THE USE OF LEARNING STYLES IN SCIENCE EDUCATION: VISUAL, AUDITORY, AND KINESTHETIC – DOES STUDENT PREFERENCE MATTER?

by

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ABSTRACT

Many educators believe that aligning instruction to learner modality based on the VAK (visual, auditory, kinesthetic/tactile) model improves learning outcomes. This study attempts to delineate these benefits in the context of a largely low-income urban middle school. This is accomplished by testing, surveying and interviewing 8th grade students on a science concept that was presented to them in one of the three modalities as outlined in the VAK model, and analyzing their ability, performance, and responses. Results determine that aligning instruction to student preference does not improve learning outcomes, and that instruction should more closely align with the modality that best represents the content being taught. However, through this process, students became empowered by their participation in the learning process, which ultimately lead to better student/teacher relationships and respectful classroom culture.

RESEARCH OBJECTIVES AND PURPOSE

By citing well-known and touted ideas such as learning modalities (Fleming & Mills, 2001), the theory of multiple intelligences (Gardner, 1983), and multisensory learning approaches, most educators share the belief in a general concept – that students differ in how they learn, and as educators, we need to individualize student learning based on student preference. However, these approaches to learning are often propagated through sharing personal ideas, opinions, and experiences, there is no universally accepted or reliable model, and peer-reviewed research is lacking (Pashler et al., 2008; Willingham, 2005).

It is no secret that science is a highly visually oriented enterprise, with much focus placed on charts, graphs, figures, data tables, computer models, and text. This is not surprising, since science has traditionally been communicated almost strictly through physical scientific journal publications. Because of this inherent preferred method of communication and data representation in the sciences, many students struggle with the comprehension and retention of scientific data. While research suggests that many students can learn better by using different or multiple senses, it is unclear what this would look like in a science classroom. *The goal of this research is to understand how student comprehension of science concepts varies with the type of learning modality utilized in a lesson, determine if aligning instruction and student learning modalities can improve student learning outcomes in my classroom, and evaluate student perceptions and reactions to learning through different instructional modalities*. In trying to identify how the students at Newberry learn best, my research objective is to take into account the students and their preferences, to try and provide them with ways in which they can engage in the curriculum, attempt to understand their preferred learning styles in order to create a curriculum to best suit their needs, and invite them to embrace their power as students to make choices to see what serves them best.

THEORETICAL FRAMEWORK

The learning styles theory refers to the idea that learners differ in regard to the type, or 'mode', of instruction that is most effective for them. The discourse within educational circles regarding student and teacher learning and instructional styles (visual, auditory, or kinesthetic) is common, and the vast majority of educators share the sentiment that catering instruction styles to learning styles improves performance and learning outcomes. This idea seems to make sense, and, anecdotally, matching instructional styles to student learning modalities works for teachers who are willing to put in the effort of differentiating their classrooms and lessons. The learning-styles idea has created a large industry that promotes the idea and sells learning-styles tests, guidebooks and workshops for educators of students of all ages, but even without taking a learning-styles exam, most people are adamant that they learn best in one way or another.

Many different models and theories of learning styles have been developed over the years – one recent study identified 71 different schemes (Coffield et al., 2004). While no model is universally accepted, they all share the central idea that individuals learn in different ways. The most common models used when assessing learning styles is referred to as 'learning modalities', or VAK (Visual, Auditory, Kinesthetic; Dunn, 1990), which claim that learners have a sensory preference for receiving and storing information that can be either auditory, visual, or kinesthetic. Of these models, the most popular are the Dunn and Dunn (1990) learning-styles model, Honey and Mumford's Learning Styles Questionnaire (1992), and Kolb's Learning Styles Inventory (1984). *I have developed my research study around the VAK learning-style theory because of its popular appeal and claimed effectiveness by practitioners.* According to this theory, most people possess a preferred learning style that is visual, auditory, or kinesthetic/tactile. ***Visual*** learners learn best by seeing, think in pictures, enjoy looking at things such as maps, charts, and videos, and have other visual skills. ***Auditory*** learners learn best by listening, have developed auditory skills, are generally good at speaking, think in words, and enjoy lectures and discussions. ***Kinesthetic/tactile*** learners learn best by moving, doing and touching, have good hand-eye coordination, process information through interacting with the space around them, and enjoy hands-on experimentation, crafts and building things.

Brief History, Appeal and Critiques

In a critical review of learning styles such as the VAK model, Pashler et al. (2008) identify learning-style theories as "type" theories (ones that classify people into distinct groups) and trace the lineage of these theories back to C.G. Jung's (1964) Myers-Briggs Type Indicator test, which provides information that purports to be helpful in making an occupational decision. While objective reviews and studies of the test show little support for its effectiveness (Druckman & Porter, 1991; Stricker & Ross, 1964), the test is still wildly popular today likely because its premise has some "eternal and deep appeal" (Pashler et al., 2008). Similar to the Myers-Briggs test, various learning styles tests, such as the VAK model, have little support in objective academic literature even after multiple expansive studies on the topic in recent years (Coffield et al., 2004; Pashler et al., 2008; Willingham, 2005). Learning style theories, according to Pashler et al. (2008), has these deep appeals, which include the appeal of being treated by educators as unique individuals, the simplicity of the idea itself, and the ability to place blame on educators who *do not* tailor their instruction, rather than the student.

