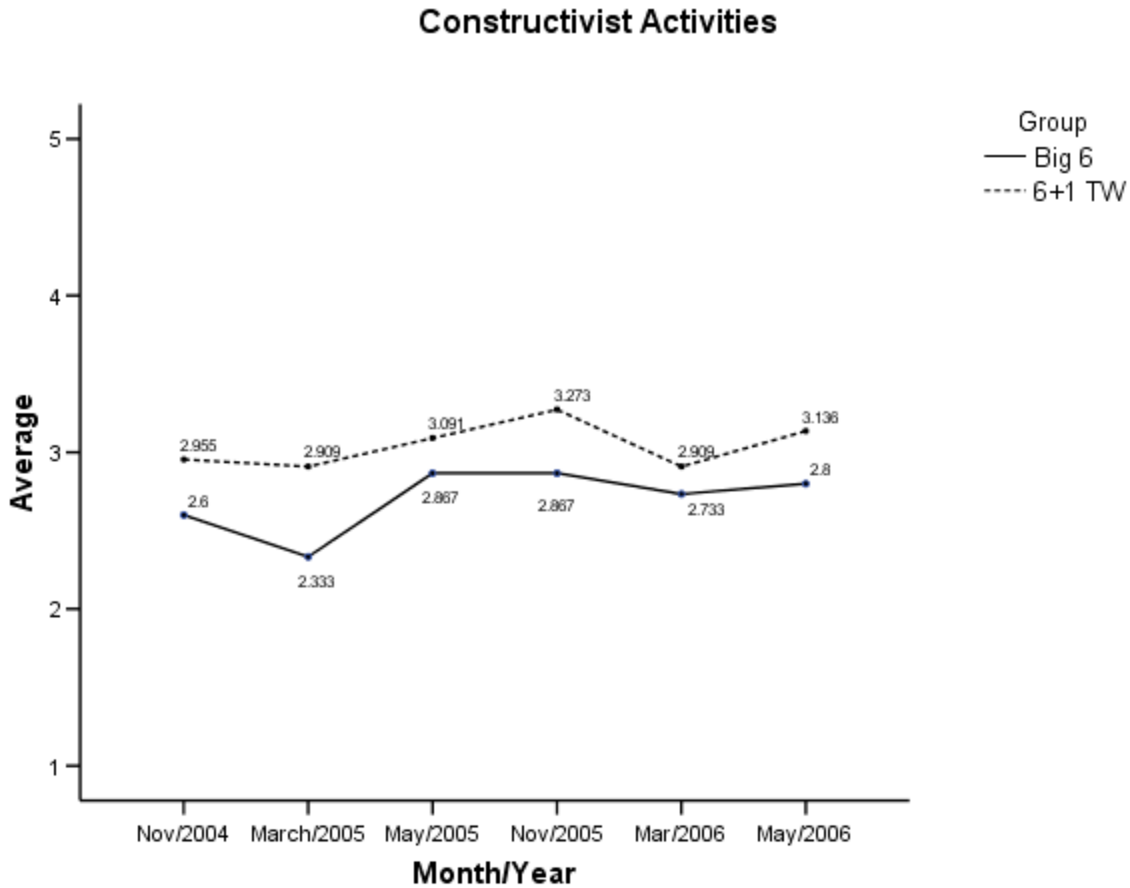
Figure 14



Short teacher questionnaire

The split-plot ANOVA considering constructivism indicated that there were no significant differences between the groups nor was there any significant growth over time. In general, the Big6™ and 6+1 Trait Writing® teachers showed no differences in their report of model technology integration in the classroom (Figure 15). On average, the two teacher treatment groups integrated the model and technology in the classroom 1-3 times every month (1=never, 2=rarely, 3=1-3 times every month, 4=1-3 times every week, 5=almost every day).

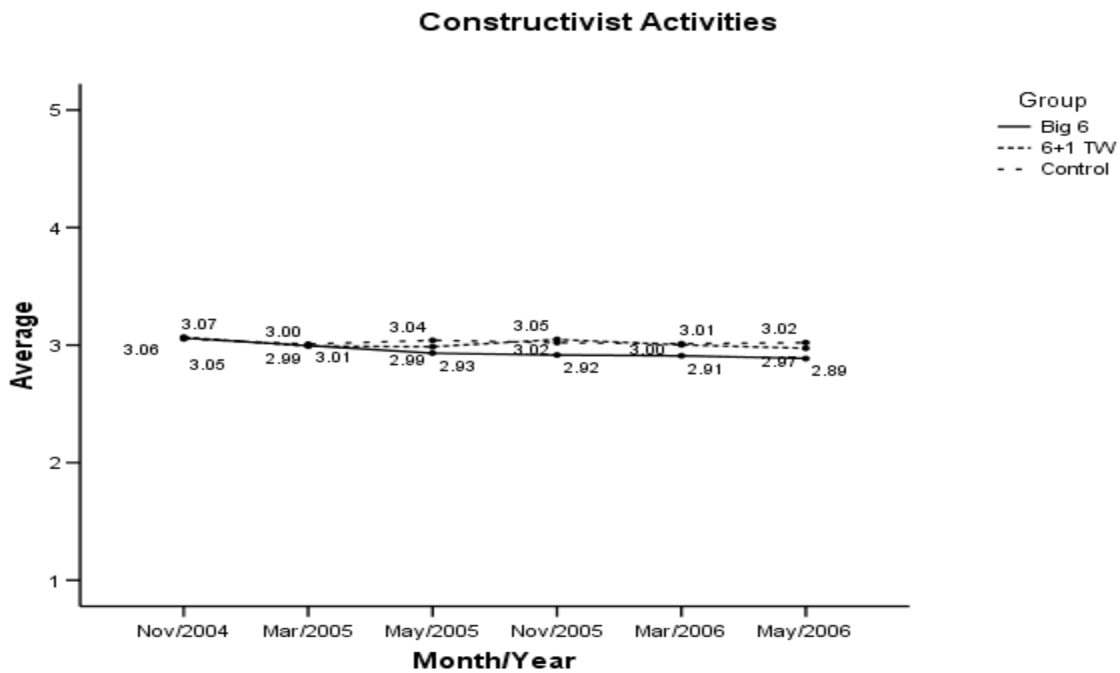
Figure 15



Student questionnaire

The split-plot ANOVA regarding students' report of constructivist learning activities revealed a statistically significant main effect across time, $F_{(5,1263)} = 13.19$, $p < 0.001$, $\eta_p^2 = 0.05$, and between groups, $F_{(2,1267)} = 9.525$, $p < 0.001$, $\eta_p^2 = 0.015$. Most pairwise comparisons were statistically significant; however these mean differences indicate that there is not practical significance within and between groups as depicted in Figure 16 (1=very often, 2=often, 3=sometimes, 4=rarely, 5=never). Thus, in general any significant differences are not of practical significance as indicated by the mean differences in Figure 9 and reported by the effect size (η_p^2).

