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Visual Formative Assessment and Learning Styles

Abstract

This action research study investigated the impact of visual formative assessments on the achievement levels of students with visual, auditory, and kinesthetic learning styles. The study was conducted in four classes of freshmen at Southwest Christian High School in Chaska, MN, with a total of eighty-four participants. Two pairs were created for the study with control and treatment groups in each pair. Students were classified according to learning style, and a unit pre-test was administered to identify growth. Treatment groups were instructed using daily visual formative assessments for the duration of the unit. Students were assessed again at the end of the instructional unit to obtain data for comparisons and analysis. The results of this study indicated a meaningfully positive impact on the achievement levels of kinesthetic learners through the use of visual formative assessments.

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Visual Formative Assessment and Learning Styles

by

Julie Pickard

B.A. University of Northwestern St. Paul, 2004

Action Research Report
Submitted in Partial Fulfillment
of the Requirements for the
Degree of Master of Education

Department of Education
Dordt College
Sioux Center, Iowa
April 2017

Visual Formative Assessment and Learning Styles

By

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Abstract

This action research study investigated the impact of visual formative assessments on the achievement levels of students with visual, auditory, and kinesthetic learning styles. The study was conducted in four classes of freshmen at Southwest Christian High School in Chaska, MN, with a total of eighty-four participants. Two pairs were created for the study with control and treatment groups in each pair. Students were classified according to learning style, and a unit pre-test was administered to identify growth. Treatment groups were instructed using daily visual formative assessments for the duration of the unit. Students were assessed again at the end of the instructional unit to obtain data for comparisons and analysis. The results of this study indicated a meaningfully positive impact on the achievement levels of kinesthetic learners through the use of visual formative assessments.

Keywords: Learning Styles

"Turn to the person next to you and discuss your thoughts." "Demonstrate your understanding of this material visually through a graphic organizer." "In your small group create a hand motion to help you remember each of these terms." In recent decades education has fundamentally shifted to a student-centered approach with great emphasis on understanding the student by means of learning style and preferences (Boston, 2002; Pashler, McDaniel, Rohrer, & Bjork, 2008). Countless inventories and categorizing tools have been created, implemented, and analyzed (Tomlinson & Demirsky, 2000). As such, the need to evaluate students' learning styles and develop instructional methods to match such preferences has gained considerable momentum in the field of education (Rogowsky, 2015). Teachers at every grade level are integrating strategies like those given above in order to meet students in their desired learning style to maximize learning outcomes.

Similarly, and in the same time frame, a growing interest in the use of formative assessment to enhance student performance has developed (Black & Wiliam, 1998). Stiggins defines formative assessment as assessment *for* learning, rather than *of* learning (2006). Black and Wiliam (1998) add that formative assessment is to be used diagnostically for both teaching and learning. This shift in traditional testing places greater emphasis on the learning process and the ability for the teacher to make instructional adjustments based on student needs and learning prior to a summative assessment (Black & Wiliam, 1998).

While both targeting learning styles and implementing formative assessment have been widely accepted as best practice in education (Tomlinson, 2000; Popham, 2008), it may follow that combining such theories would result in a maximized effect on student performance. However, no such hypothesis has been proven (Rogowsky, 2015). In fact, there is growing skepticism that any correlation can be demonstrated (Black & Wiliam, 1998). Additionally, an

extensive study of interconnecting learning styles with directed formative assessments conducted by Kratzig and Arbuthnott (2006) indicated no data to support enhanced student learning. So how does a conscientious instructor make sense of the shifting focus of the educational mainstream with the lack of sound evidence to support the combined use of student learning styles and directed formative assessment?

Problem

Given the skepticism of correlations between directed formative assessment and learning styles with an improvement in actual student learning outcomes, the current study aimed to determine if such a correlation existed in the high school classroom. Due to the overwhelming evidence in support of a null hypothesis (Boston, 2002; Wang, 2006), the current study further aimed to determine what, if any, measureable difference occurred when the study was delineated according to specific learning styles: visual, auditory, and kinesthetic. Since previous research had indicated a surprising relationship between visual formative assessment and kinesthetic learner outcomes (Krätzig & Arbuthnott, 2006), the researcher was particularly interested in this relationship and hypothesis.

Research Questions

The fact that instructional practice has followed theories widely accepted by national presenters and curriculum giants, as well as teacher-education programs, is not surprising (Dekker, Lee, Howard-Jones, & Jolles, 2012). Yet with lackluster support of data to validate its implementation, it is apparent that further analysis of the benefits of such theories is necessary. The researcher seeks to compare student performance with measurable analysis of learning style and the implementation of visual formative assessment. The questions to be evaluated are the following:

1. To what extent does the implementation of daily visual formative assessments impact the learning achievement of students with different learning styles?
    - What is the impact of visual formative assessments on visual learners?
    - What is the impact of visual formative assessments on auditory learners?
    - What is the impact of visual formative assessments on kinesthetic learners?

Definition of Terms

In order to best understand the current literature, proposed research questions, and experimental design of the current work, it is important to have a fundamental understanding of key terms. Unless specifically referenced, all defined terms are from the author of the current study.

Formative Assessment is the diagnostic use of assessment to provide feedback to teachers and students over the course of instruction (Boston, 2002).

Summative Assessment is a measured assessment that takes place after a period of instruction and requires making a judgment about the learning that has occurred (Boston, 2002).

Visual Learner is a student who prefers using graphics, pictures, shapes or colors, and visible sequencing to obtain information and communicate with others. This student benefits from being able to visually display their thinking through doodles, mind maps, and charts.

Auditory Learner is a student who prefers to obtain information by hearing/listening and often processes and organizes information through listening and speaking activities. This student prefers lectures, songs, and audio books.

Kinesthetic Learner is a student who prefers to gain information through tactile experiences that often involve movement or physical activities in place of listening or viewing.

Literature Review

As the focus of the American educational system has shifted to a more student-centered approach in recent decades, several teaching strategies have grown in prevalence and acceptance. Both formative assessment and learning styles are examples of this shift in pedagogy. Each has been thoroughly studied and identified as beneficial for improved student learning outcomes (Boston, 2002; Tomlinson, 2000). However, the combined practice has shown less conclusive evidence of success (Pashler, McDaniel, Rohrer, & Bjork, 2008; Rogowsky, Calhoun, Tallal 2015; Wang, Wang, Wang & Huang, 2006). In the present study, the relationship between these two teaching strategies was investigated. It was hypothesized that identified visual learners would benefit most from daily formative assessments and would show the greatest degree of improvement in assessment scores. The following literature review traces the development of such a theory.

Formative assessment has revolutionized the instruction and assessment practices of teachers at various educational levels. In an article by Black and Wiliam (1998), formative assessment is defined as "all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged." Launching from the earlier work of Crooks (1988) and Natriella (1987), Black and Wiliam conducted an extensive review of more than 250 relevant research articles spanning more than nine years, in which they identified the correlations between instruction and assessment with seven major areas of importance. Those areas included: examples of the effectiveness of formative assessment, assessment by teachers, student perspectives of formative assessment, and the teacher's role in assessment. These sections were followed by strategies and tactics for teachers, feedback, and finally prospects for the theory and

practice of formative assessment.

One stated weakness of the study was the broad acceptance of various definitions of formative assessment. This meant that the results were also difficult to synthesize. However, a meta-analysis and thorough description of both significant findings and problematic issues was given.

