Investigating the Impact of Video Instruction in a High School Chemistry Class

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Abstract: High school chemistry students struggle with the unit on moles due to their lack of algebraic skills and understanding of dimensional analysis. Moles is typically taught using the traditional lecture model, however, change was needed to teach the current generation of students. Therefore, the purpose of this action research project was to investigate the impact of integrating video instruction to increase learning and engagement for high school chemistry students studying a unit on moles. Through constructivist ideals, an intervention was designed where students watched a short video at the beginning of each class and collaborated on practice problems, allowing students to be actively engaged and take ownership of their learning. At the end of each class, students completed an exit ticket to check for understanding to determine the effectiveness of the video instruction. Upon completion of the unit, students took a summative assessment and completed a post-survey to assess learning and engagement. This project was important to show how video instruction can affect learning, engagement, and retention with students. Based on feedback from students, my next steps are to convert my traditional lectures into video instruction in my biology and chemistry classes. In order to increase engagement, learning, and retention, I need to continue to adjust my teaching in order to support the current generation of learners.

Introduction

Every year I notice that my high school chemistry students have a difficult time making connections to prior knowledge of algebraic concepts and dimensional analysis, thus making the unit on Moles so challenging. Typically, the unit is taught using the traditional lecture model with sample problems on the board, followed by practice problems from a worksheet. However, students often struggle throughout the unit due to their low math skills and difficulty with the manipulation of various conversion factors. As a result, students are not engaged in the course content, are unable to make appropriate connections and are not retaining the information required to pass the end of unit test.
The current generation of students learn differently. When given an assignment using technology, I’ve noticed that they are more focused, on-task, and have a longer attention span compared to an assignment printed on a handout. I have also noticed that students prefer to take notes on their own from Google Slide notes distributed through Google Classroom; they are able to take notes at their own pace and effectively contribute to a class discussion. As a result, changes need to be made in order to teach the current generation of students, rather than ignoring them and their needs (Gurvitch & Lund 2014). Technology and constructivism enhance thinking, problem solving, and learning (Gilakjani, 2013). Therefore, it was time for me to make teaching and learning more current and meaningful.

Therefore, the purpose of this action research project was to investigate the impact of integrating video instruction to increase learning and engagement for high school chemistry students studying a unit on Moles. The following research questions were investigated:

1) How does video instruction impact learning?
2) How are students engaged through video instruction compared to the traditional lecture model?
3) How can students make appropriate connections and retain the information required to pass the end of unit test?

**Literature Review**

Action research is a method to improve one’s own teaching in order to improve student learning. Action research is more systematic and data based than personal reflection, however it is more informal and personal than formal educational research. In action research, the teacher focuses attention on a problem or question about his or her own classroom (Mettetal, 2012, p. 6).

Constructivism is a learning process where knowledge is built on a foundation of prior knowledge and that learning is a result from experiences and ideas (Krahenbuhl, 2016). A constructivist classroom includes the following: student collaboration, student input in the teaching and learning process, students are treated as thinkers, teachers seek student feedback in order to better understand student learning, and assessment of student learning is an integral part of the teaching and learning process (B. Martin-Stanley, C. Martin-Stanley, 2007, para. 1). In a constructivist classroom, students come to class with their personal experiences, and cognitive and affective skills, which influence their perspective of how the world works (Sanaa, 2006). Sanaa (2006) found that students who were part of a student-centered learning environment came to class prepared and benefited from various learning strategies.

Krahenbuhl (2016) states that the implementation of technology in constructivist classrooms enables students to be more responsible for and active in the learning process, contributing to an increase in learning outcomes. Gilakjani, Leong, and Ismail (2013) state that constructivists believe there is a place for practice and drill. In addition, computers can serve as coaches and allow for as much practice as needed. Computers
enhance thinking, problem solving, and learning (Gilakjani, Leong, & Ismail, 2013, p. 57).