LITERATURE REVIEW

Three studies on learning styles are reviewed here, two of which are action research studies, and one of which is a peer-reviewed academic study. I found it difficult to find robust, empirical, peer-reviewed academic studies on the topic of student learning styles, and the one that I did find (Massa & Mayer, 2006) was conducted using college students. There is, however, no shortage of action research projects on the topic of student learning styles, and the two chosen for this review are typical representations of the wider literature.

As a graduate student, Melinda Zeeb (2004) conducted an action research study that analyzed high school students' learning needs, such as preferences and non-preferences in areas such as lighting, sound, mobility, intake, time of day preference, sensory modalities, and brain dominance, and to create awareness among the teachers, students and parents of the school of the learning process. The analyses used were the LSA-Senior test (for students) and the TSA-Education test (for teachers), put out by Prashnig Style Solutions, that, according to their website, reports that provide information on how students learn best, including student and teacher learning and instruction styles, respectively. The research, that included 276 students, concluded that the results of learning style analysis tests provided information on how to create a classroom environment conducive to learning, suggested useful management strategies, and informed the use of multi-sensory teaching methods and lesson planning techniques, but does not go into detail about specifics as to what types of learning strategies were preferred or worked best.

In a more robust action research study, 7th grade teacher Julie (2010) attempted to introduce kinesthetic/tactile instruction in her low-achieving math class in a rural middle school with "a significant number" of economically disadvantaged students. The problem was that the students were learning, but not remembering concepts learned in prior classes and grade levels. The researcher realized that in middle school, math becomes much less kinesthetic than in previous grades, forcing students to usually sit in a traditional lecture classroom for extended periods. The study explores if teaching math concepts in a kinesthetic/tactile way has a positive effect on student learning in middle school mathematics. The researcher conducted a survey, lessons using all three learning styles (auditory, visual, kinesthetic), and student interviews. She observed improvements in behavior, quiz and test sores, and growth in confidence among students, noting that the growth in confidence was the most positive effect of all. Her results and analysis is much more in-depth than Zeeb (2004), and includes charts and graphs of data, daily reflections, student feedback, and test scores to support her conclusion that using "manipulatives" in her math class improved student learning and confidence. Her approach is learning and learner centered, which allows the students to be reflective practitioners actively engaged in evaluating the ways in which they learn.

After scouring the *peer-reviewed* literature – as opposed to *action* research or non-reviewed resources, such as Zeeb (2004) and Julie (2010) – I finally came across this empirical study on learning styles. Massa and Mayer (2006) conducted a study of learning styles of college students with three experiments. To do this, they created a computer-based electronics lesson (similar to the computer-based lesson developed for the current study) that provided instruction to either verbal or visual learners, which included printed text or diagrams and illustrations. Students were identified based on their preference by administering a variety (20 total) of preference-based and ability-based tests. In this much more rigorous setting than the other two studies analyzed, Massa and Mayer found no significant tendency for better performance by those who received instruction that matched their learning preferences (ex. visual learners did not necessarily learn best from visual instruction). After replicating the tests, they concluded that there was no support for the proposition that different instructional methods should be used for visual and verbal learners.

Analysis and Implications

In Zeeb (2004), the bulk of the reliability of the methodology lies in the reliability of the learning style tests given to the 276 students and 20 teachers at the school. I found no critical analyses or peer-reviewed sources analyzing these particular tests, so their reliability remains unclear, at best. The researcher did report that the mere act of showing interest to the students about the way in which they learn and trying to align teaching strategies – regardless of its ultimate success – did lead to better classroom management and student response, which I consider the main take-away from this study. Prior to using manipulatives, Julie (2010) did conduct a learning style test on the students to find that nearly half of her students are primary kinesthetic learners. She based her whole study on this knowledge, so I would have liked to have seen a lot more about why she used the test, its reliability, and at the very least, the name of the test, which is not provided. Many recent in-depth, peer-reviewed papers regard such tests as under-researched and unreliable. Zeeb (2004) often makes blanketed, unsubstantiated claims, such as "The problem was that many times a student struggles in school because a teacher's [teaching style] conflicts with the student's [learning style]". She also provides claims of the outcome of her experiment, such as "Matching students' [learning styles] with the appropriate [teaching styles] always led to successful interaction between teachers and the student, and resulted in improved learning outcomes" (Zeeb, 2004), which are neither backed by scores or other data, nor are even very believable. Similarly, Julie (2010) takes the results from her learning style test as fact without questioning the reliability of the preference test. Massa and Mayer (2006) highlight the distinct difference between action research and peer-reviewed academic research on this topic, and the disparity of learning style beliefs between practitioners and academic researchers. Practitioners almost unanimously believe that identifying student learning style preferences and aligning them with instruction – whether this attempt is manifested in their classroom practice or not – is important to providing meaningful student learning, while academic researchers almost unanimously are of the conclusion that while learning and teaching preferences make little differences, topics should be taught based on the educational *subject's* best preference (ex. when teaching geography, you must use visuals).

As Zeeb (2004) pointed out, it seems the benefit of pursuing learning style studies in the classroom is derived not from the actual studies themselves, but rather the act of including of the students into the study, and showing students that their teachers care about their learning, and empowering them to reflect on, and have input in, their learning experience.