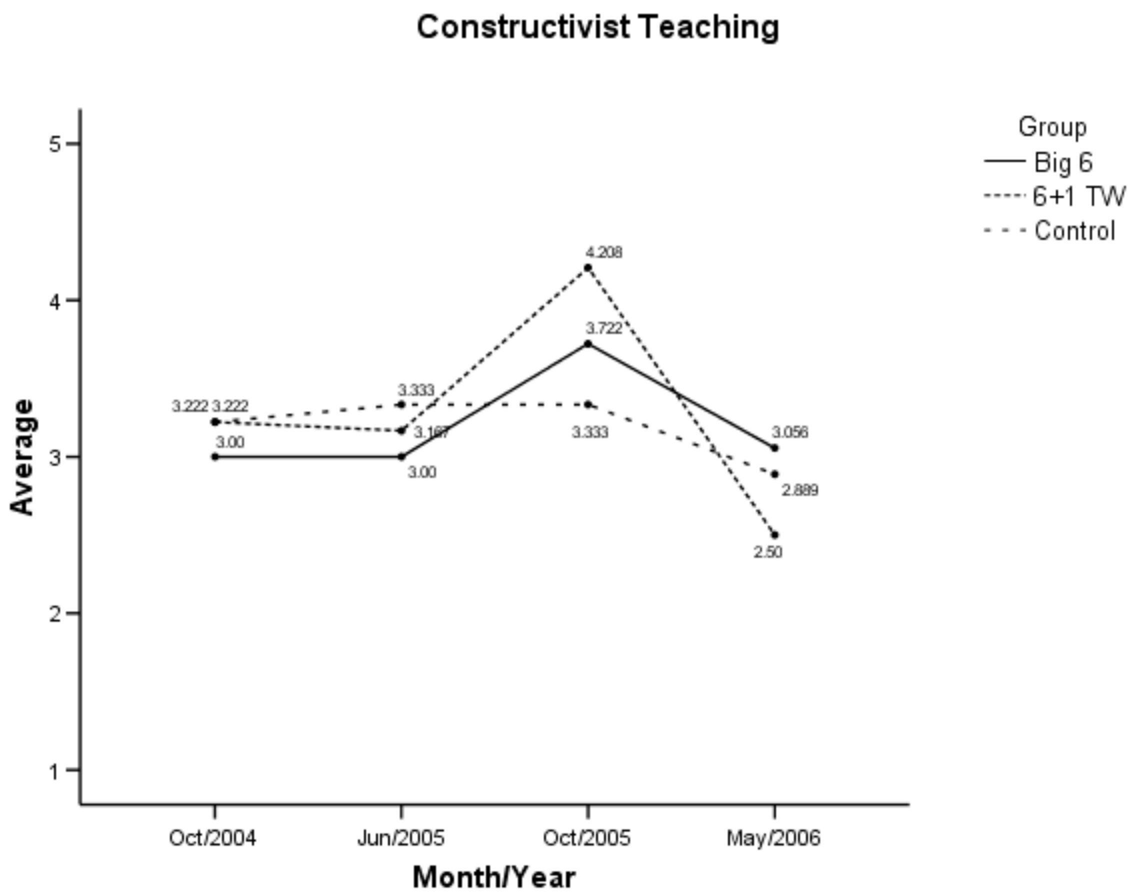
Figure 16



Classroom Observation

The split-plot ANOVA considering constructivist teaching practices indicated that there were no significant differences between the groups nor was there any significant growth over time. Examination of Figure 17 revealed that approximately 50 to 60 percent of the time constructivist teaching practices were observed in the classrooms. It is possible that non-significance is a result of the lack of power because there are large mean differences for each of the treatments groups, which was observed from June to October, 2005.

Figure 17



Summary of Integration of Technology, and Constructivist Instructional Activities in the Classroom

Overall, the integration of technology and constructivist instructional activities in the classroom remained relatively stable. The Big6™ teachers did report a slight increase in constructivist activities, but this was not supported by the students who reported no significant increases in constructivist activities. In general, teachers reported using constructivist activities 1 to 3 times a month and students reported constructivist activities being integrated sometimes in the classroom. Further, classroom observations revealed that roughly half the classroom and instructional time in all groups were based in the tenets of constructivist practices; yet no significant changes occurred from the beginning of 2004, to the end of May 2006.

Research Question	Data Sources					
	Long Teacher Questionnaire	Short Teach Questionnaire	Student Questionnaire	Student Work Samples	Classroom Observations	Achievement Test Scores
5. What are the effects of the Big6™ and 6+1 Trait Writing® on teachers' cognitive and metacognitive expectations and students' cognitive and metacognitive performance on classroom assignments?				✓		

Student Work Samples

Note that the Cognitive and Metacognitive scales are described in Appendix G. The averages in the results that follow are simply averages across students' work at each time point.

Overall teacher and student cognitive scores. The between-subjects ANOVA results for average cognitive scores showed a slight increase from November, 2004 to May, 2006: $F_{(9, 1966)} = 5.87$, $p < 0.001$ at $\alpha = 0.05$, $\eta_p^2 = 0.02$. Analysis of the pairwise comparisons revealed that this increase was significant for teachers (mean difference=.148) but students showed no significant increase in average cognitive scores. Further, there were significant differences between a teacher's cognitive expectation and a student's level of cognition in the work samples: $F_{(1, 1966)} = 44.64$, $p < 0.001$, $\eta_p^2 = 0.01$. From November, 2004 to February, 2005 the teachers' expectations of students' level of cognition was similar to the students' actual work sample level of cognition (Figure 18). Teachers' cognitive expectation increased from November, 2006 to May, 2006 by an average of .15. Note that the values for these cognitive expectations range from 1 to 7, thus the average increase in the level of the teacher's cognitive expectation over time was negligible. The students' slight decrease was not statistically significant, thus their level of cognition remained stable while the teachers' cognitive expectation increased.

Overall teacher and student metacognitive scores. The between-subjects ANOVA for teacher average metacognitive scores showed a slight increase from November, 2004 to May, 2006: $F_{(9, 1966)} = 16.03$, $p < 0.001$, $\eta_p^2 = 0.07$. Similar to the average cognitive scores the pairwise comparison revealed that teachers showed a significant increase while students did not significantly increase from 2004 to 2006. There were also significant differences between a teacher's metacognitive expectation and a student's level of metacognition in the work samples: $F_{(1, 1966)} = 26.03$, $p < 0.001$, $\eta_p^2 = 0.01$. As with cognition, from November, 2004 to February, 2005 the teachers' expectations of students' level of cognition was similar to the students' actual work sample level of metacognition (Figure 19). Teachers' metacognitive expectation increased from November, 2006 to May, 2006 by an average .51. Note, this value is derived from a 1(non-metacognitive) to 4 (conditional knowledge) scale. Thus, the metacognitive expectations shifted from non-metacognitive and declarative work to declarative and procedural work. The students' slight increase was again not statistically significant, thus their level of metacognition remained stable while the teachers' metacognitive expectation increased. In general, the metacognitive results mirrored the cognitive results.