Conclusive support was identified from the articles analyzed that formative assessment does improve student learning. In fact, achievement progress appeared to be among the largest ever reported for educational interventions. An effect size of 0.4-0.7 was cited from among the articles analyzed and touted as the equivalent of raising the mathematics attainment score of an average country into the top five.

Two avenues for future research proposed by Black and Wiliam were the lack of evidence that formative assessment provides significant benefit to the disadvantaged and low-attaining students, as frequently hypothesized. Second, and described as a group of problems, was the possible tension and confusion between formative and summative assessments for both teachers and students. Black and Wiliam countered these problems in closing by adding that while there were some marginal, and even negative, results found the range of formative assessment techniques exercised in their study and the profound resulting gains point to the robust success of formative assessment.

Inspired by the work of Black and Wiliam (1998), James Popham (2008) added to the formative assessment discussion, citing the benefits of formative assessment for both the classroom dividends and the positive effect on student performance on accountability tests. Popham discussed the historical development of formative assessment from the early work of Scriven (1967), Bloom (1969), and eventually Black and Wiliam (1998), culminating with the

2006 Council of Chief State School officers (CCSSO) developing a new consortium focused specifically on formative assessment. Out of this consortium came the Formative Assessment for Students and Teachers (FAST SCASS). This group began in 2006 to find improvements in the quality of students' learning. According to Popham, FAST SCASS was credited with more clearly defining formative assessment as a process, not any particular test, to benefit both students and teachers during instruction, and in providing assessment-based feedback so that teachers and students could make adjustments to improve students' achievement in curricular goals.

Popham warned against the careless claims of several testing companies claiming to utilize formative assessment in annual, or semi-annual achievement tests. Popham went so far as to say that such claims were disingenuous, as these tests do not embody any of the descriptors of FAST SCASS' description of formative assessment.

Popham then went on to provide both a data-free argument for implementation of formative assessment and a data-driven argument. First, stating that it makes eminent sense for teachers to alter instruction based on students' achievement. Second, Popham examined and approved the research of Black and Wiliam (1998) as a sound meta-analysis of empirical evidence and data in support of formative assessment.

Akin to formative assessment is the instructional practice of teaching informed by students' learning styles and preferences. Through the work of Howard Gardner (1983), Carol Ann Tomlinson (2000), and countless other experts the growing profile of a student has steered current educational trends and curriculum. Two authors here underline the importance of such differentiated instruction.

In 2000 Tomlinson and Demirsky wrote a book unpacking and endorsing differentiation. A roadmap for effectively implementing differentiation was outlined as a teacher's response to learners' needs. The authors also described differentiation by means of tasks, grouping, and ongoing assessments/adjustments. Further, Tomlinson and Demirsky offered three generalized uses of differentiation in content, process, and product. Within the process strand, differentiation of students was outlined as stemming from readiness, interest and learning profile.

The authors offered seven examples of differentiation based on learning profiles, including two specifically designed with learning styles in mind: (1) Presenting information through auditory, visual, and kinesthetic modes, and (2) Encouraging students to explore information and ideas through auditory, visual, and kinesthetic modes.

Additionally, Tomlinson and Demirsky warned that differentiation rooted in ineffective classroom practices cannot succeed. Also, differentiation was more than a strategy -- instead, a way of thinking. Finally, Tomlinson and Demirsky concluded that differentiation is truly a movement toward expertise.

In an article by Silver, Strong, and Perini (1997), the key differences between learning styles and multiple intelligences were outlined, and the effectiveness of combining the theories was endorsed. First, the roots for each theory were traced back to insights from biology, anthropology, psychology, and an examination of art and culture. However, Silver et al. defined learning styles as distinct in the way they emphasize different ways people think and feel as they solve problems, create, and interact. The authors went on to say that learning styles are more concerned with the process of learning than on the content or products of it.

Silver et al. credited Butler (1984), Gregorc (1985), Jung (1927), and Briggs and Myers (1977) as pioneers in the learning style theory and clarified that learning styles focus primarily on the learning process and the personality of the learner.

Additionally, Silver et al. presented four broad learning styles:

a. The Mastery style learner
b. The Understanding style learner
c. The Self-Expressive style learner
d. The Interpersonal style learner

The authors continued that learning styles are not fixed, but rather develop and evolve as a learner grows in experience.

Throughout the article both strengths and weaknesses of the Learning style theory were defined. Strengths were cited as:

a. the focus on how different individuals process information across many content areas
b. the recognition of the role cognitive and affective processes play in learning (deepening insights into motivation of students)
c. the emphasis on thought in learning (avoiding lower-level learning activities)

Weaknesses recognized in the article were:

a. the failure to recognize how learning styles vary in different content areas
b. the theory is not as sensitive as it should be to the effects of context and purpose on learning.

The authors then aimed to mesh the concepts of learning styles and multiple intelligences into an *Integrated Intelligence Menu* by describing a set of four learning processes/abilities for each learning style, listing samples of vocations people were likely to choose based on learning

profiles, and descriptions of products that such people with the specified learning style might create.

In closing, Silver et al. outlined the use of such a menu as a teacher's key to developing each student's capacity to learn, and helping each student discover and develop their own abilities and interests. Further, the implementation of the menu would respect and celebrate the diversity of each student while meeting high academic standards.

With such evidence and robust acceptance of the effectiveness of both formative assessment and instruction by learning styles, it would follow that the combination of such strategies would compound the gains in student learning outcomes. However, a number of studies analyzing the interconnected hypothesis indicate a lack of empirical evidence to support this theory. The following four studies outline the implications of the interconnected hypothesis.

In a 2008 article by Pashler, McDaniel, Rohrer and Bjork, the interconnected hypothesis of mode of instruction and preferred learning style were examined in relationship to student learning outcomes. The authors were charged with determining whether these practices could be supported with any scientific evidence. Pashler and his associates determined ample evidence that students would readily disclose a preferred mode of instruction and information gathering, and also a robust amount of educational resources supporting the practice. However, researchers found virtually no evidence to support an interaction pattern in students learning to a higher degree when presented material in their preferred learning style.

Pashler et al. described a rise in learning style approach dating back to the 1940's, and later C.G. Jung and the 1964 model of theorizing personality. This also influenced the Myers and Briggs' assessment during the 1960's. As such theories gained popularity and acceptance from the general American public the growing need to see children as individuals became

prominent in educational instruction and curriculum. Pashler et al. determined that specific evidence must be present to endorse modality instruction (instruction based on one's learning style). Researchers deemed a pattern of interactions as the necessary evidence for proving the interconnected hypothesis. Thus, the learning styles hypothesis receives support only if an experiment reveals what is commonly known as crossover interaction.

The experiment first classified students as having learning style A or learning style B. Students were then randomly assigned to learning method 1 or 2. After being given the same test, scores were analyzed against the hypothesis that the learning method that optimized the mean test score of one group would be different from the learning method that optimized the mean test score of the other group. Graphics showing results according to test score, learning method, and interactions were given.

Pashler et al. discovered that the core evidence for style-by-treatment interaction was missing. No crossover pattern emerged. In fact, after analyzing the remarkably vast amounts of previous literature, they could only cite one study that differed in results from their own. That example, from Sternberg, Grigorenko, Ferrari, and Clinkenbeard (1999) was flawed by design according to Pashler et al. who then praised the findings of Cook, Thompson, Thompson, and Thompson (2009) as a sound experiment with negative results similar to their own, as well as other studies by Massa and Mayer (2006) and Constantinidou and Baker (2002). Pashler et al. concluded with a warning that any application of learning styles in classrooms is unwarranted, and the current research does not provide adequate support for its implementation. Instead, they called for the future research of aptitude-by-treatment interactions that likely lay outside of learning style methods.