Several studies examined the effectiveness of technology in science classrooms, which included: video-based preparation and in class problem solving, using supplemental proprietary software, and flipped classroom instruction. All studies showed a gain in post test scores compared to the control group. The video-based preparation and class problem solving study discovered that the video assignments stimulated student interest and engagement and they learned the material better as they had the opportunity to work on problems during class time (Stockwell, 2015). The study that used the supplemental proprietary software found that students were able to demonstrate their visual and conceptual understanding of dimensional analysis. Integrating technology provides teachers a way to engage students and present content with images that serve as visual cues to help students link measurement units (Ellis, 2013). The flipped instruction study suggests that students may have benefited from various active learning strategies. Flipped instruction provides a way for students to grapple with complex concepts and debate and discuss meaning with their peers (Leo, 2016).

Project Design & Development

In order to replace the current traditional lecture method curriculum on Moles, I had to: include dimensional analysis into the curriculum, search for and create videos that would scaffold the content material, create practice problems for students to work on in class, and create daily exit tickets to check for student understanding.

Dimensional Analysis

According to the literature review, high school and college students come to chemistry class unprepared for the unit on Moles due to a lack of algebraic skills. Students come with negative perceptions of mathematics, which can affect student performance in chemistry (Saitta, Gittings, & Geiger, 2011). Heavy reliance on algebraic skills in chemistry class leads to cognitive overload for students (Blakely, 2011). According to Saitta, Gittings, and Geiger (2011), even though unit conversions are taught over several grade levels, many students have not mastered this topic by the time they enter college. Therefore, I decided to provide students with the basics of dimensional analysis during the first two days of the unit using prior knowledge of familiar measurement units, such as inches, feet, miles, seconds, minutes, hours, years, and pounds. Students used their prior knowledge and applied it to new knowledge, including: the steps to setting up a problem, which units to place as the numerator and denominator, what units to cross out and the reasons why. During the second class period, students continued to practice dimensional analysis using familiar measurement units, however, they learned how to use two or more conversion factors to solve problems. Adding dimensional analysis to the curriculum provided students with the math skills needed to solve chemistry problems, including moles, molar mass, atoms, and molecules.
Videos and Voiceovers

In order to incorporate video instruction into the curriculum, I had to search for short, less than 10 minute videos that supported my scaffolding approach to Moles. Each video had to introduce new material that was appropriate to the level of my class. The less is more approach focuses on instructional design techniques aimed at reducing extraneous processing (Mayer, 2014). Therefore, finding the ideal video to represent this was a challenge.

I was able to find six YouTube videos created by other teachers who introduced the new material and provided examples on how to solve the problems. Edpuzzle was utilized for three of the YouTube videos in order to do voiceovers (see Appendix A) throughout the videos to guide students. The voiceovers reminded students to pause the video to allow them time to take notes and to solve the example problems provided. There was one YouTube video (see Figure 1) that introduced the content perfectly, however, provided an overwhelming amount of example problems, therefore, the voiceover prompted students to advance the video to the next section in order to prevent extraneous overload. The edit feature in Edpuzzle allowed me to cut the beginning and ending of the videos but I was unable to cut the middle of the video, hence the voiceover to advance the video to the next section. However, during implementation, I learned that Edpuzzle wouldn’t allow students to skip a portion of the video as I was not aware that I was supposed to select “allow skipping” prior to assigning the video to students. However, students adapted and continued with the video.

![Figure 1. YouTube video: Converting units using multiple conversion factors. Yellow boxes represent areas with voiceovers created by me.](image)

Since the material is very content specific, I had to create three videos using Screencastify (see Figure 2 and Appendix B). Screencastify recorded my voice as I displayed the Google Slide on the computer screen and used my mouse as a pointer as I
explained each step. The YouTube and Screencastify videos needed to be adjusted so that videos could be played on school computers and accessed through student’s Google Apps for Education (GAFE) account. Students had access to the videos through Google Classroom, which also allowed them to access the videos outside of class on any device with internet connection.