Figure 18

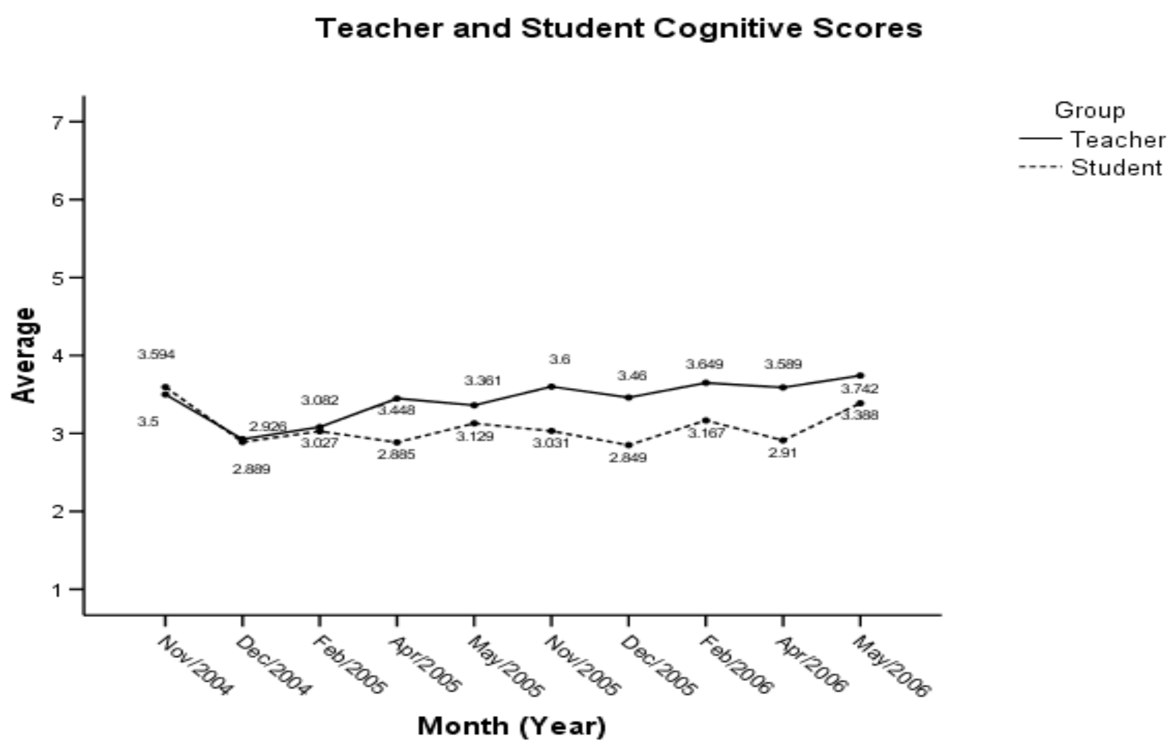
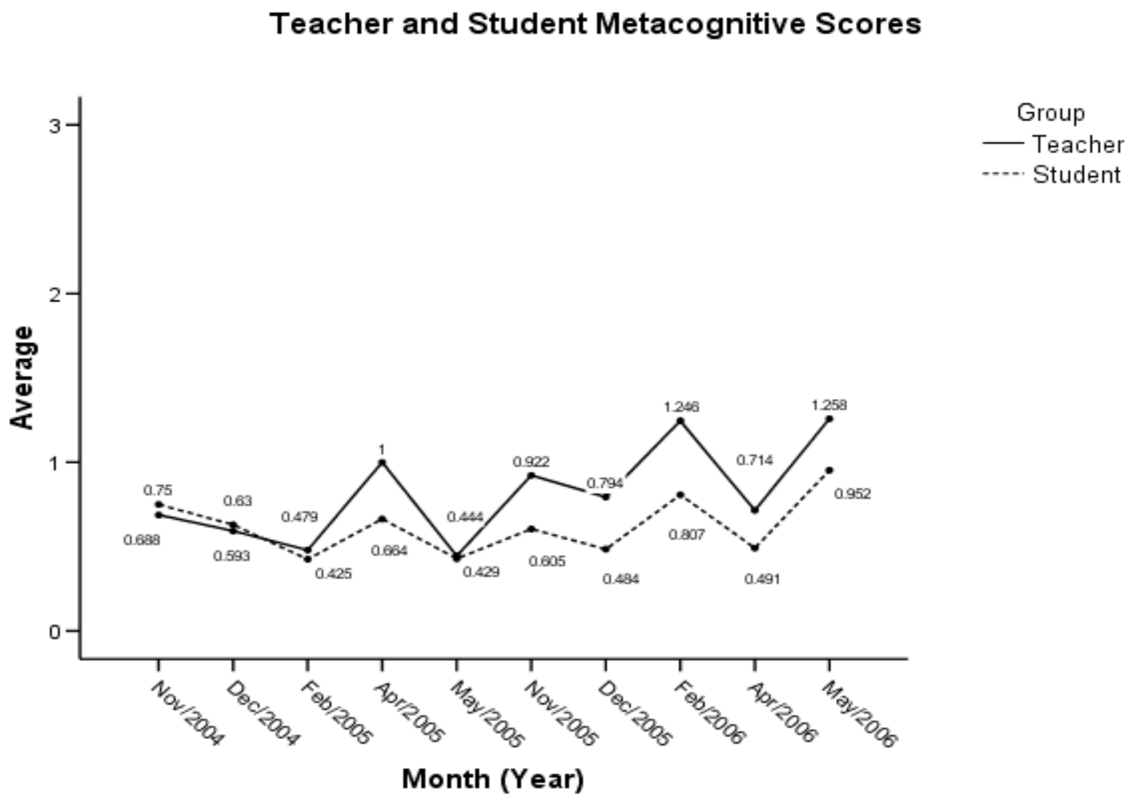
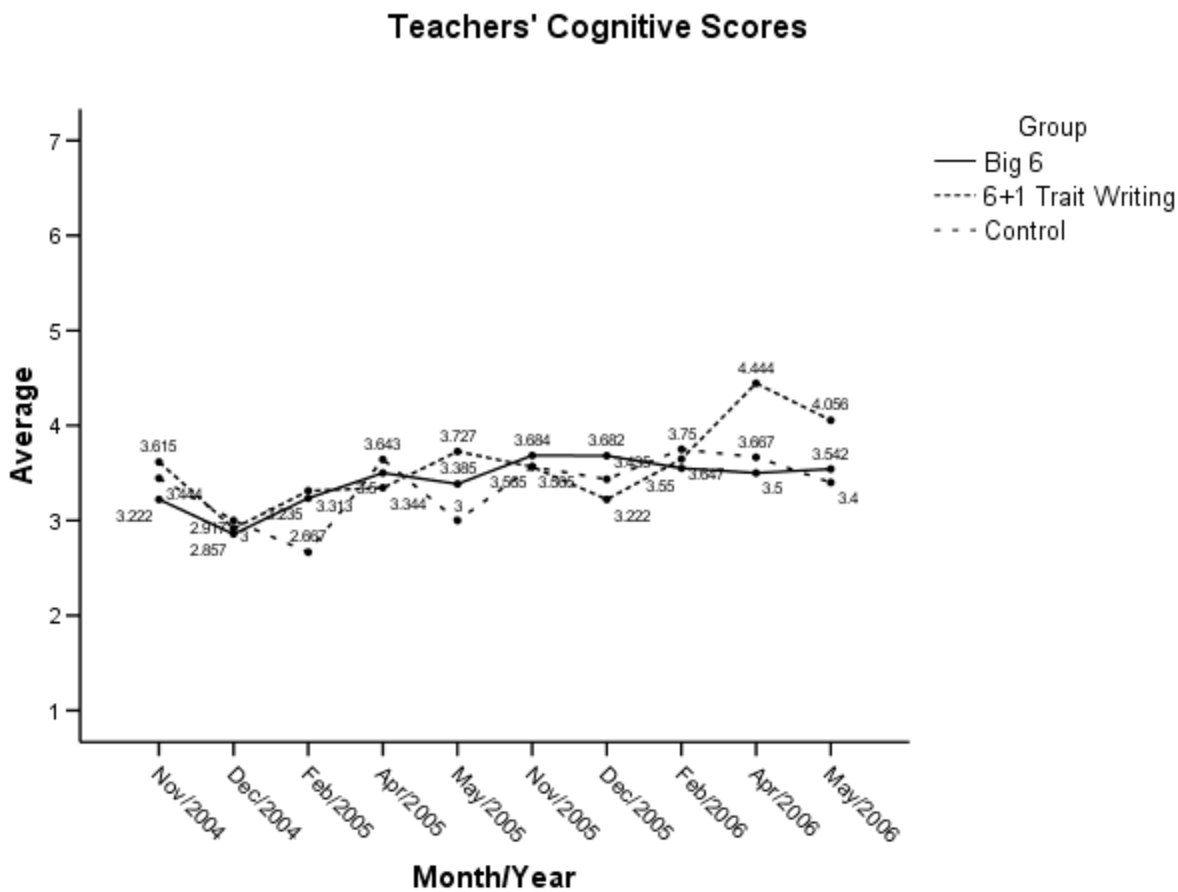