A similar article by Rogowsky, Calhoun, and Tallal (2015), outlined the lack of empirical evidence to support a positive relationship between teaching strategies geared toward specific learning styles and increased student learning outcomes. Various categorizing methods of learning styles were discussed; Kolb (1985), Herrmann (1996), Gregorc (1982), Dunn (1989), and consideration of learning styles was endorsed. The Pashler (2008) experiment was referenced several times and was offered as the basis for the given research experiment. Two research questions were analyzed. First, what is the extent to which learning style preferences (auditory, visual) equate to learning aptitudes (listening comprehension, reading comprehension)? And second, what is the extent to which learning style preferences and/or learning aptitudes predict how much an individual comprehends and retains based on mode of instruction (audiobook, e-text)?

The authors found three interconnected hypothesis. First, there will be a positive correlation between auditory learning style preference and listening comprehension. Second, there will be a positive correlation between visual word learning style preference and reading comprehension. And finally, individuals with a visual learning style preference will comprehend better when they read rather than listen, and conversely, individuals with an auditory learning style preference will comprehend better when they listen rather than read.

The conclusion drawn by Rogowsky et al. was that while the theory of learning-styles-based instruction is appealing, there is little empirical evidence to support its implementation. For research question 1: Differences in learning style preferences were not found to significantly predict differences in learning aptitude. Further, no statistically significant results proved such theories. This conclusion supported the initial problem discussed in the introduction. The experiment did not support the interconnected hypothesis, but it did reveal significant results

indicating that the visual learners outperformed auditory learners in all measures of aptitude. Similarly, the results failed to show a significant difference for research question #2. These results matched that of Pashler's initial study from 2008.

One limitation of the study that was discussed was the unequal difficulty of the L-AT and R-AT as a possible flaw in the results. A second limitation was that all comprehension questions were given in written format only and not offered verbally for auditory learners. A final statement warning that by continually accommodating auditory learners' preference with increased instruction in an auditory format is futile, and they might benefit more from receiving instruction that specifically targets and strengthens their visual word skills.

In an article by Wang, Wang, Wang, and Huang (2006), learning styles and formative assessment strategies were analyzed in regard to enhancing student achievement in web-based learning. Several important factors contributing to the success of student learning outcomes were listed with student learning styles being highlighted. The web-based learning environment and it's specific parameters was also noted in the introduction as a basis for the need to understand student learning styles as they approach learning online. Kolb's Learning Style Inventory was identified as widely accepted by educators and would also be the basis for measurement within the study. Kolb's model of four learning styles was described both through narrative and a graphic figure. Several previous studies were cited as a basis for learning styles being a key element in predicting the success of students learning in an online format, these studies were published in the early nineties and the year 2000. The literature review also cited various articles connecting formative assessment to student achievement. Three advantages to online tests used as formative assessments were discussed and praised. Another study analyzing which types of formative assessments work best was also discussed. Finally, three research

questions were presented. First, do learning styles and formative assessment strategy affect student-learning achievement? Second, what kind of formative assessment strategy can be built into the e-learning environment to facilitate student learning? And third, what kind of learning style best suits the e-learning environment? The hypothesis was that there would be some degree of positive change due to at least one of the factors being tested.

The study was completed using 455 seventh-graders from 12 classes of 6 junior high schools in 5 countries in central Taiwan. A quasi-experimental design was used with the formative assessment model (WATA) and Kolb's learning style as independent variables, and learning achievements during one measured unit as the dependent variable. The students were pre-tested and then summatively assessed using a 100-point test composed of 20 questions. The students were divided into four groups of learning styles using Kolb's inventory.

The ANCOVA results indicated that both formative assessments ($F= 3.76$, $P< 0.05$) and learning style ($F= 6.81$, $P< 0.01$) are significant factors in student learning. But, no significant interaction effects between formative assessment strategies and learning style on subject achievement ($F= 0.58$, $P> 0.05$) were found. The post hoc analysis, however, did show a significant difference in the treatment group and the non-treatment groups (each given different summative assessment environments, online and paper-pencil test). And those results were further dissected.

Wang et al. conclusively proved both a relationship between formative assessment and student learning outcomes, and between learning styles and student learning outcomes. However, Wang et al. were not able to show any effect of the relationship between the formative assessments and learning styles on learning outcomes, concluding that a more diverse

experiment with a greater number of formative assessments and different types of formative activities may lead to greater findings in the relationships between these two factors.

In an influential article by Krätzig and Arbuthnott (2006), the learning style theory's correlation to memory performance was tested. Krätzig and Arbuthnott defined learning style as a combination of cognitive, affective, and psychological characteristics describing how an individual interacts with their environment. The authors went on to say this correlation underlies the manner in which a student absorbs, retains, and processes new information.

Krätzig and Arbuthnott offered two research questions. First, an investigation to test the learning styles hypothesis in a standardized memory test involving visual, auditory, and kinesthetic instructional settings. Second, an investigation to determine how the participants arrived at their responses to the learning styles inventory utilized in the research. For the analysis, 65 students from the University of Regina psychology program volunteered to be tested. After completing a learning styles inventory (BLSI) and a self-assessment of learning style, students were given three objective measures used to test visual, auditory, and kinesthetic learning. Those used were the Rey–Osterrieth Complex Figure Test (1941/1944/1993), the Babcock Story Recall test (1995), and the Tactual Performance Test (TPT 1995).

In study 1, which involved all 65 participants, the alpha level of all analysis was set at .05. The results of Test 1 did not show significant relationships between learning style and objective memory. In the BLSA, scores on the visual component were negatively correlated with scores on the auditory component ($r = -.50$, $p < .01$), indicating they were perceived as opposite by some participants. In study 2, which involved an in-depth analysis of just 10 participants, again no significant relationships between self-reported learning styles and standardized memory performance could be found. In this case $p = -.024$. The authors also noted

Coffield, Moseley, Hall, and Ecclestone (2004) with similar research and similarly negative results.

In a discussion of the two studies, conclusive evidence signaled no correlation between learning styles and improvement in participants' ability to use objective memory skills. The only significant finding was an unexpected relationship between kinesthetic style as determined by the BLSI and the visual memory assessment. These results counter the assumption of the learning styles model. Krätzig and Arbuthnott concluded that the study raised serious doubts about learning style specificity and instead supported the idea that each individual uses a combination of different learning modalities." Krätzig and Arbuthnott added that learning styles could not replace content-appropriate forms of instruction, and that instructors should seek to present learning material in multiple sensory modalities for greatest student achievement.

Methods

Previous research indicated that although learning styles have been widely accepted and utilized from an instructional standpoint, there was also a lack of empirical evidence to support the use of learning styles to increase student achievement. One interesting result, stemming from the research of Krätzig and Arbuthnott, was the correlation between visual formative assessment strategies and the improved learning outcomes of kinesthetic learners. The design and research questions of the current study launched from Krätzig and Arbuthnott's findings and aimed to determine what degree daily visual formative assessments impacted the learning achievement of students with visual, auditory, and kinesthetic learning styles.