METHODS

This study took place in the 8th grade science classroom at Newberry Elementary Math and Science Academy in the Lincoln Park neighborhood in Chicago, IL. The school's demographics are 39% Black, 30% Hispanic, 23% White, 5% Asian, and 4% other, and 63% of the students are from low-income households. There are two classes of 8th grade science totaling about 60 students. The school is on a block schedule, and the classes meet every other day for 90 minutes. Just this year, Newberry implemented a 1-to-1 Chromebook program in their 6th-8th grade classrooms that emphasizes the use of the DigEdu platform, which allows students to go through topic modules on their personal computers that can include audio, video, and interactive simulations. Based on brief discussions with many students, this platform has been well received by the 8th graders who, like most young people, are technologically inclined. The DigEdu platform is a new technology which claims on their website,

> "DigEdu recognizes that individualized learning is a key to truly engaging and reaching all students, which is why we enabled our platform to allow for easy differentiation for groups or individual students. As soon as you've gotten your lesson ready for the class, you can adjust it to meet the students' different needs and learning styles, and they won't be embarrassed when you hand them a differentiated worksheet."

Three DigEdu computer modules were developed on the basic physics topic of understanding and graphing position vs. time. This topic was chosen because (1) it can be taught in many ways, (2) has no obvious modality that best matches the content, (3) is a relatively simple concept but requires abstract thinking, and (4) includes both text and data representation that can be adjusted to fit all modalities. Prior to beginning the survey, all students were informed of the purpose of the study, the idea of the VAK model, and a description of the different types of learning styles with examples. Following this introduction, students were given a four-part module that included an introduction (p.18), lesson (p.19), short quiz (p.24), and reflection (p.26). All parts were the same for all students except the lesson portion, which was differentiated into primarily visual (p.19), auditory (p.22), and tactile/kinesthetic (p.23) modalities. According to the VAK learning styles model, these are the three primary ways in which information can be presented. The three different modules included similar content, but differed in the way in which the student received/interacted with the content: the **visual** instruction included only written text and supplementary graphs, the **auditory** instruction included only videos in which the content was verbally explained with supplementary images, and during which the students had a chance to discuss the content with other students, and the **kinesthetic/tactile** instruction directed students to an interactive online simulation in which the students could manipulate a graph in order to experience the physical relationship. The data from the module was collected digitally for analysis. Two groups of three students (six total) were selected for interviews. The two groups consisted of a student who was given instruction in each modality. One group of students performed very well on the content quiz (students 1 through 3) while the other group was average (students 4 through 6).

DATA/FINDINGS

Quantitative Analysis

Fifty-one students completed the survey and quiz, and 17 students each were randomly assigned either the visual, auditory, or kinesthetic/tactile modality preference quiz. Figure 1 (p.27) is a graphical representation of the survey and quiz results, which shows how many students in each modality group answered each of the six quiz questions correctly. From the graph, we can extrapolate which questions were more difficult for the students as a whole (questions 4 and 5 - these questions require a more abstract understanding of the topic). No group did significantly better on these, or any of the other, questions. However, since the modality instruction that the students were given were assigned randomly and not based on their personal preference, the even distribution of quiz results was to be expected, and even validates the fairness between each type of instruction.

The data that has the most profound implications for the purpose of knowing if aligning instruction modality to student learning modalities is shown graphically in Figure 2 (p.27). This graph shows students who both prefer and were instructed within a certain modality (blue), as well as students who prefer a different modality than that in which they were instructed (red). The graph seems to show that students who were instructed within their preferred learning modality did slightly better than their counterparts who preferred a different modality than that of which they were instructed. However, a 'difference in means' statistical analysis based on number of respondents (population), average correct answers and standard deviation concluded that these results are not statistically significant even at an 80% confidence level (95% confidence is generally accepted as significant among statisticians), and therefore cannot be considered evidence that teaching toward students' preferred learning style is beneficial. A future study that includes many more students could provide more robust data with statistical significance.

Other quantitative data shows that students liked the visual lesson the most, and the kinesthetic lesson the least (Figure 3, p.28). Also, students think that, as a whole, teachers at their school provide instruction that lacks in the kinesthetic/tactile modality (Figure 4, p.28), but their science instruction, specifically, implements all three modalities equally (Figure 5, p.28).

Qualitative Analysis

In addition to quantitative results, I also interviewed six students on their experiences with the module and their learning in general, as well as took notes about the whole class reaction and experience to the study. From these observations and interviews, and few trends appeared: (1) many students didn't have a strong preference for one learning style over another, and a few were able to articulate that the learning style should be dependent on the content, (2) most students seemed to agree that a healthy mixture of the three types of learning are important, and (3) almost all students (both interviewed and observed) were unusually interested and cooperative during the research process, and responded positively to the instruction and task.

Only 25% of the students surveyed responded that they "*definitely* have a preference" when it comes to their learning style. This suggests that while the students were curious about the idea of having a learning preference, a majority of them were apprehensive about categorizing themselves quickly into a box. This skepticism materialized organically during the discussions in each interview group. From group 1, student 3 remarked:

> It really depends on the context of what you're learning, like a project we just did now, like seeing the pennies and stuff, obviously that was a cool experience and stuff, so that helped, but like it really depends on the activity.

The experiment with the pennies this student is referring to was a science activity we did in class prior to the interview in which students had to describe how inertia played a role during a situation in which they could knock out the bottom penny from a stack of pennies without knocking the whole tower over. The students all agreed that this experiment was useful in learning about inertia, but agreed with Student 1 that not all knowledge can be learned by doing a hands-on activity when she said, "The only time we ever actually do that is in science, because you can't really do that in English and math". When asked about how the penny experiment either helped or hindered learning about inertia, student 5 responded:

> I mean, if we saw it on a computer, for example if some random person just did that, I wouldn't say I wouldn't understand it, it would just be harder for us to get the point, but if she told us, like if we heard, then I wouldn't have gotten anything. So she makes those experiments or study lessons or whatever you want to call it, she makes it… I don't know

> the word but she makes it fun to do because she either will see it on the computer or we'll do it ourselves and it helps us understand what we're doing better, because every way doesn't work for everything, so we just do the ways that does work.