Figure 19



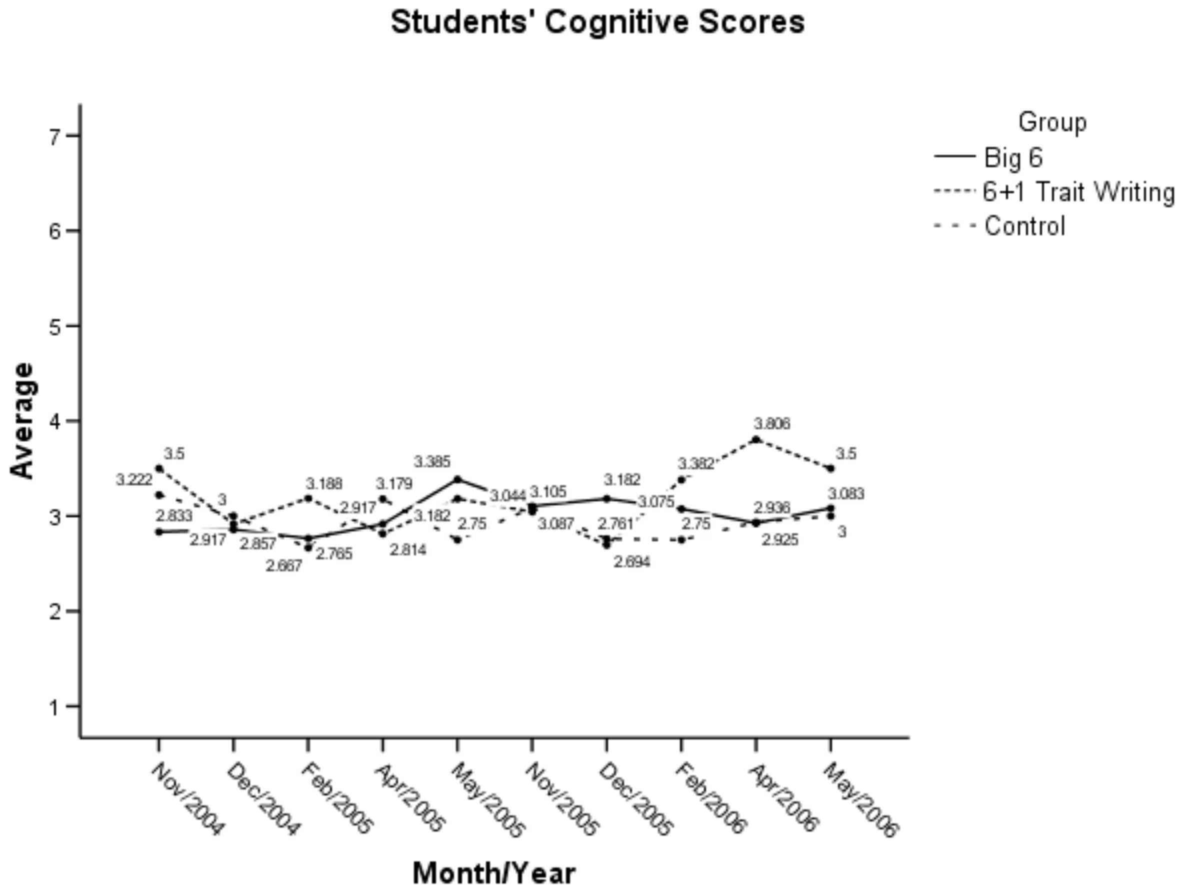
Teachers' cognitive scores. The between-subjects ANOVA used to examine differences over time for the average cognitive scores was statistically significant: $F_{(9, 965)} = 4.46$, $p < 0.001$, $\eta_p^2 = 0.04$ (Figure 20). Further, there were significant differences between the experimental and control groups in level of cognition in the work samples: $F_{(2, 965)} = 3.12$, $p = 0.044$, $\eta_p^2 = 0.006$. The groups were similar in their level of cognition from November, 2004 to February, 2006. In April, 2006 the 6+1 Trait Writing® showed significant increase in cognitive scores over both the Big6™ and control groups. Further, the 6+1 Trait Writing® group was the only group of the three that showed a significant increase in cognitive scores from 2004 to 2006. Thus, teachers' cognitive scores moved from being slightly below the cognitive level of analyze to being between the cognitive level of analyze and apply.