Participants

The participants for this study were 84 ninth-graders from a suburban high school in the Minneapolis metropolitan area. The M age was 15. There were four classes of 9th Grade Bible

students during the 2016-2017 school year, and these pre-organized groups were utilized for the experiment. Two of the classes were in the honors level and two in the survey level. The honors students (to be named Pair 1) were expected to enter the unit of study with significantly more background knowledge than their counterparts from Pair 2. For the experiment one honors group was utilized as a control, and one survey group was utilized as a control, with the other sections given treatment. Within the 84 participants, there were 37 females and 47 males. Aside from prior knowledge explained above, participants were widely homogenous, coming from middle-class homes in the suburban area of Minneapolis.

Materials

The study began by identifying student learning styles using a modified version of O'Brien's 1985 Learning Styles Questionnaire. O'Brian's model consisted of 30 questions organized with 10 questions from three learning styles, each displayed together in groups of 10. For the experiment, the researcher randomized these questions to ensure authentic student responses. The questionnaire was also completed electronically using the Quia testing software in survey mode. A pilot study was conducted using 20 former students/teaching staff to ensure reliability of the questionnaire. Results from the questionnaire were then manually tallied and recorded onto the Student Learning Profile Record, which would later indicate the student's pre-test score, post-test score, and degree of change as well.

For the data measures of student learning, a pre-test and post-test were created utilizing existing curriculum materials. The only modification made was to alter the questions from multiple choice to short answer/free response. Thus, the element of guessed correct responses was minimized.

Throughout the unit various visual formative assessments were utilized for the treatment groups in each pair. These included daily graphic organizers in the form of flash cards. The graphic organizer template was created by the researcher to visually capture the character traits and actions of each individual studied during the unit in a concise manner with a color-coded heading and symbol unique to each studied individual. In addition, color-coded notes and diagrams were also utilized with treatment groups.

Design

A Paired Sample t-test design was utilized for the present research. The four classes of freshmen completed a visual/auditory/kinesthetic (VAK) learning styles inventory to determine the dominant learning style of each participant. This inventory was given during class time prior to the experiment. Students were then identified by these learning styles for the experiment. The learning styles questionnaire was based on O'Brien's 1985 model. Participants answered 30 questions using a 5-point Likert scale to determine their scores as a visual, auditory, and kinesthetic learner, with the dominant score being used for the present research. In the event of matching scores on the questionnaire, the student's scores were used under a separate category labeled "multiple."

The independent variable in this experiment was the visual formative assessments given to the treatment groups. In the classrooms of the treatment groups, daily visual formative assessments were given and analyzed by both participants and teacher. These visual strategies included graphic organizer flash cards, color-coded notes and handouts, and diagraming exercises. The control groups were taught in the traditional manner as outlined by the curriculum without the daily formative assessments through visuals. It should be noted that the

traditional classroom did utilize visuals and formative assessments occasionally but not with the daily focus.

The dependent variable in this experiment was the post-test given for the Kings and Prophets unit covered in the Old Testament Survey and Honors Old Testament classes. This portion of the unit assessment focused on the people covered throughout the material, approximately 25 individuals.

The post-test results were analyzed to determine if a noticeable change had occurred in either the control or treatment groups. The results from the post-test were further analyzed to determine to what degree daily visual formative assessments impacted the learning achievement of students with visual, auditory, and kinesthetic learning styles.

Procedure

After participants completed the 30-question survey identifying them as visual, auditory, kinesthetic, or multiple learners, the results were manually tallied by the researcher to identify the numerical value (based on a 5-point Likert scale assigned to the questions) of the student's tendencies to be a learner of each style. These results were recorded on the Student Learning Profile Record. The records were then color-coded showing visual learners as orange, auditory learners as yellow, kinesthetic learners as blue, and multiple learners as black on all following documents.

The overall results of each group were analyzed by the researcher and advising professor. It was determined that the best opportunity to uncover recognizable connections between kinesthetic learners and visual formative assessments would be demonstrated if the groups containing the largest percentage of kinesthetic learners within each pair were studied as the treatment groups.

A 50-question pre-test was administered on the first day of the unit to measure baseline knowledge of the people from the Prophets and Kings unit. The free response assessment held two questions about each individual. No word bank was offered in order to limit the guess-correct responses. Pre-test scores were manually calculated and recorded on both the pre-test document and the Student Learning Profile Record.

For the next six weeks the four classes, in two pairs, were instructed in the content of Biblical Prophets and Kings. Each control group was taught in the curriculum-directed manner that the researcher had used for the last five years. Each treatment group also received this teaching approach with the addition of daily visuals and formative assessments. Treatment groups compiled 25 graphic organizer flash cards that visually organized information about the studied individuals' character and actions. The flash cards were color-coded into groups: Kings of the United Kingdom before Solomon, David's family, Prophets, Kings of the Northern Kingdom, and Kings of the Southern Kingdom. The flash cards also included a simple symbol to encapsulate the individual and information on the card. A color-matching flow chart of these individuals was also utilized throughout the unit, as well as corresponding fill-in-the-blank notes.

At the end of the instructional period all four groups completed the post-test. The results of this assessment were also manually scored and recorded on both the test document and the Student Learning Profile Record. Posttest results were then analyzed for degree of change and entered into a spreadsheet.

The spreadsheet organized information according to experiment pair, treatment/non-treatment group, student name, learning style, sex, pre-test score, post-test score, and degree of change.

Results

Data Analysis

The primary research question chosen by the researcher asks: To what extent does the implementation of daily visual formative assessments impact the learning achievement of students with different learning styles?

- What is the impact of visual formative assessments on visual learners?
- What is the impact of visual formative assessments on auditory learners?
- What is the impact of visual formative assessments on kinesthetic learners?

Results were analyzed using raw data organized into tables of comparison according to the independent variable of learning style. Within each learning style the dependent variable of degree of growth was then charted to demonstrate comparisons between treatment and control groups, as well as comparisons from among the independent variable groups. For the scope of this study, and due to the clear conclusions offered through the raw data, the more complex *t* test commonly utilized in such quantitative experimental research was not deemed necessary by the researcher or advisor.

Findings

Table 1
Overall Pair Data

Group/Pair	Pre test Average	Post test Average	Growth Average
Control 1	19.44	42.39	22.95
Test 1	19.96	43.91	23.95
Control 2	4.81	38.69	33.88
Test 2	4.32	34.89	30.57