This student is saying that not every modality works for every lesson, so it just makes sense to implement the modality that makes the most sense for particular subjects. When it comes to inertia, it just makes sense that students *experience* it to understand the concept. Separately, in interview group 2, student 4 brought up the same point:

> I think it depends on the subject. In science, I think you have to touch stuff, so you can get a better understanding. But, like math, you have to be able to see the equation, and then you can do it, but like reading you have to be able to listen to her read the story to comprehend it, so it really depends on the subject.

These insightful students are not alone in thinking that the instruction modality should not be determined by the students' preferences, as most practicing educators and action research authors seem to think. Instead, the students think that instruction modality should be determined by the instructional content – a view shared by academic researchers on this topic (Coffield et al., 2004; Pashler et al., 2008; Willingham, 2005).

As the students pointed out, however, this does not mean that a particular subject should only be taught in the single modality that makes the most sense, but that there should be a healthy mixture of instruction so that all students can learn. Students in group 2 discuss the importance of learning about a topic in a variety of ways:

> Student 4: I couldn't just learn with visual things, I feel like I would need at least the auditory and visual. If I was just going to do visual, like, not at all.
> Researcher: So just reading a textbook is no good?
> Student: 4: Yeah, like that's why I don't understand the social studies book, I think the first time we did it, we had to read it by ourselves and answer questions, and I failed it…
> Student 5: But she went over it with us and we did pretty good…
> Student 4: And then the second time we went over the book, she actually read it, explained it, and did a diagram on the board, and that made me understand a *whole* lot better.

The students' inability to understand the text until they were able to discuss it and view a diagram seemed to be a class-wide phenomenon. Once the teacher incorporated more learning modalities than simply reading text, the students understood it "a *whole* lot better". These students describe, without knowing it, the 'multisensory learning approach', which has been validated by academic research (Kátai et al., 2008; Hung, 2003), and suggests that using a range of sensory approaches in teaching allows different types of learners to engage with the content, instead of determining a learner's modality preference and catering teaching to this preference. These same students discuss the importance of knowing how to learn and engage in all modalitites in life outside of school, and how they are not mutually exclusive:

> Student 5: …so it's better to get all of the ways, like, we're going to have to know all of the ways to understand using auditory and tactile and stuff like that, and this is like getting practice, so they're all teaching us in different ways, or more than one way.
>
> Student 4: …for me, science is not very, like, I can't comprehend it very well. But if I actually do something, like listen to it and see it, I think it will click [snaps fingers] like that.

The last major trend I found in this data is that, as a whole, students were noticeably more interested and cooperative as I was presenting my research and interviewing them than they are during a typical day of standard science instruction – they intently listened to my overview of learning styles, asked many questions about the research and their role in it, and were delighted to hear that their input will make a difference as to how I will formulate my lessons when I begin student teaching later in the year. These students are not so often engaged in the learning process. My interaction with students 4 and 5 revealed what I hope the rest of the students were thinking:

> **Student** 5: I think you're a cool person in life. All the other people I didn't like as much, I mean maybe because one of them was pregnant, and that kind of made…
> **Researcher**: What are you talking about?

Student 5: I mean, like, student teachers, in general, and she was kinda cranky. I mean, we had teachers who didn't really care about, that they would teach us a lesson, and they would say, "read the book, have fun, enjoy life", you actually help us!
Student 4: And this is the first time we've had an interview! I think you're cool, you're very cool. And you're a "Good" person!

In attempting to understand how these students learn on an individual level, and by interviewing them about their experiences and empowering them with a voice that can influence their experiences, these students feel like I really care about them as individuals and unique learners (which I do!). This simple fact engaged the students in their education, and compelled them to tell me that they appreciate this effort.

IMPLICATIONS FOR PRACTICE

As a future student teacher in these 8th grade classrooms, the experience of being able to empower students with having a voice in their education was very positive for both the students and myself. Asking for their input both through the computer survey and in personal interviews helped us reach a higher level of respect for each other that has only benefitted our current relationships and my future classroom management strategies. As described before, I am not the only practitioner who has experienced this, as both Julie (2010) and Zeeb (2004) reported improvements in behavior, growth in confidence, and better classroom management and student response. However, these types of student responses are separate from the effectiveness of learning style models themselves, such as VAK. So, even though there were many positive outcomes of this research, I worry that I have mislead students into thinking that they are only capable of learning well in a particular modality. Instead of repeating learning styles research such as this, which nearly all peer-reviewed academic studies and this current study have determined to be unproductive, it would behoove practitioners to implement the parts of this study that *were* productive, such empowering students by creating an inclusive environment, showing them that their teachers care about their learning, and engaging them to reflect on, and have input in, their learning. This can be accomplished independently of learning styles research by any number of communicative strategies that allow for an open, respectful dialogue between students and educators.