Figure 20



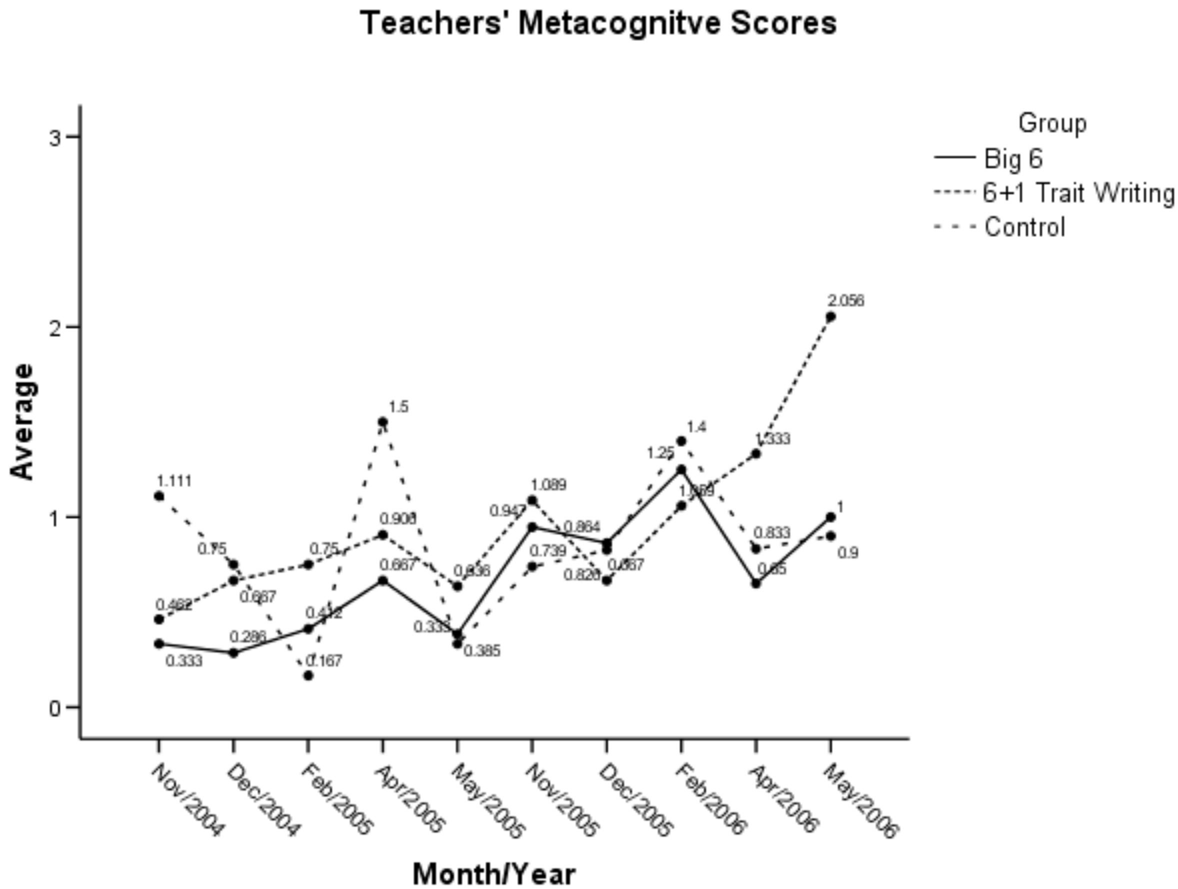
Students' cognitive scores. The between-subjects ANOVA was used to assess change for average student cognitive scores was not statistically significant indicating there was not any growth over time for any groups (see Figure 21). Alternatively, there were significant differences between the experimental and control groups in level of cognition in the work samples: $F_{(2, 957)} = 5.72$, $p < 0.01$, $\eta_p^2 = 0.012$. Thus, the 6+1 Trait Writing® exhibited slightly higher levels of cognition (between synthesize and analyze) in their work samples than either the Big6™ or the control groups.

Figure 21



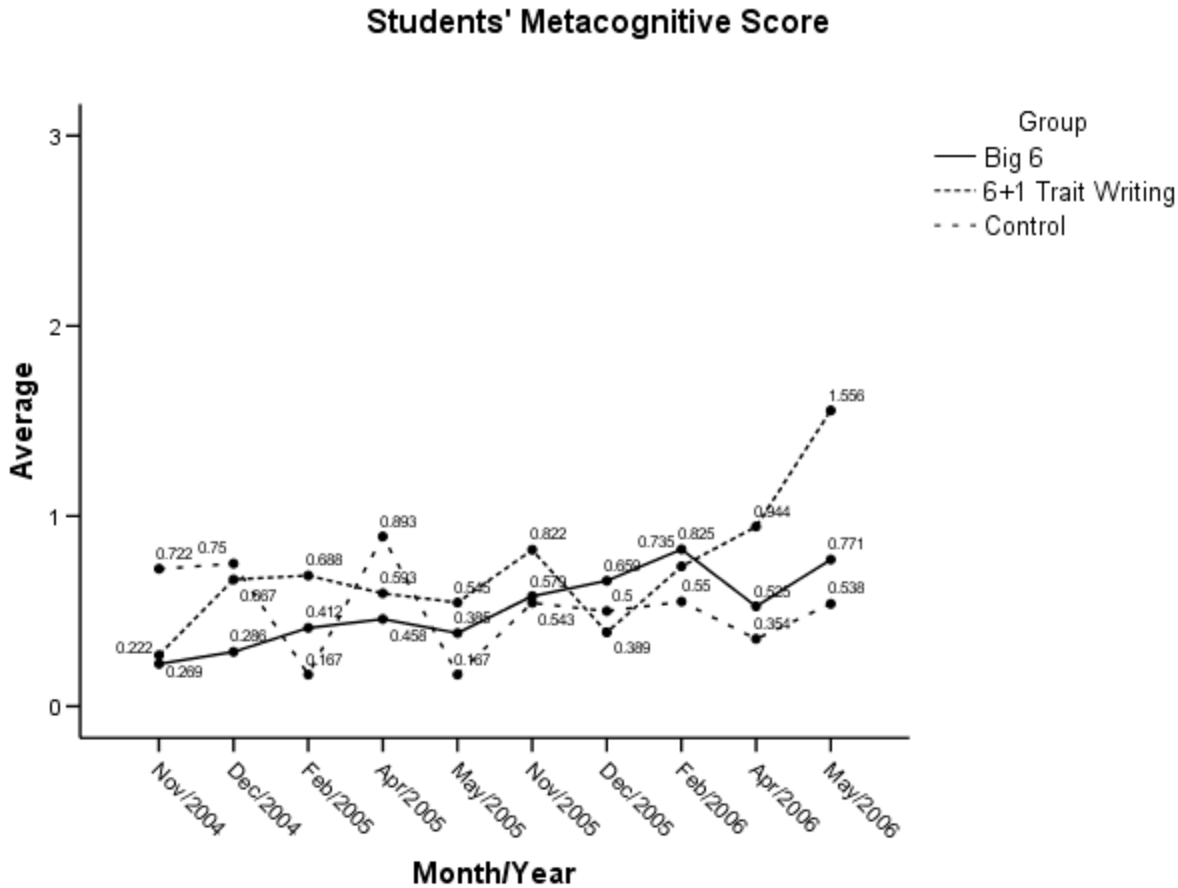
Teachers' metacognitive scores. Examination of the between-subjects ANOVA for teachers' level of metacognitive engagement required in student activities indicated a significant increase in the level of metacognition required from November, 2004 to May, 2006: $F_{(9, 964)} = 8.68$, $p < 0.001$, $\eta_p^2 = 0.02$ (see Figure 22). Thus, both the Big6™ and control group increased from close to non-metacognitive to declarative and the 6+1 Trait Writing® group increased from declarative to procedural. Further, there were significant differences between the experimental and control groups in the level of metacognition in the work samples: $F_{(2, 964)} = 12.64$, $p = 0.044$, $\eta_p^2 = 0.11$.

Figure 22



Students' metacognitive scores. The between-subjects ANOVA for student metacognitive scores indicated a statistically significant increase from November, 2004 to May, 2006: $F_{(9, 958)} = 6.41$, $p < 0.001$, $\eta_p^2 = 0.06$ (see Figure 23). Further, there were significant differences between the experimental and control groups in level of metacognition in the work samples: $F_{(2, 958)} = 9.44$, $p < 0.001$, $\eta_p^2 = 0.02$. Examination of the differences in means revealed the Big6™ and control groups had levels of metacognition slightly below declarative and the 6+1 Trait Writing® group had metacognitive scores approaching that of procedural knowledge. Again, the 6+1 Trait Writing® group showed the largest increase (from close to non-metacognitive to between declarative and procedural) and also had significantly higher metacognitive scores than the Big6™ and control groups.