![Finding Molar Mass](image)

**Figure 2.** Screencastify video on molar mass.

**Practice Problems**

After students watched the video(s) in class, they worked in groups and collaborated with peers on practice problems (see Appendices C & D). The purpose of the practice problems (see Figure 3) allowed students time to process and reinforce what was discussed in the video. Working in groups allowed students to hear themselves and peers explain their thought process as they worked through practice problems (Saitta, Gittings, & Geiger, 2011). At this time, I facilitated and addressed questions and misconceptions in a small group or whole class discussion as needed. In a study conducted by B. Stockwell, M. Stockwell, Cennamo, and Jiang (2015) on blended learning, they concluded that providing students with practice problems to solve during class resulted in significantly improved exam scores compared to having the instructor describe the same problems and their solutions during the course of a lecture (B. Stockwell, M. Stockwell, Cennamo, & Jiang, 2015).
Quantitative Data

At the end of each class period, students were given a short one or two question exit ticket (see Figure 4 and Appendix E), to check for student understanding. The exit ticket was scored by following a rubric (see Appendix F). Rather than focus on the final answer, the goal was to focus on how students set up their problem and cancelled units; this is the most challenging for students every year. By doing this, students were able to practice and reinforce new concepts in order to solve various problems. The exit tickets were returned to students the following class period in order to provide immediate feedback.

Figure 3. Practice Problem on atoms and molecules.

Figure 4. Exit ticket from Atoms & Molecules lesson.

The summative unit test (see Appendix G) was administered on the last day of the unit. The problems on the summative test were scored using the rubric from the exit ticket. In addition, student’s final solution had to include the correct significant figures and measurement unit.

Quantitative data was recorded on the data collection sheet (see Appendix H). The data collection sheet included participant numbers, exit ticket scores, and summative test scores. This sheet was used to record and analyze data.
Qualitative Data

Data on engagement was collected daily through classroom observations using the observational protocol (see Appendix I). This protocol was used to record engaged and/or unengaged behaviors of students. The following behaviors were observed: listening/watching, contributing to discussions, working collaboratively, completing tasks, asking questions, and effective use of technology. Observations were recorded while students worked on bell work questions, watched the videos, worked in groups on practice problems, and completed the exit ticket at the end of class. I also used prior teaching experiences to gauge the engagement of video instruction compared to the traditional lecture method.

In addition, qualitative data on engagement was collected using an anonymous online post-survey (see Appendix J) of students’ perceptions of the unit. Students completed the post-survey after they turned in the end of unit test on the last day of the unit. Students were given a sheet of paper with directions (see Appendix K) including the link to the online post-survey. The post-survey included multiple choice questions asking how often the video tutorials were viewed, if the video tutorials were viewed outside of class, and how likely are they to search for a video on YouTube to get more information about something they are learning in school. The post-survey also included text responses asking for the advantages/disadvantages of watching the tutorials, their favorite and most challenging parts of the unit, and their personal choice of video sites to use.

Conclusion

Each year I have struggled teaching this unit on moles to my high school chemistry students because they lack the algebraic skills needed to solve mole problems. It was obvious that students weren’t engaged and couldn’t retain the information in order to pass the end of unit test. It was very frustrating. My traditional lecture method was not working and needed to change.

This was my first attempt with video instruction, which required a lot of preparation and work prior to implementation. However, it was worth the effort as change from the traditional lecture method was needed in order to increase engagement, learning, and retention.

In addition to transforming my traditional lectures to video instruction, I also included two days of dimensional analysis review; which is a topic students learn in previous grades. However, students do not retain this skill and needed a review in order to refresh their prior knowledge. It was refreshing to learn through the literature review that college professors experience similar problems with their introduction to chemistry classes. The addition of dimensional analysis was an asset to the unit as it provided students with the review needed in order to utilize the algebraic skills in order to solve mole problems.

Technology is a great tool with various challenges. I learned that the students’ Google Apps for Education (GAFE) account would not allow students to access videos and/or
documents that were not originally created in my teacher GAFE account. I also learned that the videos through Edpuzzle had to be set up to allow students to advance through the video prior to assigning the video to them. In addition, I noticed that transfer students were not able to access the first two videos in Edpuzzle and had to share computers with classmates. This was probably a technical issue between GAFE and Edpuzzle, and should be addressed to the technology coordinator at my school.

Video instruction is unique as it records audio and the computer screen. Many takes can be made when creating a video, however, it is still possible to miss errors. It was amazing to witness students pointing out errors in the YouTube videos and videos I created.