CONCLUSION

Exploration of student learning styles, such as outlined in the VAK model, has long had – and continues to have - praise, appeal and anecdotally positive outcomes in educational circles, and its implementation by practitioners most certainly comes from a good place. However, as educators, we must be willing to constantly reflect and reevaluate even our most strongly held ideas in the best interest of our students. From this study, and the vast majority of peer-reviewed studies on the subject, we know that aligning instructional preferences to student learning preferences based on learning styles models such as VAK is an exercise in futility in and of itself. This is not to say that students do not vary in the ways that they learn best, but rather attempting to individualize their instruction is not useful. Instead, both students in this study and researchers of these ideas suggest the modality of instruction is most beneficial when aligned with the content in the lesson (ex. using a map to teach about geography), and using as many modalities as the content allows – regardless of what students "prefer" – is the most effective means of instruction. This study highlights, however, the many positive outcomes in student dispositions, student/teacher relationships and classroom management derived from empowering students with a voice in the classroom that can, and should, be implemented regularly, independently from learning style research.

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APPENDIX

(Part 1 of 4 – All students surveyed)

How do you learn best?

Some education specialists have suggested that students differ in the ways that they learn and process new information. They say students can primarily learn best in one of three ways:

Visual - learn best by seeing information (*PowerPoints, diagrams, textbooks, etc.*)

Auditory - learn best by hearing information (*listening to and talking with teacher and/or peers.*)

Tactile/Kinesthetic - learn best by physical interaction with information (*feeling/touching, labs, manipulating objects*)

Do you have a preference for how you think you learn best, or do you learn equally well all three ways?

- ☐ I *definitely* have a preference
- ☐ I *think* I have a preference
- ☐ I learn equally well all three ways
- ☐ I am not sure...

If you have a preference, which do you prefer?

- ☐ Visual
- ☐ Auditory
- ☐ Tactile/Kinesthetic
- ☐ No preference

Why do you prefer this method? Or, If you don't have a preference, why not?
(free response)

Which method is used most by teachers at Newberry?

- ☐ Visual
- ☐ Auditory
- ☐ Tactile/Kinesthetic
- ☐ About the same
- ☐ I don't know...

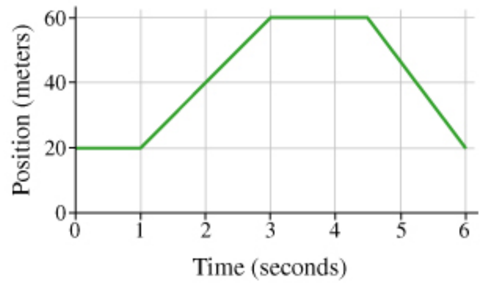
Which is used most in your science class?

- ☐ Visual
- ☐ Auditory
- ☐ Tactile/Kinesthetic
- ☐ About the same
- ☐ I don't know...

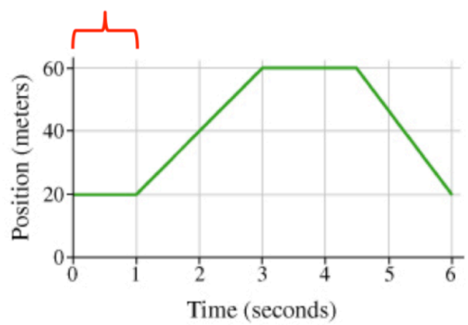
(Part 2 of 4 – VISUAL MODALITY – 17 (*one third) students instructed)*

Position vs. Time Graphs

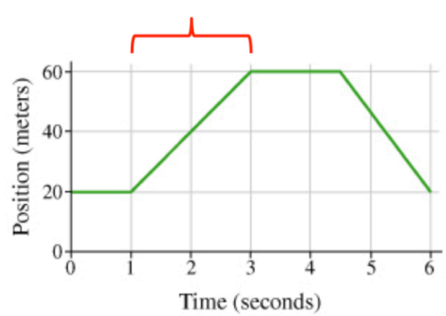
Positions vs. time graphs are a way to represent the motion of an object on a graph.



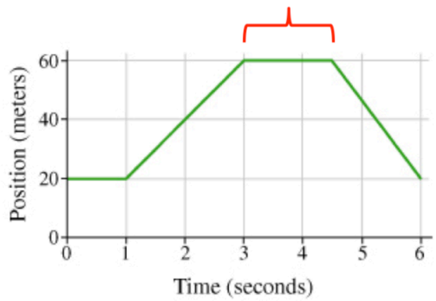
Above is a position vs. time graph of, let's say, a cat. As you can see in this graph, time (in seconds) is represented on the x-axis (the bottom of the graph), while the position (in meters) of the cat is represented by the y-axis (the left side of the graph).



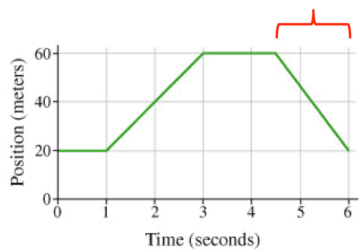
As time progresses from the beginning until 1 second (as indicated by the red bracket), we can see that the cat's position remains at 20m, so we know the cat has not moved.



Between 1 and 3 seconds, the cat's position changes from 20m to 60m. This means that the cat moved forward at the same speed for two seconds, and went 40m – that's a fast cat!