Figure 23



Summary

In general, overall teacher and student cognitive scores remained between synthesize and analyze with teachers showing slightly greater levels of cognitive expectations than what students produced. Similar results were found for metacognition. These results indicated students' metacognitive scores representing declarative knowledge, while teachers' expected levels of metacognition expressed in the assignments being slightly greater than students. In comparing the treatment groups, the 6+1 Trait Writing® teachers and students had cognitive scores around procedural with teachers having slightly higher expectations than what students produced. The 6+1 Trait Writing® group also showed the highest level of metacognition and the largest increase for both teachers and students moving from below declarative to slightly above procedural. In general, students' cognitive and metacognitive results corroborated the teachers' cognitive and metacognitive results.

Research Question	Data Sources					
	Long Teacher Questionnaire	Short Teach Questionnaire	Student Questionnaire	Student Work Samples	Classroom Observations	Achievement Test Scores
6. Does the integration of technology in either treatment model, *Big6™* or *6+1 Trait Writing® method*, affect student achievement in science?				✓		✓

A multilevel model approach with longitudinal data was considered with the three levels being time, students and schools. The models and results are presented below. Also, note that cognitive and metacognitive scores were derived from the WILATA by taking an average of the student work samples on metacognition and cognition for student scores in May, 2006.

Model-1a. The first model fitted was a student level unconditional means model, which excludes predictors at all levels and assesses the amount of outcome variation that exists at each level, thus serving as a baseline for subsequent comparison. The level-1 and level-2 models are written as:

$$\begin{aligned} Y_{it} &= \pi_{0i} + \varepsilon_{it}, \quad \text{where } \varepsilon_{it} \sim N(0,\sigma_{\varepsilon}^{2}) \\ \pi_{0i} &= \gamma_{00} + \xi_{0i}, \quad \text{where } \xi_{0i} \sim N(0,\sigma_{0}^{2}) \end{aligned} \qquad 1$$

Table 4 presents the results of fitting Model-1a to the science achievement data, which estimates the science achievement grand mean across all students and years. The mean science achievement score of 695.87 was statistically significant ($p < .001$), which means the parameter is not zero in the population. The random effects portion of Model-1a can be interpreted as an estimated intra-class correlation coefficient, which means that a little more than half of the variation in science scores can be attributed to differences among students and 43% to within-student differences. Thus, it was concluded that the average student's science achievement varies from year-to-year and that students differ from each other in science achievement. The next step was to attempt to link both within- and between-person variance in science achievement to the predictors.

Table 4

Model-1a: Unconditional means model fixed and random effect coefficients for science achievement

Fixed Effect	Parameter	*SE*	*t*
Average student	695.87	0.60	1155.97***
Random Effect	Variance Component	*SE*	*Z*
Level 1			
Within-student: $\sigma^2_{\pi\varepsilon}$	566.89	14.57	38.90***
Level 2			
Student average initial status: $\sigma^2_{\pi 11}$	765.13	30.49	25.09***

Note. * $p < .05$; ** $p < .01$; *** $p < .001$

Model-2a. The unconditional growth model introduced year as a predictor of student science achievement (Table 5). The level-1 and level-2 models are written as:

$$\begin{aligned} Y_{it} &= \pi_{0i} + \pi_{1i} y_{it} + \varepsilon_{it} \\ \pi_{0i} &= \gamma_{00} + \xi_{0i} \\ \pi_{1i} &= \gamma_{10} + \xi_{1i}. \end{aligned} \tag{2}$$

The average true change trajectory for science achievement had both a statistically significant, non-zero intercept of 687.49 and a non-zero slope of 8.92. Thus, science achievement scores rose steadily between 2005 and 2006, from 687.49 to 705.33. Comparisons of the within-student variation in Model-2a to Model-1a revealed a decline of .25 (from 566.89 to 422.99) or 25% of the within-student variation (residual) in science achievement scores as associated with linear year. By also considering the relationship between predicted and observed science achievement scores it was found that 4.0% of the total variability in science achievement is associated with growth from year-to-year.

Table 5

Model-2a: Unconditional linear growth model fixed and random effect coefficients for science achievement

Fixed Effect	Parameter	*SE*	*t*
Average initial status: γ_{00}	687.49	0.74	930.94***
Average learning rate: γ_{10}	8.92	0.46	19.26***
Random Effect	Variance Component	*SE*	*Z*
Level-1			
Within-student: $\sigma^2_{\pi\varepsilon}$	422.99	48.03	18.32***
Level-2			
Student average initial	880.10	16.00	26.43***
Student average learning	100.24	17.08	5.87**
Covariance: $\sigma_{\pi 21}$	-82.58	22.91	-3.60***

Note. * $p < .05$; ** $p < .01$; *** $p < .001$

Model-3a. For this model a school level was introduced to examine between-school variability. This three-level model is written as:

$$\begin{aligned}
Y_{itj} &= \pi_{0ij} + \pi_{1ij} y_{itj} + \varepsilon_{itj}, \\
\pi_{0ij} &= \gamma_{00j} + \xi_{0ij}, \\
\pi_{1ij} &= \gamma_{10j} + \xi_{1ij}, \\
\beta_{00j} &= \gamma_{000} + r_{00j}, \\
\beta_{10j} &= \gamma_{100} + r_{10j}.
\end{aligned} \tag{3}$$

The results for fitting Model-3a are presented in Table 6 resulted in similar averaged growth trajectories for all children and all schools as Model-2a. Thus, the estimated initial status for science achievement scores was 685.74 and the average learning rate per year time point was 7.84. The percent of variance between schools in initial status was found to be approximately 86% and 42% of the variance for learning rates. The amount of variance for student initial status and learning rate was 23% and 2%, respectively. Since a large porting of the variance existed between schools, school level predictors were explored in subsequent multilevel models.

Table 6

Model-3a: Unconditional linear growth model fixed and random effect coefficients for science achievement

Fixed Effect	Parameter	*SE*	*t*
Average initial status: γ_{000}	685.74	2.32	296.08***
Average learning rate: γ_{100}	7.84	0.88	8.92***
Random Effect	Variance Component	*SE*	*Z*
Level-1			
Within-student: $\sigma^2_{\pi\varepsilon}$	413.41	15.47	26.73***
Level-2 (students within schools)			
Student average initial status: $\sigma^2_{\pi 11}$	121.34	30.61	3.96***
Student average learning rate:	9.35	2.53	3.69***
Covariance: $\sigma_{\pi 21}$	-20.30	7.00	-2.90***
Level-3 (between schools)			
School average initial status: $\sigma^2_{\beta 11}$	753.94	43.25	17.43***
School average learning rate: $\sigma^2_{\beta 22}$	90.08	16.15	5.58***
Covariance: $\sigma_{\beta 21}$	-62.69	20.97	-2.99**

Note. * $p < .05$; ** $p < .01$; *** $p < .001$

Model-4a. The only difference between Model-4a and Model-3a was the introduction of a school level covariate metacognition into Model-4a. Thus, for brevity, Model-4a will not be delineated. The coefficient for metacognition was 25.86, thus when controlling for differences between schools in levels of metacognition the overall mean science achievement scores across all schools increased by 25.86. Alternatively, the schools metacognitive level did not significantly affect growth rates for science achievement. Examination of the variance components reveled that 15% of the explainable variation in school average initial status is accounted for by metacognition.

Model-5a. This model introduced school level cognition derived from the work samples and scored with the WILATA as a covariate to Model-3a. The coefficient for cognition was 19.57, thus when controlling for differences between schools in levels of cognition the overall mean science achievement scores across all schools increased by 19.57. Alternatively, the schools cognitive level did not significantly affect growth rates for science achievement. Examination of the variance components reveled that 40% of the explainable variation in school average initial status is accounted for by cognition.