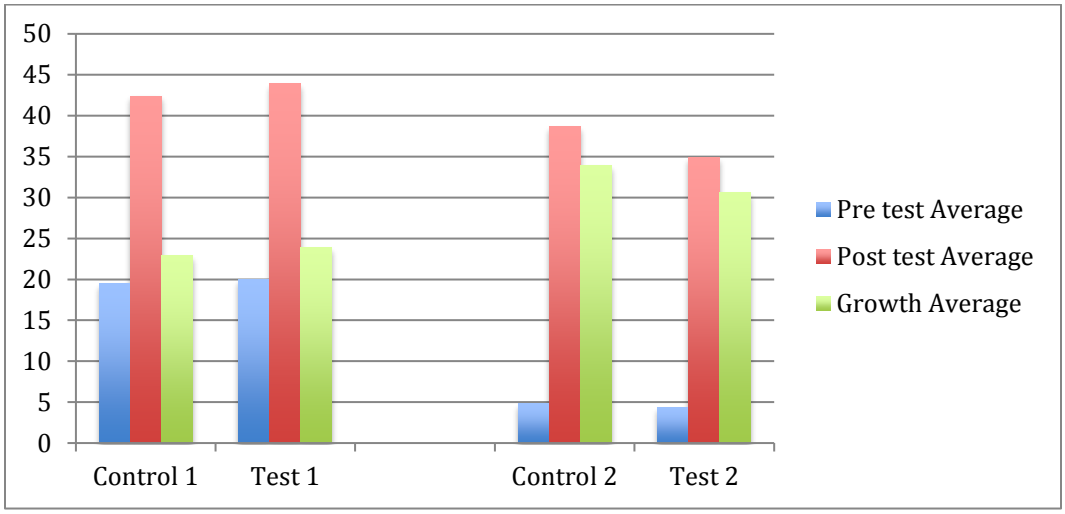

Figure 1
Overall Pair Data

When comparing the data of both pairs overall, the researcher noted that not all students automatically benefitted from using the visual aids. In fact, the treatment group in pair 2 showed less growth overall than the control group. This finding is significant in ruling out a blanket positive outcome by utilizing visual formative assessments.

The researcher also found significantly more growth in pair 2 due to higher pre-test scores in Pair 1 than expected because of the prior knowledge Pair 1 brought to the unit. Several Pair 1 students (9/41) maximized their growth potential by scoring 100% on the post-test, and this may have skewed data results.

Table 2
Subset-Visual Learners

Group/Pair	Learning Style	Pre test Average	Post test Average	Growth Average
Control 1	Visual	21.75	44.0	22.25
Treatment 1	Visual	21.67	46.17	24.5
Control 2	Visual	5.18	38.45	33.27
Treatment 2	Visual	5.0	32.50	27.5

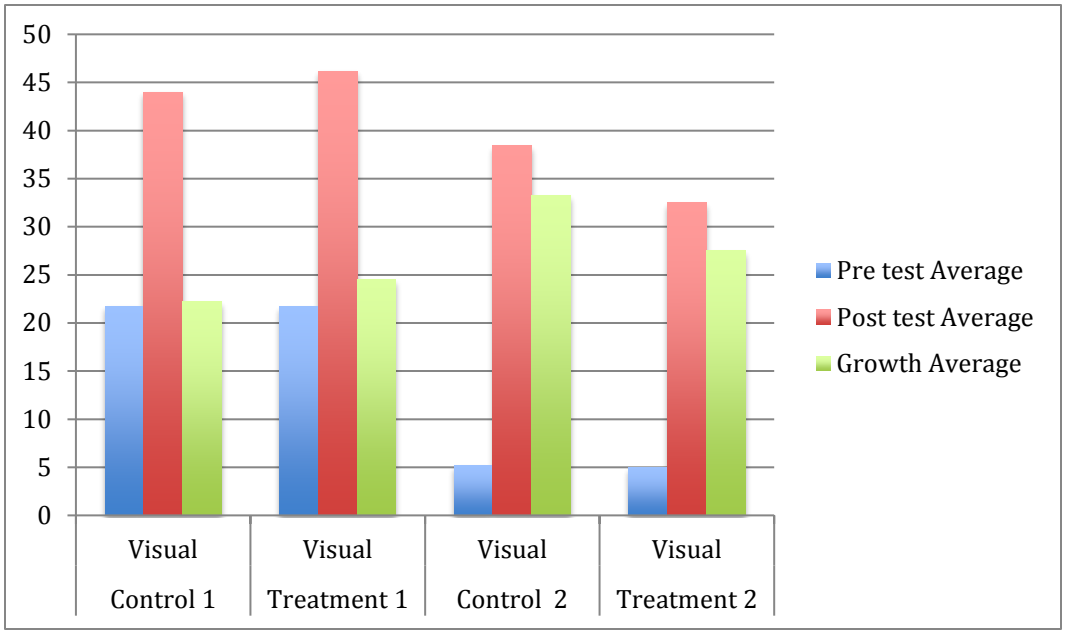

Figure 2
Subset-Visual Learners

After comparing both Pair 1 and Pair 2 overall, the researcher narrowed data by learning style to look for effects relating to each style. The first sub group analyzed was the visual learner group.

In support of the study by Black and Wiliam, there is not an automatic crossover between visual teaching strategies and visual learner achievement. The treatment group in pair 2,

incidentally, scored lower on average than the control group from the same pair, thus supporting the overwhelming majority of previous literature supporting the null hypothesis.

Table 3
Subset-Auditory Learners

Group/Pair	Learning Style	Pre test Average	Post test Average	Growth Average
Control 1	Auditory	11.5	37.5	26
Treatment 1	Auditory	23.67	38.67	15
Control 2	Auditory	No sample	No sample	No sample
Treatment 2	Auditory	1	25.33	24.33

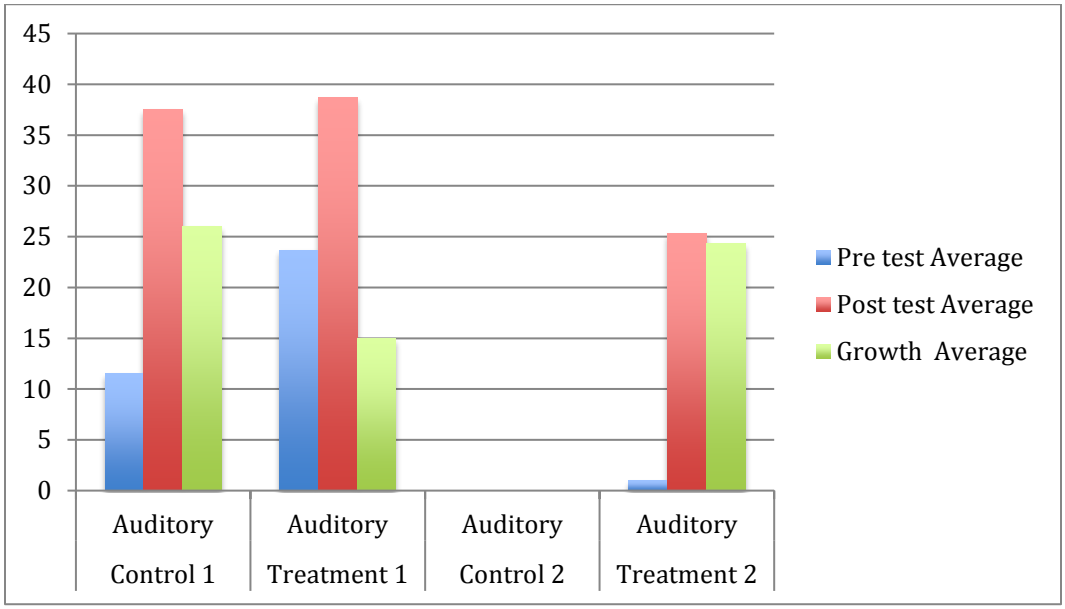

Figure 3
Subset-Auditory Learners

Second, the results from the auditory learner group were examined. The researcher noted that small sample size makes accurate data unlikely. There were only 2 auditory learners in the Pair 1 control group, and 3 auditory learners in the Pair 1 treatment group. The Pair 2 control group had 0 students, and the Pair 2 treatment group included just 3 students.