Based on feedback from students, my next steps are to convert my traditional lectures into video instruction in my biology and chemistry classes in order to increase engagement, learning, and retention. I need to continue to adjust my teaching in order to support the current generation of learners. Video instruction is the next step needed to support the learning of all students. As technology continues to change and the generation of learners change, I will need to adjust my teaching craft in order to adapt and meet the ever-changing needs in the classroom.

For those who would like to try video instruction in their class, I would suggest to keep the videos simple. Start by searching for videos online. For someone who would like to create their own videos, I suggest using the content information you already have such as lecture notes on Google Slides or PowerPoint. Use a simple video screen recorder such as Screencastify to record the screen and audio for the video. I would also suggest trying the free versions of various video screen recorders until you find the one that fits the needs of your students. Lastly, never give up, learning new technology is challenging but will be worth it in the end for both you and your students.

References


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Appendix A:
Screenshot of YouTube Video. Yellow boxes represent areas with voiceover.
Appendix B:
Screenshot of video using Screencastify

The mass of an Fe bar is 16.8 g. How many Fe atoms are in the bar?

\[
16.8 \text{ g} \times \frac{6.02 \times 10^{23} \text{ atoms}}{56 \text{ g}}
\]
**Appendix C:**

**Sample practice problems on dimensional analysis**

**LSA: Dimensional Analysis, part II**

**Directions:** Solve each problem using dimensional analysis. Every number must have a unit. Show your work: include conversion factors and cross/cancel units.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
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<tbody>
<tr>
<td>The average American student is in class 5.5 hours per day. How many</td>
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<td>seconds is this?</td>
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<tr>
<td>How many minutes are in 31 days?</td>
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<tr>
<td>If a person weighs 125 lbs, 8 oz., how many mg does he or she weigh?</td>
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<td>Click the link below:</td>
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<td><a href="https://docs.google.com/document/d/1Yr_ACq4Kr3IcfCz8foYOThLmH-ya4j_187ZBtDApM/edit">https://docs.google.com/document/d/1Yr_ACq4Kr3IcfCz8foYOThLmH-ya4j_187ZBtDApM/edit</a></td>
<td></td>
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<tr>
<td>Create your own question using at least two conversion factors. Use the</td>
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<td>paper provided. Include the following:</td>
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<tr>
<td>● write your question</td>
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<tr>
<td>● show your work (cross out the units)</td>
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<td>● solve your problem and circle your final answer</td>
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<td>● Turn in</td>
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</tbody>
</table>
Use the paper provided to create the following for your LSA:

- Create a poster explaining how to select the correct conversion factor
- Include “pictures” for each “rule”
- 4 colors
Appendix D:
Sample practice problems on atoms and molecules

How many water molecules are in one drop of water that only weighs one gram?

1. Start with what you are given.
2. Add the conversion factor......arrange it so you can cross out units.
3. Use your calculator.

Pono had dinner at Jasmine’s house. To impress her, he calculated that the dinnerware was made of 125 grams of pure silver. How many atoms are in it?

1. Start with what you are given.
2. Add the conversion factor......arrange it so you can cross out units.
3. Use your calculator.
Exit Ticket:  Atoms & Molecules

Name:

Calculate the following. Show your work.

Sam was stressed out so much before his date with Kim that he sweated 10.5 grams of sweat down his forehead. How many molecules of water were there in the 10.5 grams if it's pure H\textsubscript{2}O?

---

Exit Ticket:  Atoms & Molecules

Name:

Calculate the following. Show your work.