Model-6a. This model examined technology use in the classroom. With the addition of technology the coefficient for cognition was 3.72, thus when controlling for differences between schools in levels of classroom technology use the overall mean science achievement scores across all schools increased by 3.72 as compared to 19.57 in the previous model. Alternatively, the schools' technology use did not significantly affect growth rates for science achievement. Examination of the variance components reveled that approximately 10% of the explainable variation in school average initial status is accounted for by classroom technology use.

Model-7a. This model examined technology use across classrooms when controlling for differences in metacognition and cognition. The result showed that the effects of cognition and metacognition were no longer significant when included in Model-7a with classroom technology use. Differences in initial status in science achievement scores were deemed to be accounted for by the variance of technology use. Thus, the final model included only classroom technology use (Model-6a).

Summary of science achievement results

Several intermediate models were considered to examine the effects of the 6+1 Trait Writing®, Big6™, and control groups from 2005 to 2006. Results revealed no statistically significant differences between groups. Further, a 3-level model with zone (rural, suburban, urban) as a predictor of science achievement at the school level did not account for additional variance. Also, models including cognition, metacognition or technology did not account for significant increases in science achievement scores. Thus, the predictors included in the aforementioned models did not account for significant growth in science achievement. In general, the only pertinent finding was that technology use in the classroom accounted for 10% of the variance initial science achievement scores. In summary, whether or not schools used technology accounted for a small amount of the differences in science achievement scores across schools at the onset of the study, but growth in these same scores was not due to technology use.

Research Question	Data Sources					
	Long Teacher Questionnaire	Short Teach Questionnaire	Student Questionnaire	Student Work Samples	Classroom Observations	Achievement Test Scores
7. Does the integration of technology in either treatment model, *Big6™* or *6+1 Trait Writing® method*, affect student achievement in social studies?				✓		✓

A multilevel model approach with longitudinal data was considered with the three levels being time, students and schools. The models and results are presented below.

Model-1b. The first model fitted to the social studies achievement data was a student level unconditional means model, which was the same as Model-1b, thus it will not be redefined. Table 7 presents the results of fitting Model-1b to the social studies achievement data, which estimates the science achievement grand mean across all students and years. The mean social studies achievement score of 677.28 was also statistically significant. The random effects of this model indicated that 77% of the variation in social studies achievement scores can be attributed to differences among students and 23% to within-student differences. Thus, it can be concluded that a majority of the variation in average student's social studies achievement is due to differences between students.

Table 7

Model-1b: Unconditional means model fixed and random effect coefficients for social studies achievement

Fixed Effect	Parameter	*SE*	*t*
Average student status: γ_{00}	677.28	0.68	1001.89***
Random Effect	Variance Component	*SE*	*Z*
Level 1			
Within-student: $\sigma^2_{\pi\varepsilon}$	241.68	7.86	30.90***
Level 2			
Student average initial status: $\sigma^2_{\pi 11}$	814.65	25.67	31.76***

Note. * $p < .05$; ** $p < .01$; *** $p < .001$

Model-2b. The unconditional growth model introduced year as a predictor of student social studies achievement (Table 8).The average true change trajectory for social studies achievement had both a statistically significant, non-zero intercept of 675.51 and a non-zero slope of 2.55. Thus, social studies achievement scores rose only slightly between 2005 and 2006, from 675.51 to 680.61. Comparisons of the within-student variation in Model-2b to Model-1b revealed a decline of .54 (from 241.68 to 110.83) or 54% of the within-student variation (residual) in social studies achievement scores is associated with linear year. Though 54% of the within-student variation is associated with growth, the sample correlation between the predicted and observed social studies achievement scores is .075. Thus, only .6% of the total variability in social studies achievement is due to year-to-year growth.

Table 8

Model-2b: Unconditional linear growth model fixed and random effect coefficients for social studies achievement

Fixed Effect	Parameter	*SE*	*t*
Average initial status: γ_{00}	675.51	0.70	962.41***
Average learning rate: γ_{10}	2.55	0.43	5.92***
Random Effect	Variance Component	*SE*	*Z*
Level-1			
Within-student: $\sigma^2_{\pi\varepsilon}$	110.83	5.17	21.43***
Level-2			
Student average initial status: $\sigma^2_{\pi 11}$	868.58	29.56	29.39***
Student average learning rate: $\sigma^2_{\pi 22}$	100.24	17.08	5.87**
Covariance: $\sigma_{\pi 21}$	-87.94	19.53	-4.50***

Note. * $p < .05$; ** $p < .01$; *** $p < .001$

Model-3b. For this model, a school-level was introduced to examine between-school variability. The results for fitting Model-3a are presented in Table 9 resulted in similar averaged growth trajectories for all children and all schools as Model-2a. Thus, the estimated initial status for social studies achievement scores was 676.09 and the average learning rate per year time point was 2.26. The percent of variance between schools in initial status was found to be approximately 87% (755.61/[755.61+117.43]) and 56% (147.49/[147.49+117.43]) of the variance for learning rates. The amount of variance for student initial status and learning rate was 52% (117.43/[117.43+109.30]) and 1% (1.42/[1.42+109.30]), respectively. Since a large porting of the variance existed between schools, school level predictors were explored in subsequent multilevel models.

Table 9

Model-3b: Unconditional linear growth model fixed and random effect coefficients for social studies achievement

Fixed Effect	Parameter	*SE*	*t*
Average initial status: γ_{000}	676.09	2.25	300.74***
Average learning rate: γ_{100}	2.26	0.53	4.25***
Random Effect	Variance Component	*SE*	*Z*
Level-1			
Within-student: $\sigma^2_{\pi\varepsilon}$	109.30	5.112	21.37***
Level-2 (students within schools)			
Student average initial status: $\sigma^2_{\pi 11}$	117.43	32.21	3.65***
Student average learning rate:	1.42	1.15	1.24
Covariance: $\sigma_{\pi 21}$	-5.01	5.51	-0.91
Level-3 (between schools)			
School average initial status: $\sigma^2_{\beta 11}$	755.61	26.57	28.43***
School average learning rate: $\sigma^2_{\beta 22}$	147.49	15.32	9.63***
Covariance: $\sigma_{\beta 21}$	-81.93	18.44	-4.44**

Note. * $p < .05$; ** $p < .01$; *** $p < .001$

Model-4b. Again, the only difference between Model-4b and Model-3b was the introduction of a school level covariate metacognition into Model-4b. The coefficient for metacognition was 9.83 thus when controlling for differences between schools in levels of metacognition the overall mean social studies achievement scores across all schools increased by 9.83. Alternatively, the schools' metacognitive level did not significantly affect growth rates for social studies achievement. Additional variance was not accounted for by the inclusion of metacognition.

Model-5b. This model introduced school level cognition as a covariate to Model-3b. The coefficient for cognition was 8.96, thus when controlling for differences between schools in levels of cognition the overall mean social studies achievement scores across all schools increased by 8.96. Alternatively, the schools' cognitive level did not significantly affect growth rates for social studies achievement. Additional variance was not accounted for by the inclusion of cognition.