However, intriguing results were still demonstrated. The Pair 1 treatment group had the lowest degree of growth found in all subset groups. This sub group showed less than half of the degree of change that many of the visual and kinesthetic learners demonstrated.

Even more interesting, the largest growth differential came between Pair 1's control and treatment sub groups, with the control group outscoring the treatment group by 11 points on average.

Table 4
Subset- Kinesthetic Learners

Group/Pair	Learning Style	Pre test Average	Post test Average	Growth Average
Control 1	Kinesthetic	20.63	43.75	23.12
Treatment 1	Kinesthetic	16.5	44.5	28
Control 2	Kinesthetic	2.92	37.92	35
Treatment 2	Kinesthetic	5.3	41.2	35.9

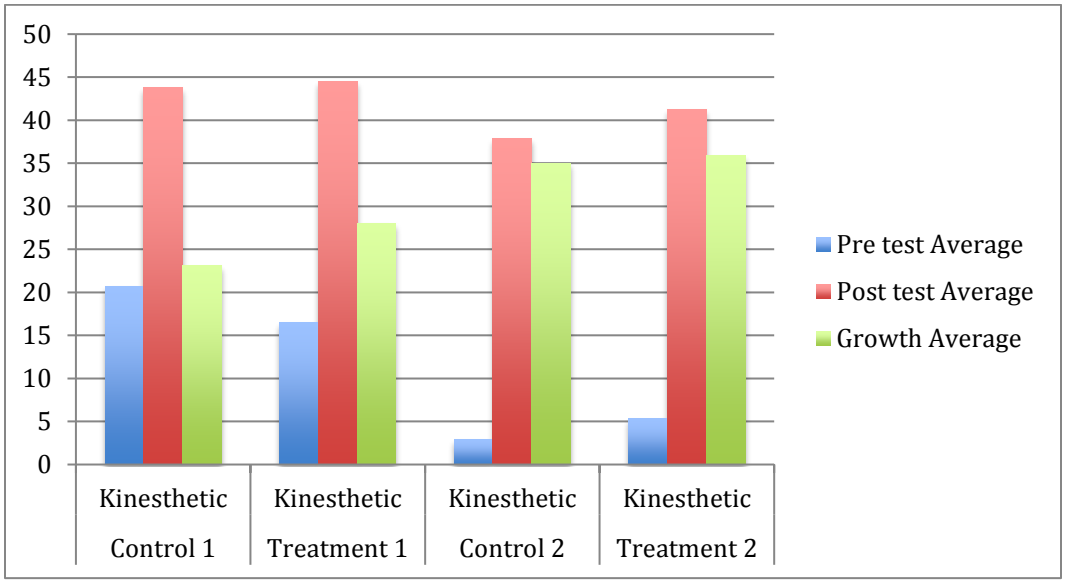

Figure 4
Subset- Kinesthetic Learners

Results from the kinesthetic sub group were examined next by the researcher. This group was specifically identified at the beginning of the study as a group of interest, based on the findings of Krätzig and Arbuthnott. The highest degree of growth was shown by kinesthetic learners in general, and the highest degree of change from a subset group came from the Pair 2 treatment group. This result matched the findings of Krätzig and Arbuthnott.

The researcher also noted that the lowest pre-tests of the study came from Pair 2 within this subset, allowing the greatest potential for growth.

Kinesthetic learners from the Pair 1 treatment group showed more growth than any of the other Pair 1 groups. Kinesthetic learners of the Pair 2 treatment group also showed more growth than any of the other Pair 2 groups. This result also coincided with data from the Krätzig and Arbuthnott experiment.

Table 5:
Subset- Multiple Learning Style Learners

Group/Pair	Learning Style	Pre test Average	Post test Average	Growth by Average
Control 1	Multiple	18.75	40.5	21.75
Treatment 1	Multiple	18.5	41.5	23
Control 2	Multiple	11	42.67	31.67
Treatment 2	Multiple	3	22.5	19.5

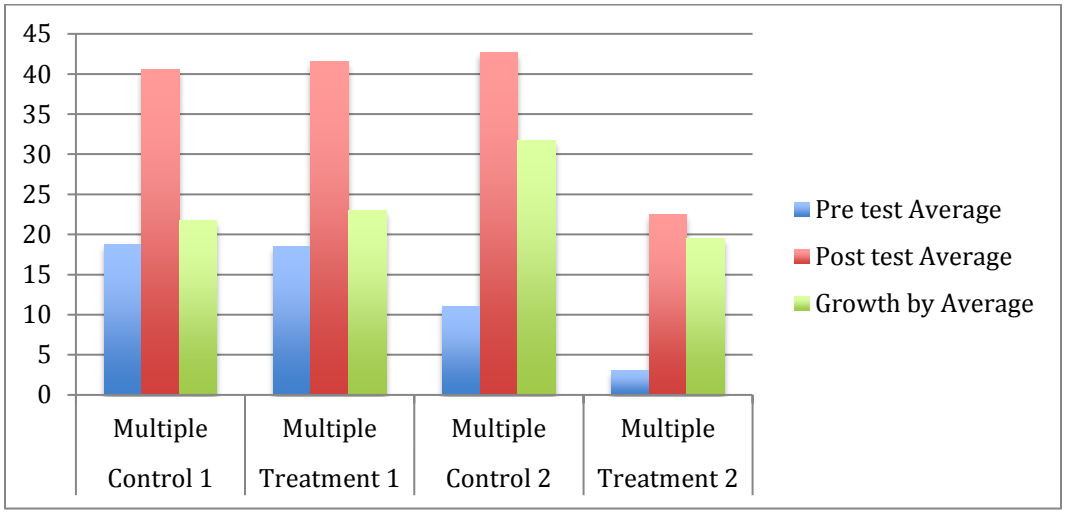

Figure 5:
Subset- Multiple Learning Style Learners

Next, the researcher analyzed data from the multiple learning styles subset group. Again, the small sample was noted making accurate data more difficult. However, of interest was the finding that all but one participant from within this subset was in part an auditory learner, and similar results were found between the multiple learners and auditory learners.

Again a substantial difference appears in Pair 2's control and test groups (similar to that of auditory learners), and very slight differences between the Pair 1 groups emerged.

Table 6:
Treatment Groups Growth Comparison

Subset Group	Average growth
Visual 1	24.5
Visual 2	27.5
Auditory 1	15
Auditory 2	24.33
Kinesthetic 1	28
Kinesthetic 2	35.9
Multiple 1	23
Multiple 2	19.5

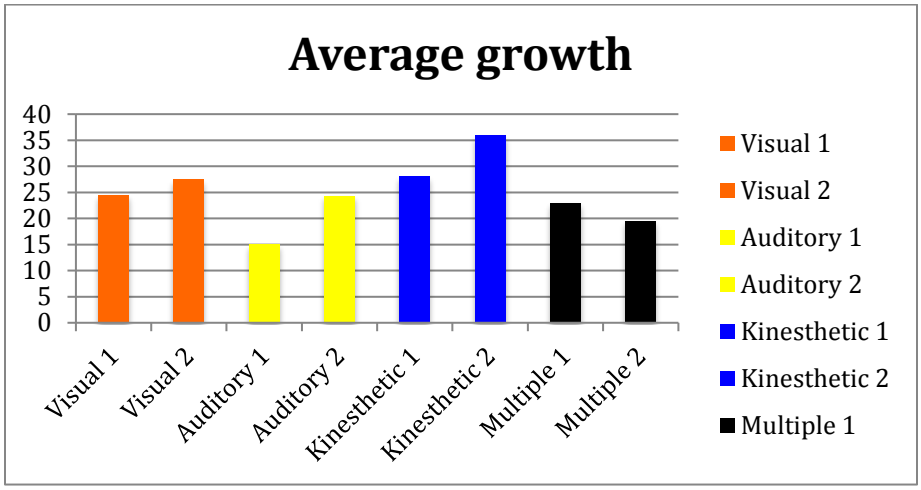

Figure 6:
Treatment Groups Growth Comparison

After analyzing each learning style for trends, important comparisons were also made by the researcher. Of note were the highest subgroup growth scores, which both came from kinesthetic treatment groups. Conversely, the auditory treatment groups showed the lowest growth on average, and the auditory treatment group from Pair 1 demonstrated the lowest growth of all subset groups. Upon further analysis, all but one participant from within the multiple group were also auditory, possibly explaining low scores in both categories

With such a difference in the degree of change between the learning styles the researcher was also interested in a comparison between the top 50% of degree of growth and the bottom 50%.