Sam was stressed out so much before his date with Kim that he sweated 12.5 grams of sweat down his forehead. How many molecules of water were there in the 12.5 grams if it's pure H\textsubscript{2}O?
# Appendix F:
## Rubric for Daily Exit Tickets

<table>
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<tr>
<th>Strategy: Problem Set-Up</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
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</thead>
<tbody>
<tr>
<td>Uses an efficient and effective strategy to solve problem. Units are located in the correct location of fraction and are crossed out.</td>
<td>Uses an effective strategy to solve problem. Units are located in the correct location of the fraction.</td>
<td>Uses a strategy to solve problem, but it is not effective. Units are located in incorrect location of the fraction.</td>
<td>Does not use strategy to solve the problem. No work shown.</td>
<td></td>
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</table>

| Concept: | | | |
| Shows complete understanding of concepts used to solve the problem. Ex: using conversion factors properly. | Shows substantial understanding of concepts used to solve the problem. | Shows some understanding needed to solve the problem. | Shows very limited understanding of the underlying concepts needed to solve the problems OR is not written. |

| Terminology / Symbols: | | | |
| Advanced, correct terminology and symbols are used, making it easy to understand what was done. Ex: grams, moles, atoms, molecules. | Correct terminology and symbols are used, making it easy to understand what was done. | Correct terminology and symbols are used, but it is sometimes not easy to understand what was done. | There is little use, or a lot of inappropriate use of terminology and symbols. |

Adapted from: https://www.west-fargo.k12.nd.us/district/academic/images/MathProblemSolvingRubric.pdf
Appendix G:
Part of End of Unit Test

General Chemistry Test – Moles

**Part I:** Write the molar mass for the following compounds: (2 pts each)

1) $\text{H}_2\text{CO}_3$  
2) $\text{Mg}_2(\text{PO}_4)_2$  
3) $\text{Ca(NO}_3)_2$

4) $\text{C}_2\text{H}_4\text{I}_3$  
5) $\text{AgCl}$

**Part II:** How many moles in the following: (2 points each)

6) 34.7 g of $\text{H}_2\text{CO}_3$

7) 505 g of $\text{Mg}_2(\text{PO}_4)_2$

8) 2.5 g of $\text{C}_2\text{H}_4\text{I}_3$

9) 2.5 g of $\text{C}_2\text{H}_4\text{I}_3$

10) $2.7 \times 10^3$ g of $\text{AgCl}$
Appendix H:
Data Collection Sheet

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<td>1</td>
<td>Names and scores will be kept confidential. Participant numbers will replace student names. Quiz = Exit Ticket</td>
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<td>Quiz, Day 3</td>
<td>Quiz, Day 4</td>
<td>Quiz, Day 5</td>
<td>Moles Test</td>
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Appendix I:  
Observational Protocol

Student Engagement Observation Tool

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<td>1: Listening / Watching</td>
<td>1: Not listening/watching</td>
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<td>2: Contributing to discussions</td>
<td>2: Not contributing to discussions</td>
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</tr>
<tr>
<td>3: Working collaboratively</td>
<td>3: Not working collaboratively</td>
<td></td>
</tr>
<tr>
<td>4: Completing tasks</td>
<td>4: Not completing tasks</td>
<td></td>
</tr>
<tr>
<td>5: Asking questions</td>
<td>5: Not asking questions</td>
<td></td>
</tr>
<tr>
<td>6: Uses technology effectively</td>
<td>6: Uses technology inappropriately</td>
<td></td>
</tr>
</tbody>
</table>

Adapted from Kristel de Leon
Appendix J:
Screenshot of Online Post-Survey

How often did you view the video tutorials? *
- 1 time
- 2-3 times
- More than 4 times

Did you view the video tutorials outside of class? *
- Yes
- No

What were the advantages of watching the video tutorials? *
Your answer

What were the disadvantages of watching the video tutorials? *
Your answer

What was your favorite part of this unit? *
Your answer

What did you find most challenging? *
Your answer
Appendix K:
Directions and link to post-survey

Directions and link to post-survey

Thank you for participating in the project titled: *Investigating the Impact of Video Instruction in a High School Chemistry Class*. The purpose of this action research project was to investigate the impact of integrating video instruction to increase learning and engagement for 11th grade general chemistry students studying a unit on Moles at a public high school on the Big Island. You were selected to complete this post-survey as you provided assent to participate and your parents provided consent to participate in this research project. Please complete this online post-survey on your experience to the video instruction on the unit on moles, it will take about 5 minutes to complete. All responses are anonymous, therefore, your name is not attached to your responses. Thank you very much!

Link to Google Form:  https://goo.gl/LG3uDY