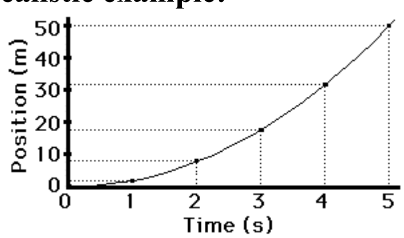


Between 3 and 4.5 seconds, we see the line remains at 60m, so we know that the cat does not move (probably taking a break after running so quickly…)



Between 4.5 and 6 seconds, the cat's position changes from 60m back down to 20m. This means that the cat moved 40m back to where it started at the 20m position. BUT, it did so in only 1.5 seconds, which means it moved FASTER than it did between seconds 1 and 3, which was the same distance, but took 2 seconds instead of 1.5.

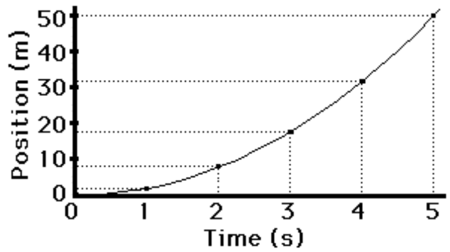
OKAY, here's another, more realistic example:

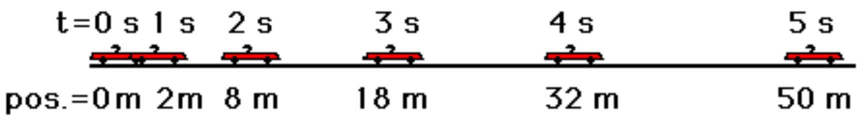


Just like the last position vs. time graph, this has time (in seconds) at the bottom, and position (in meters) on the left. Let's say this one is a car, starting at position 0.

What do you think the curved line means? (free response)

Unlike the last graph, which had a straight line go directly to a sloped straight line, this graph has a gradual curve upward. This means that the car is accelerating, starting slowly, and but getting faster and faster.





Notice on the graph how the lines coming up from above the x-axis (time) hit the curved line and correspond with the numbers on the y-axis (position):

- At 1 second, the car is at 2m
- At 2 seconds, the car is at 8m
- At 3 seconds, the car is at 18m
- At 4 seconds, the car is at 32m
- At 5 seconds the car is at 50m

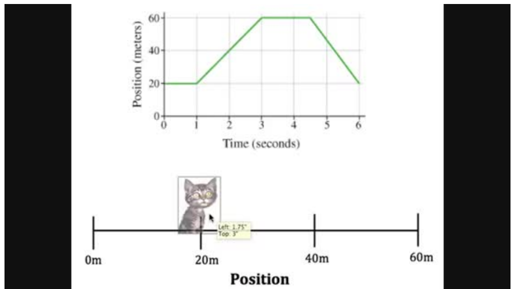
Can you see how this means that the car is speeding up?

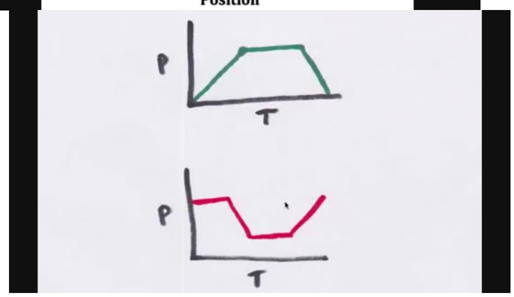
Okay, now that you know how to read position vs. time graphs, let's test your understanding. PLEASE RESPOND TO THE FOLLOWING QUESTIONS TO THE BEST OF YOUR ABILITY!

(Part 2 of 4 – AUDITORY MODALITY – 17 (one third) students instructed)

Position vs. Time graphs

Just watch the two videos below!





Links to videos provided within DigEdu platform. Videos can be found at:
http://www.youtube.com/watch?v=vaTqzFCBtrA
http://www.youtube.com/watch?v=iyRfacIJJiI

Question 1 (Instructions provided in video)

- A
- B
- C
- D
- I have no idea...

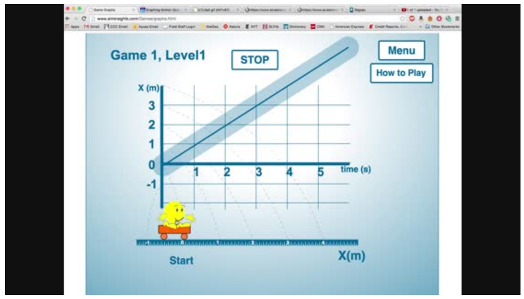
Question 2 (Instructions provided in video)

- A
- B
- C
- D
- I have no idea...

(Part 2 of 4 – KINESTHETIC MODALITY – 17 (one third) students instructed)

Position vs. Time Graphs

Watch the video below and follow the instructions:



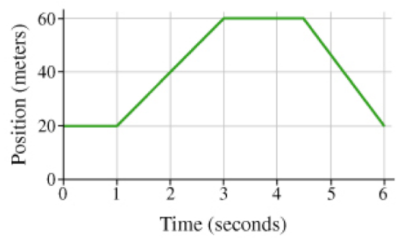
Video can be viewed at: http://www.youtube.com/watch?v=JlHfprD9wFE

Now, like I said in the video, try to recreate the shape of these TWO graphs in the online simulation. Don't worry about the numbers when recreating your shapes. BUT, do think about what the graphs *mean* in terms of how they describe the movement of the little yellow cart man (Is he moving backwards? Forwards? Standing still? Going fast or slow?).

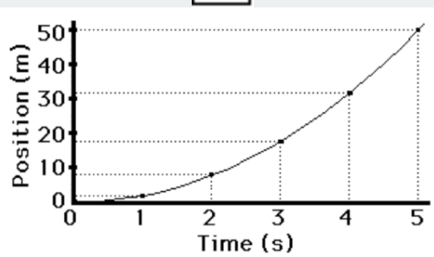
Answer the short questions after recreating each graph, then go through a couple levels in the simulation.