Model-6b. This model examined technology use in the classroom. The coefficient for cognition was 5.42, thus when controlling for differences between schools in levels of classroom technology use the overall mean social studies achievement scores across all schools increased by 5.42. Alternatively, the schools' technology use did not significantly affect growth rates for social studies achievement. Examination of the variance components revealed that approximately 40% of the explainable variation in school average initial status is accounted for by classroom technology use. Since metacognition and cognition were shown to have little effect this was the final model.

Summary of social studies achievement results

Students in the social studies classrooms did exhibit growth in achievement, but it was comparatively less than the science achievement scores. Several intermediate models were also considered to examine the effects of the 6+1 Trait Writing®, Big6™, and control groups from 2005 to 2006. Results revealed no statistically significant differences between groups. Further, a 3-level model with zone (rural, suburban, urban) as a predictor of social studies achievement at the school level did not account for additional variance. Thus, growth was not due to any of the predictors included in the models. Similar to the science achievement findings, the only pertinent finding was that technology use in the classroom accounted for 40% of the variance in initial social studies achievement scores. In summary, whether or not schools used technology accounted for a significant portion of the differences in social studies achievement scores across schools at the onset of the study, but growth in these same scores was not due to technology use or any additional predictors.

Subscales

Research Question: Do students in the Big6™ and 6+1 Trait Writing® and control groups score equally as well on achievement test items that assess higher-order thinking?

The following are the Wisconsin Knowledge and Concepts Examinations items that were selected by an outside consultant to be most promising for subscale analysis. It was determined that by first picking the test items that had the most relevance to the intent of both the Big 6 and 6 + 1 Trait models. Because Wisconsin has such high test scores, some of the items have ceiling problems but given the desired outcomes of the two programs, these are the best candidates for more detailed analysis between project students and non-project students.

Due to security and confidentiality, the actual test items can not be provided since the assessment is still in use.

SUBJECT SUBSKILL CODE	Item3 2003-2004	Items 2004-2005	Items 2005-2006
SCIENCE			
**B.3	46		4, 8
**B.5	41,	42, 45	13
**C.1	36, 39, 54	53	14
**C.6	46, 53	4, 16, 26, 34, 47	32
C.7			17, 33
H.3			38
SOCIAL STUDIES			
**A.2	3, 4, 12	20, 21, 22, 26 13	34, 35
B.1			4, 5
**B.8	32,	18, 19, 30	18, 24, 25, 26

The following analyses were performed on WKCE items that were deemed appropriate for further subscale analysis.. For the WKCE science section 23 items were deemed appropriate and for social studies 21 items were chosen.

A between-subjects ANOVA for science scores revealed significant differences between the Big6™, the 6+1 Trait Writing®, and the control groups, $F_{(2, 2601)} = 7.89$, $p<.001$, $\eta_p^2 = .006$. Though all mean differences were relatively small as supported by the small effect size. The 6+1 Trait Writing® group exhibited the largest average on these items followed by the Big6™ students, and then the control group. The mean difference between the control students and the 6+1 Trait Writing® students was approximately 0.4

Figure 24

A between-subjects ANOVA for social studies scores revealed significant differences between the Big6™, the 6+1 Trait Writing®, and the control groups, $F_{(2, 1243)} = 12.01$, $p<.001$, $\eta_p^2 = .019$ (see Figure 25). Again, mean differences were relatively small as supported by the small effect size. Somewhat unexpectedly the control group exhibited the largest average on these items followed by the 6+1 Trait Writing® and the Big6™ students.

Figure 25

Summary of Findings

Model Fidelity

In general, teachers incorporated their respective instructional model (e.g., 6+1 Trait Writing® or Big6™) approximately 1 – 3 times a month and when they did engage the students teachers used a little less than half the class time dedicated to teaching their respective model. Overall, model use and engagement was moderate with no practical group differences. Furthermore, the *6+1 Trait Writing®* remained fairly consistent in spending approximately half the class time engaging students in activities related to the *6+1 Trait Writing®* model. The *Big6™* teachers remained relatively consistent as well in spending about half the class time engaging students in activities related to the *Big6™* model.

Students felt that they rarely learned about their respective instructional model (e.g., 6+1 Trait Writing® or Big6™). This was slightly lower than teachers' reported instructional engagement of the models with their students. Though there were slight differences between groups, these mean differences did not exhibit a practically sizable effect. In other words, over the course of the study mean differences between groups were small and not practically meaningful.

Overall, teachers reported teaching their respective treatment model to their classes somewhat more than what students reported learning about the model. Observational results corroborate with teacher and student reports. However, despite similar results across data sources, the models were not taught on a regular basis, which yield concerns for the validity of students' skills in application of the model as measured by their school achievement.

Technology

In general, the teachers indicated moderate levels of computer and technology use with some significant differences over time and between the control, 6+1 Trait Writing®, and Big6™ groups. Overall, the 6+1 Trait Writing® group used technology slightly more than the other two groups consistently over time. Teachers had students using computers to complete assignments every few weeks or at least once a month with the 6+1 Trait Writing® group showing a slight increase in computer use. In general, students rarely used software with the exception of the 6+1 Trait Writing® group showing a significant increase in software use. Finally, teachers reported believing they possessed average skills in their use of computers and the internet. Teachers' perceptions of their computer skills were relatively consistent across time regardless of their assigned treatment group.

Student responses on the questionnaire were similar to those expressed by their teachers. In general, students reported infrequent use of technology and computers in school. A closer examination of students' responses on the questionnaire by their treatment group revealed significant differences between groups, however the effects of the mean differences between groups were small. The 6+1 Trait Writing® students consistently felt they used computers and technology more than the control and Big6™ groups. Thus, the control and Big6™ groups used technology about the same amount of the time. Though, again the group mean differences were generally small.

In terms of student achievement data from standardized tests, whether or not schools used technology accounted for a small amount of the differences in science achievement scores across schools at the onset of the study, but growth in these same scores was not due to technology use. For social studies achievement, the use of technology accounted for a significant portion of the differences across schools at the onset of the study, but over the two years social studies achievement growth was not accounted for by either technology or any additional predictors.

Overall, teacher and student questionnaire results corroborate technology use on a biweekly basis. However the 6+1 Trait Writing® used technology slightly more than the other two groups consistently over time.

Constructivism

In general, teachers did not have high expectations of engaging their students in learning by constructivist type teaching practices. Though, the 6+1 Trait Writing® group had higher expectations of constructivist learning than their Big6™ counterparts. However, these expectations were not greater than the control group for the 6+1 Trait Writing® group. Further, teachers rarely used constructivist type activities within their classroom and this was consistent across instructional groups. Thus, while teachers across groups slightly agreed with constructivist beliefs, there were no significant changes in teachers' reported beliefs from the beginning of 2004, to the end of May 2006. Additionally, teachers did not differ significantly in their constructivist beliefs regardless of the treatment group to which they were assigned.

Overall, the integration of technology and constructivist instructional activities in the classroom remained relatively stable. The Big6™ teachers did report a slight increase in constructivist activities, but this was not supported by the students who reported no significant increases in constructivist activities. In general, teachers reported using constructivist activities 1 to 3 times a month and students reported constructivist activities sometimes being integrated in the classroom. Further, classroom observations revealed that roughly half the classroom and instructional time in all groups were based in the tenets of constructivist practices; yet no significant changes occurred from the beginning of 2004, to the end of May 2006.