Table 7:
Bottom 50% of Student Growth from among treatment groups

Visual	Auditory	Kinesthetic	Multiple
5	5	8	3

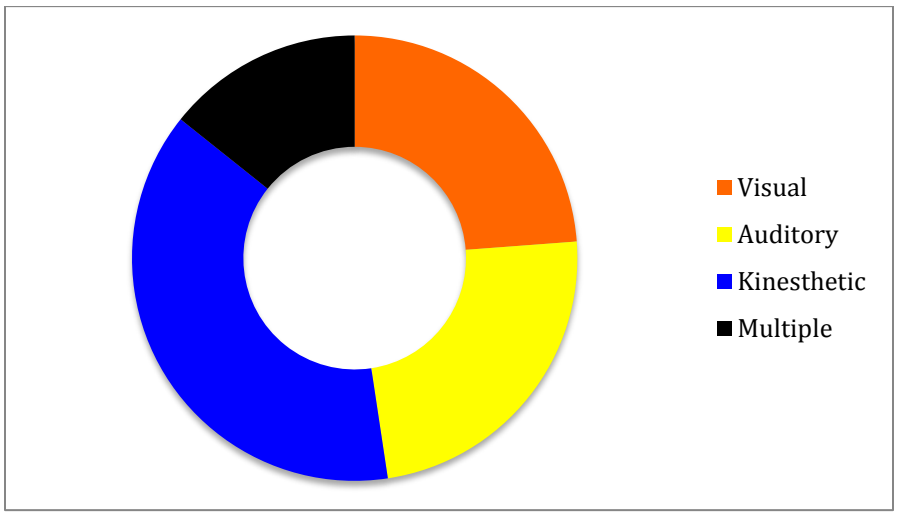

Figure 7:
Bottom 50% of Student Growth from among treatment groups

When examining the bottom 50% of growth the researcher noted the relatively equal amounts of participants within each learning style subset group, with only three more kinesthetic learners than visual or auditory, and five more kinesthetic learners than multiple learners. By contrast, Table and Chart 8 display the statistics found in the top 50% of growth. Here, the researcher noted 9 more participants coming from the kinesthetic learner group than the visual learner group, and 13 more kinesthetic learners than auditory or multiple. This overwhelming group of kinesthetic learners sharply contrasts the balance found in Table and Chart 7.

Table 8:
Top 50% of Student Growth from among treatment groups

Visual	Auditory	Kinesthetic	Multiple
5	1	14	1

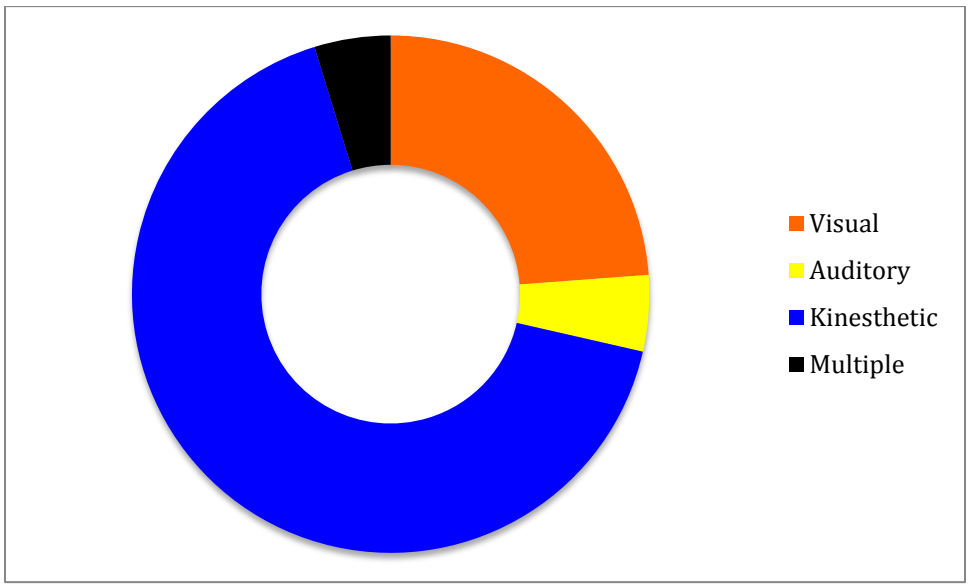

Figure 8:
Top 50% of Student Growth from among treatment groups

Table 9:
Kinesthetic Treatment Groups by gender

Group/Pair	Sex	Pre test Average	Post test Average	Growth Average
Treatment 1	Female	18	43.25	25.25
Treatment 1	Male	15.75	45.13	29.38
Treatment 2	Female	7.33	47.67	40.34
Treatment 2	Male	4.4	38.43	34.03

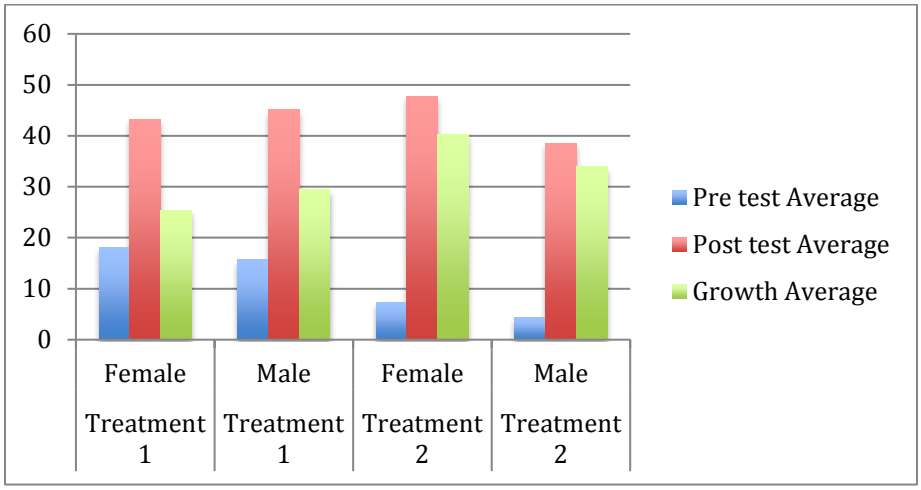

Figure 9:
Kinesthetic Treatment Groups by gender

A final analysis of the kinesthetic learner data left the researcher unable to determine a certain difference of the impact of visual assessments on male and female kinesthetic learners. With Pair 1's male participants outgrowing the females, but Pair 2's female participants showing greater degree of change, the findings were mixed. The males in Pair 1 scored lower on the pre-test than their female counterparts, but then outperformed them on the post-test. A different result was demonstrated by the males in Pair 2 who scored lower than the females on both the pre and post-tests. Thus, the females in Pair 2 benefitted most from among the treatment groups.