Here is the link to the simulation:

http://www.siminsights.com/Games/graphs.html



Describe the movement of the yellow cart man between 0 and 3 seconds, according to this graph. What is he doing? How far did he move? (free response)

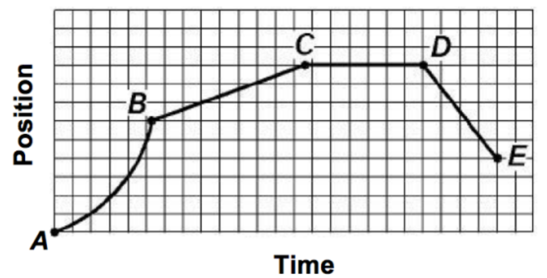


What is the yellow cart man doing when you recreate this graph? (free response)

(Part 3 of 4 – All students surveyed)

Short Quiz

Please do your best to answer all of the questions to the best of your ability. Remember, the purpose of this activity is to determine how YOU learn best!



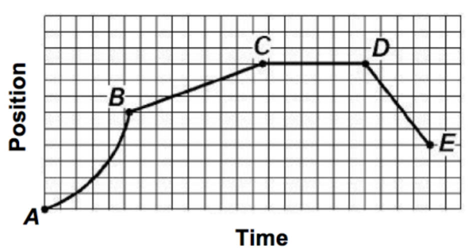
1. This is a graph of Mrs. McKinney walking through the hallway during lunch hour. Which segment of this graph represents Mrs. McKinney when she is not moving?

- AB
- BC
- CD
- DE
- None

1 point

2. Which segment represents Mrs. McKinney walking backwards?

- AB
- BC
- CD
- DE
- None



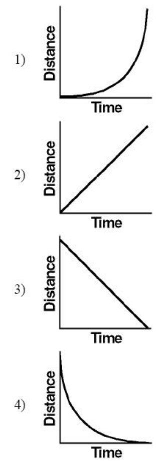
3. What is Mrs. McKinney doing during segment AB?

- Walking forward at the same speed
- Walking backward at the same speed
- Speeding up to catch a student
- Slowing down because she's out of breath

1 point

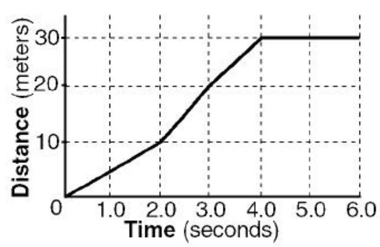
4. Is Mrs. McKinney going faster during BC or DE?

- BC
- DE
- Same speed



5. From the graphs above, which represents the motion of an object whose speed is increasing? ('Distance' means the same thing as 'position')

- 1
- 2
- 3
- 4
- None



6. The position vs. time graph above represents the position of an object moving in a straight line. What is the speed of the object during the time interval time = 2.0 seconds to time = 4.0 seconds?

- 10 m/s (meters per second)
- 5 m/s
- 0 m/s
- 7.5 m/s

(Part 4 of 4 – All students surveyed)

Reflect - How do you learn?

Did you like the way the information in this lesson was presented?

- ☐ Yes
- ☐ No

Why or why not? (free response)

Do you think you learned the material and did well on the quiz?

- ☐ Yes
- ☐ Kinda...
- ☐ No

Would you be willing to let me (Mr. Good) interview you about this lesson and your experience?

- ☐ Yes
- ☐ No

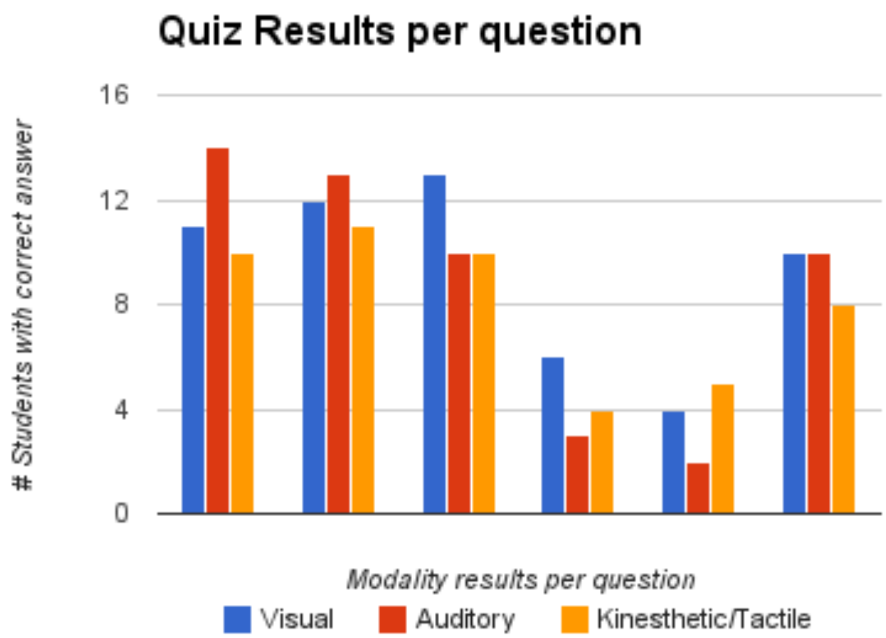


Figure 1 - Quiz results per question - This graph shows the number of students in each modality group who answered each question correctly. Numbers are out of 17 possible correct answers (17 students instructed in each modality group).

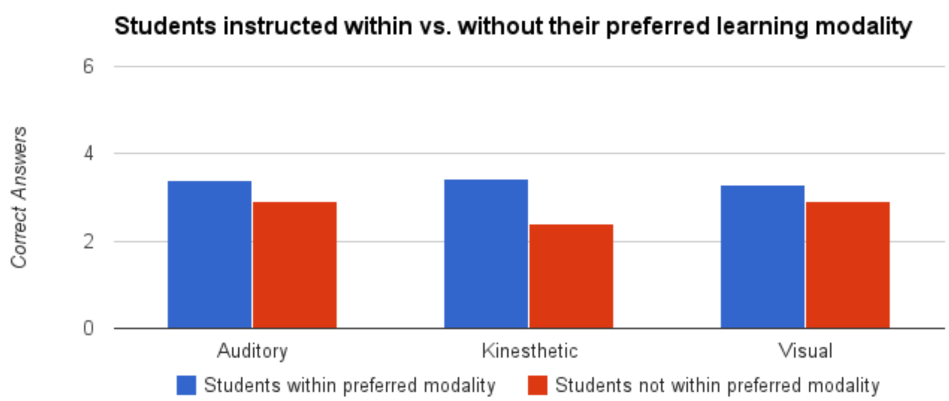


Figure 2 – Students instructed within vs. without their preferred learning modality. This graph shows students who both prefer and instructed within a certain modality (blue), as well as students who prefer a different modality than that in which they were instructed (red). The graph seems to show that students who instructed within their modality did slightly better than their counterparts who preferred a different modality than that in which they were instructed. However, a 'difference in means' statistical analysis based on number of respondents (population), average correct answers and standard deviation concluded that these results are not statistically significant even at an 80% confidence level, and therefore cannot be considered evidence that teaching toward students' preferred learning style is beneficial.

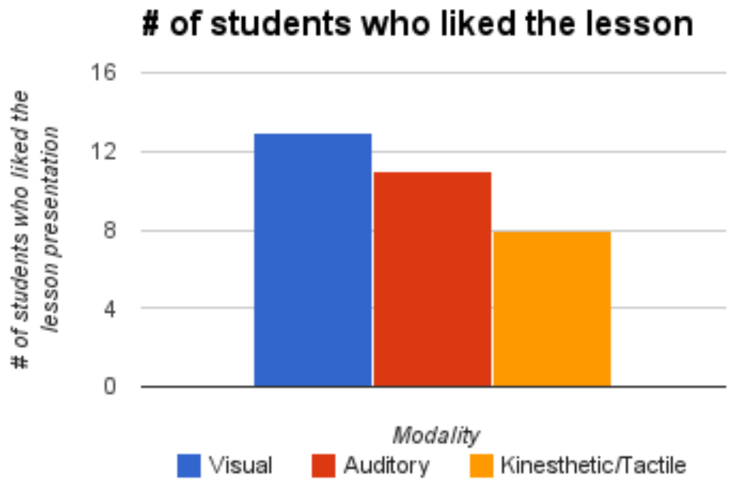


Figure 3 – This graph shows the number of students who liked the way in which their lesson was presented

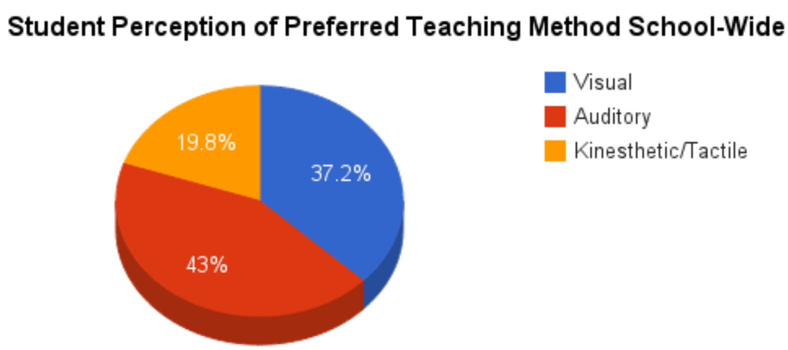


Figure 4 – Results of students' perceptions of their teachers' (school-wide) teaching method. Note that Kinesthetic/Tactile is a teaching method that students think is generally lacking in their school.

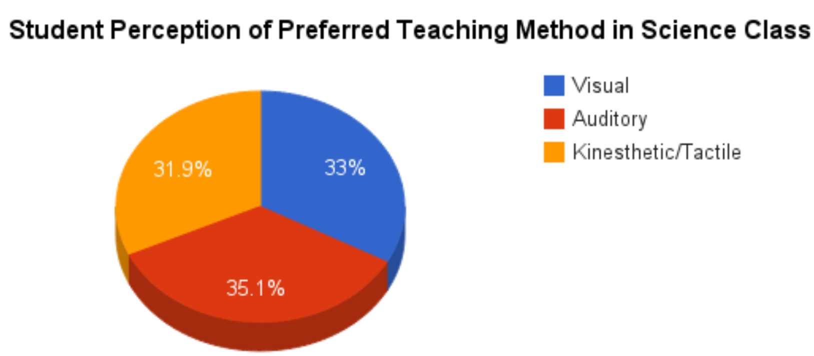


Figure 5 – Results of students' perceptions of their science instruction method. Note that all three methods are equally addressed.