Discussion

Overview of the Study

The educational system has readily accepted and implemented the use of targeted learning style instruction and the use of formative assessment with the understanding that such strategies enhance student learning and performance (Tomlinson, 2000; Boston 2002; Stiggins, 2006; Popham, 2008). While there is evidence to support each technique, there is little to no evidence that the combined use produces an additional improvement in student learning (Rogowsky, 2015). The purpose of this study was to investigate the following question: To what

extent does the implementation of daily visual formative assessments impact the learning achievement of students with different learning styles?

- What is the impact of visual formative assessments on visual learners?
- What is the impact of visual formative assessments on auditory learners?
- What is the impact of visual formative assessments on kinesthetic learners?

To address this question, students within the treatment groups from each pair were instructed using daily visuals as formative assessments and the degree of change between the unit pre and post-tests from each of these students was analyzed. Comparisons between groups with each learning style were then evaluated against one another and the control groups.

Summary of Findings

After analyzing both pairs within the experiment the data suggested that the use of daily visual formative assessments may impact the learning achievement of each learning style to different degrees. Overall, the daily use of visuals will not automatically have a positive impact on all learners, as indicated in the overall pair table. However, significant results were demonstrated among the individual learning style groups.

The visual learners showed moderate growth in degree of change from the pre-test to the post-test. Mixed results were displayed between the two pairs in the study. Similarly, students from the multiple learning styles group also showed mixed results between the two pairs, but with less growth than the visual learners group.

The auditory learners demonstrated the least amount of growth from all subset groups. In fact, a sizable negative result was shown between the control and treatment groups from pair 1.

The most important finding of the study was the growth shown by kinesthetic learners. This subgroup demonstrated the highest levels of growth and was also the only subset to show

positive impact on the treatment groups from both pairs. Further analysis of the top 50% of growth shown by treatment participants indicated that this group was comprised of 66% kinesthetic learners.

Recommendations

Based on the given data, the research would recommend the use of daily visuals and visual formative assessments to aid kinesthetic learners in obtaining and retaining knowledge. The study confirms research from the literature review suggesting little to no automatic crossover between teaching targeted to a specific learning style and the achievement level of students within that same learning style. However, while the use of daily visuals did not significantly impact the visual learners subgroup, consistent and noteworthy impacts were demonstrated by the kinesthetic subgroup. The research confirmed a mixed pedagogical approach for best achievement results among all students. Worth noting however, was the enjoyment and confidence that students from among the treatment groups gained through the experimental study. Several students, both male and females, from within the visual learners group involved in the study voluntarily continued the visual formative assessment exercises after the scope of the study.

Limitations of the Study

The research was carried out with careful planning and oversight, yet there were several factors limiting the study and results. The supporting data was derived from a limited sample group. With just 84 participants to observe, instruct, and assess, the findings were very specific to this homogeneous group within one school community. Coupled with this was the limitation of pre-determined groups according to enrollment in the current semester. Thus, the groups were not randomly generated. To better understand the impact of teaching on learning style groups

more extensive research should be conducted in a variety of academic settings with randomly created sample groups.

Although its contents were widely utilized by organizations and schools around the country, the Learning Styles Questionnaire was not independently verified. Financial restrictions kept the researcher from using a more comprehensive and validated assessment tool.

In addition, the prior knowledge of some students most likely impacted the potential growth on the post-test. With a few students from pair 1 scoring surprisingly high on the pre-test, their potential for growth was limited. For more accurate findings the post-test should be designed such that students could not master all test material, thus capping their potential for growth as the current study did.

When considering future research on learning styles many avenues could be pursued. Continued research on correlations between specific teaching pedagogies and their impact on specific learning styles could demonstrate other unique crossover results such as the effect of visuals on kinesthetic learners here. Additionally, research could be done on the balance of teaching activities tied to specific learning styles within popular curriculum programs most widely used in today's classrooms. Finally, continued research could be conducted to determine the accuracy of learning style questionnaire tools when the measures/questions are self reported.

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Appendices

Appendix A
Learning style inventory

1. _____ I enjoy doodling and even my notes have lots of pictures and arrows in them.
2. _____ My written work doesn't look neat to me. My papers have crossed-out words and erasures.
3. _____ I don't like to read directions; I'd rather just start doing.
4. _____ I remember something better if I write it down.
5. _____ It helps to use my finger as a pointer when reading to keep my place.
6. _____ I learn best when I am shown how to do something, and I have the opportunity to do it.
7. _____ I get lost or am late if someone tells me how to get to a new place, and I don't write down the directions.
8. _____ Papers with very small print, blotchy dittos or poor copies are tough on me.
9. _____ Studying at a desk is not for me.
10. _____ When trying to remember someone's telephone number, or something new like that, it helps me to get a picture of it in my mind.
11. _____ I understand how to do something if someone tells me, rather than having to read the same thing to myself.
12. _____ I tend to solve problems through a more trial-and-error approach, rather than from a step-by-step method.
13. _____ If I am taking a test, I can "see" the textbook page and where the answer is located.
14. _____ I remember things that I hear, rather than things that I see or read.
15. _____ Before I follow directions, it helps me to see someone else do it first.
16. _____ It helps me to look at the person while listening; it keeps me focused.
17. _____ Writing is tiring. I press down too hard with my pen or pencil.
18. _____ I find myself needing frequent breaks while studying.
19. _____ Using flashcards helps me to retain material for tests.
20. _____ My eyes get tired fast, even though the eye doctor says that my eyes are ok.
21. _____ I am not skilled in giving verbal explanations or directions.
22. _____ It's hard for me to understand what a person is saying when there are people talking or music playing.
23. _____ When I read, I mix up words that look alike, such as "them" and "then," "bad" and "dad."
24. _____ I do not become easily lost, even in strange surroundings.
25. _____ It's hard for me to understand a joke when someone tells me.
26. _____ It's hard for me to read other people's handwriting.
27. _____ I think better when I have the freedom to move around.
28. _____ It is better for me to get work done in a quiet place.
29. _____ If I had the choice to learn new information through a lecture or textbook, I would choose to hear it rather than read it.
30. _____ When I can't think of a specific word, I'll use my hands a lot and call something a "what-cha-ma-call-it" or a "thing-a-ma-jig."

Appendix B
Student Learning Profile Record

Student Learning Profile Record

Name: _____ Class Hour: _____

Treatment Group: _____

Scores:

1. _____	2. _____	3. _____
4. _____	5. _____	6. _____
7. _____	8. _____	9. _____
10. _____	11. _____	12. _____
13. _____	14. _____	15. _____
16. _____	17. _____	18. _____
19. _____	20. _____	21. _____
22. _____	23. _____	24. _____
25. _____	26. _____	27. _____
28. _____	29. _____	30. _____
V: _____	A: _____	K: _____

Pre-test score: _____
Post-test score: _____
Degree of change: _____

Appendix C
Visual Formative Assessment: Flash Card Template

Map the Person: