

THE EFFECTS OF INCORPORATING ORGANIZATION IN NOTEBOOKS TO
SYNTHESIZE KNOWLEDGE IN A HIGH SCHOOL CHEMISTRY CLASS

by

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A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2021

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ACKNOWLEDGEMENTS

Thank you to all of my students at Buchanan High School that tried during this school year. This year was a very hard educational year for students and teachers alike. The students shared their lives, their ups, and their downs everyday on Zoom. The lack of hands on activities was evident everyday and only reminded me how important the process of learning is in science with reflection. These students continue to inspire me to do my best and push them to become stronger.

My mother had a strong wish for me to earn my masters in science. She has been with me in spirit during this journey. She is the reason I became a teacher after September 11th. I love you, I miss you, and I hope I continue to make you proud. Thank you grandma and dad for giving me the mental support to make her wish possible.

Thank you to Richard, Cece, Jennifer, and Dimple for being the everyday support on how to continue and become even strong for our students.

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ABSTRACT

The lack of organization in a science notebook makes it difficult for students to put multiple science concepts together in a chemistry class. This research study looked at how incorporating organization in notebooks through reflections on activities, group conversations, class discourse, summaries of labs, and creating a graphical organizer will impact their class conversation, self-regulation, and assessment scores. Three classes were studied over a full unit on bonding in a suburban chemistry class. Two classes were given a treatment of daily organizational support towards making a graphical organizer while the comparison group was given the same time without the guided questions or organizational support. A weekly survey of students' feelings on their understanding was given. The survey showed that overall students felt the graphical organizer was helpful. The comparison group found it overwhelming to complete without the guidance that the treatment received. The time each group took showed a significant difference in their ability to answer beginning of class questions. The treatment group showed a significant growth in their ability to make a graphical organizer. The students showed self-regulation by not completing different class assignments and assessments. The class discourse was very limited by both groups due to the class being online on Zoom. The treatment group showed a positive gain in supporting students in organizing a reflection notebook in their chemistry class because it forced them to do discourse.

INTRODUCTION AND BACKGROUND

Buchanan High School

For the last six years, I have been teaching at Buchanan High School (BHS) in Clovis, California. Located in the Central Valley of California, Clovis is a suburb of Fresno known for their schools (Niche, 2021). Buchanan had a slightly lower free and reduced meals at 31.4% compared to the districts overall value of 44.0% (CDE, 2021). BHS had a 31.8% socioeconomically disadvantaged population out of the 2,706 students enrolled in the 2020-2021 school year (California, 2021).

Buchanan High School recognized the lack of movement with lower social-economic students in reading. The “Reading Apprenticeship” by WestEd was the program that BHS incorporated in all subject areas. This gave a focus on the metacognition tasks that students are asked to do within a class. The classroom environment needs to have daily routines to support intellectual engagement with academic texts from sentence frames to summaries (Schoenbach, 2012). All the daily routines are activities that do not connect to other activities. The practices learned in the program are to be incorporated over all subjects so students gain a stronger learning in their reading and writing skills over different subjects to overall improve on those skills. The program had strength in gaining student’s understanding of how they learn, knowing their metacognition. One routine that was missing was the connection between content and their retention.

Context of the Study

Over the last few years, I have been working towards bringing the Next Generation Science Standards (NGSS) into my chemistry classroom. I found that my students initially struggled with the concept of being able to achieve in an activity-based environment. They were comfortable with daily routines learned over all subjects, especially on their metacognition, but did not know how to connect with activities more than one day long, at best. Before they set foot in my classroom, they felt that they were not going to perform well in the class. This led me down a path of using growth mindset ideas to show students that they could learn new ideas while working together. Students progressed from a fixed mindset to a growth mindset during the year. This was seen from the initial blame game as their reasoning for not learning, fixed mindset, to working in the process of learning through their struggles (Dweck, 2008). A growth mindset has become a daily routine in my class within our daily pledge and practice discussions.

Writing their thoughts down in a notebook was the routine that I focused my students on during activities to gather knowledge to move towards a NGSS classroom. Students would write their summary from an activity and connect it back to a previous point of information. This was more challenging than I had initially thought. High school students want to be given a fact to write down, memorize for the test, and then move on. During online learning, this mentally had only heightened. This would not be the notebook that my students utilized in class. Even if students wanted to have that organization, it is not how they learn. Students learn best by allowing them to have

different entry points to knowledge and develop intellectual engagement with the content (Schoenbach, 2012).

Life is all about continuing to learn and make stronger connections with knowledge that you already have. I have always believed that life-long-learning and a growth mindset are experiences and thoughts that help improve a student's experience in the classroom and in life. I wanted my students to see the science in class, in their lives, and in the world. To continue this focus, I started to get into the notebook movement in science. After a month of trying a specific layout, I knew that I could not follow this idea and that my students would not benefit from the total layout. A high school student just laughs when you ask them to draw a light bulb on a page. Over the last few years, I have found success with certain formatting for reflective notes. This was very evident when I had students over multiple courses and could watch their organization when others did not have it.

The notebook became a collection of student's ideas, connections they made, and showed the questions they had not answered from the activities. The knowledge gained was being lost from one page to the next. The idea of flipping to a previous page was lost with my students. An organizational flow was needed so gained knowledge could be revisited in later units. This became very apparent during the end of the year with stoichiometry problems. Both summaries from previous and current activities needed to meet in their journal. By supporting my students to move away from memorizing and move towards inquiry and explanation, they would be aligned into the NGSS curriculum (NSTA, 2014). Students would learn more about their world and their metacognition

when they look at how they learn from doing science within the practices of science. They would be more engaged, have more fun, therefore enjoy learning.

Purpose of the Study

Many of my chemistry students want a vocabulary term to write in their notebook, remember it for a test, and then forget it. The lack of retention from previous units has been a problem for many students in my chemistry class. Physical science is different from biology in thought process from moving away from facts and vocabulary to describing systems and measuring changes. At my site, students take traditional notes in their biology class, meaning they copy the vocab from the screen, memorize, and forget after taking a test.

I have watched different programs come in and out with science notebooking over the years. An outline, essential question, and reflection have been a notebook focus that I have used over the years. Little by little, I have changed the questions and outline to support student reflections and connections with their content. This portion of notebooking is one that I feel I have a good grasp on. I have struggled with the idea of a table of contents or a way to connect a whole unit within the notebook. A higher order thought process, like one used in a graphical organizer, needs structure for students to bridge the process, content, and infusion styles taught in physical sciences (Barak, 2008).

The purpose of this study was to look at how small amounts of time each day could support a graphical organizer for student assimilation of knowledge. Time is never my friend as a teacher because I find too many ways to fill class time with activities, whiteboard practice, group challenges, and reflection time. I wanted to know if a small

daily amount of time focused on their graphical organizer would make the final unit graphical organizer more usable or is a final day reflection all that is needed for students to have felt organized in their thoughts. The graphical organizer meant more to me than simply an organized page.

Rationale of the Study

By conducting this research project, I envisioned understanding if weekly reflections in class was more usable by my students than an end-of-the-unit day. The focus on the graphical organizer showed me a glimpse into my students learning process. The focus was on the organization with underlying goals towards student's self-reliance, self-esteem, and actual organization. The process of reflection note taking is one that I was hoping would stay with students far beyond their chemistry class. The goal was to help students get away from the copying of a slide to writing notes for themselves, like a personal comment to help remind them later exactly what they understood. The reflective notes needed a wrap up like a graphical organizer.

Previous group discussions made connections from previous days and lessons in class but within a few days, those connections had been forgotten. Even when I would tell them to write it in their notebooks, they choose not to reread the pages because they knew I would remind them. I wanted my students to start valuing their notebook and the pages within. Previous years would do graphical organizers, models, and visuals on whiteboards but were not added to their notebook pages. I have also seen the other side where I have given too much. Last school year, I started organizing the notebook too much. A teacher should not put in more time than students. If I make too many

connections in their notebook, they are not making connections without me. I want students to see the usefulness in making these connections and the ability to not lose them. This is a life-long process that will help them.

Focus Statement/Question

The focus question for this study, how does organization in a notebook help students make connections in their chemistry understanding?

Sub-questions included the following:

- How can implementing reflections and summaries from activities impact knowledge connections?
- How will scientific discourse support self-regulation on their chemistry understanding?
- How will using graphical organizers support self-reflection of students?
- What is the impact of these strategies on their teacher?

CONCEPTUAL FRAMEWORK

NGSS and Synthesizing Learning

Beyond the support in helping students learn, is the importance of a teacher and their planning. A planning triangle looks at how a teacher should balance the three essentials to a plan: standards, learning activities and experiences, and gapless explanation for anchoring event (Windschitl, 2018). The tighter this triangle is, the more likely students will understand a clear connection between lessons and content. The structure of science lessons should include planning for engagement, elicit student's ideas, supporting ongoing changes in student's thinking, and drawing together evidence to be used in explanations (Windschitl, 2018). These same ideas in science lesson planning should be incorporated into note taking or note booking to give it structure.

The framework wants intertwined learning experiences in the science classroom (Natl, 2011, Appendix A). The cognitive development based on learning is a constructivism viewpoint, like Piaget. To give order to a lesson, or a notebook, Piaget felt that a plan should enhance a student's logical and conceptual growth (Teachnology, n.d.). There is a need for a written notebook since people produce knowledge from their experiences. If these experiences are not written out, how can a person keep track of their understanding? Piaget was a believer in assimilating experiences for growth. A person needs to incorporate new experiences into the old experiences, develop new outlooks, rethink their misunderstandings, and allow for evaluation of what is important, in order to alter their perceptions (Teachnology, n.d.). Based on Piaget's study on cognitive

development, learning will occur with evaluation, but Piaget never focused on what influenced learning except that learning occurred.

Drawing and Models

Using models in science allows the student, other students, and teachers to see the growth and progression in a student's knowledge and understanding. One point of confusion for many students is the use of models in doing science-learning science (Hardman, 2017). Students not only need to be able to make models, but also evaluate their representation of reality and usefulness. For learning the practices towards science, one must infer things about a phenomenon based on manipulation and investigations of different models (Hardman, 2017). A collection of different models is needed to explain a theory since many scientific theories use multiple models, not just one (Hardman, 2017). For students to be able to compare different models to learn the science, they need to keep track of their reflections and models.

The components that students need to keep track of are experiences and models. In Japan students are more used to writing down their thoughts. One component of Japanese education that helps students effectively learn science is the importance given to using diagrams in their notebooks. Thirty-seven American students were compared to 42 Japanese students learning science. Eighty-three percent of the Japanese students took notes while only 43% of the American students took notes. Forty percent included an explanation next to their notes while only 8% of the American students wrote an explanation. The only students who wrote explanations had written diagrams in their notes. The American students found less importance and value with including diagrams.

The American students were relying on the importance of their verbal explanation (Manalo, 2013).

Organization and Note-taking

Taking the time to write the diagrams and models will help students to see their understandings. A bridge between verbal explanation and being organized in thought, like using a model, need to be found. By using guided-inquiry based instruction, students will increase their organizational skills (Gupta, 2015). Three different groups were tested in how writing skills changed in a chemistry course based on the instruction. A first-year traditional chemistry course was compared to a first-year guided-inquiry chemistry course and a second-year traditional chemistry course (organic chemistry) where they found statistically different results only when the guided-inquiry course was compared. The largest differences between the guided-inquiry course and the other courses were in organization, application, and comprehension. The researchers noted the relation of instruction to an improved use of critical thinking skills for students that lead to the differences in their scores (Gupta, 2015). For students to increase their organizational skills, an improvement of critical thinking skills in students' needs to be a focus.

An inquiry-guided method of teaching is based on the claim that knowledge is built from someone's experiences and interactions with a phenomenon (Rusche, 2011). For a student to be able to create notes, they need to be able to determine what is needed in their notes. A critical self-reflection improves a student's critical thinking skills and helps a student develop their self-knowledge (Rusche, 2011). Two methods show success in students learning material from writing: question cards and reflections. In an English

class, students were given question cards that had students bring their own questions from reading. The cards were used in multiple formats, but the key was a student created the questions to refocus the material. After a discussion related to the cards, students were given time to make a reflection. The reflection, not a summary, provided the students with an opportunity to write after they read which reduced the loss of information (Rusche, 2011). Notes will be stronger if there is a focus on reflections more than summaries and when the students can create their own questions to focus their notes around.

Scientific education appears to be the strongest when a student is deep in the practice of doing science. Within chemistry, this can mean activities as well as models. Research shows that a student needs to discuss the material to be able to internalize and understand the knowledge. A lecture can get the information across faster and will be easier for a student to copy. Tell and practice (T&P) is the largest form of instruction in the United States (Schwartz, 2011). A newer practice known as inventing with contrasting cases (ICC) allows students to design their knowledge based on experiences (Schwartz, 2011). Within the research on these two different practices, a learning transfer seen in note taking is very valuable. In the ICC program, students outperformed the T&P students in transferring the knowledge of ratios. All students performed above 80% on worksheets, but when they had students apply the ratio problems to different problems, a learning transfer, they found the ICC students drew their ideas on their sheets. The T&P students would only write out the formulas that they had been given and did not make any models or drawings to show how the ratio worked (Schwartz, 2011). For students to

draw ideas and models into their notebooks, they need to be given the experience without being told the formulas. If a ratio problem should be solved without applying it, then a lecture format will work just as well as an experience.

Drawing Graphical Organizers and Note-taking

Utilizing drawings in the notebook will improve long-term memory and help explain the work done in a problem. The use of art in the notebook helps memory performance and higher-level thinking. When visual art integration was implemented in a science class, an increase of 28.2% was found on retention (Rosen-O’Leary, 2019). Teaching students to incorporate more drawings instead of text is seen in graphical organizers. Students need to be shown how to use visuals instead of relying on explanation style notes. Science and engineering students in Japan were found to have stronger college GPAs when they incorporated visual explanations beyond diagrams (Manalo, 2013). An effect size of $d=1.04$, exceeds Cohen’s standard for large-size effects, was found only when diagrams were used within their note taking. The drawings included arrows and symbols to link three or more concept ideas together. The visuals these students were using are a graphical organizer.

Students will increase their ability to draw models and diagrams in their notes by having experiences. By writing down their notes, students will have a deeper learning by increasing the cognitive process of internalizing knowledge (Salame, 2020). Reading and writing involve multiple senses and together make learning a deeper, longer lasting knowledge bank. After observing students’ brains, a definite activation was seen in the Broca’s area (University, 2011). When people write by hand, their brain receives

feedback from a motor action that is far stronger than if that person types. Typing has less of a feedback than by using a hand to write (University, 2011). A strong activation was seen in the Broca area when a student read a verb, which is linked to a physical activity. The act of writing does take longer than typing but the increased activation in the brain shows that handwritten notes will allow for more connections to be made.

Other Note-taking Focuses

A graphical organizer is not a focus or a key page within science notebooks. A multilingual (English, German, French, and Luxembourgish) use of a science notebook followed 14 students over a week to see how open-formatted notebooks helped them synthesize their knowledge. There were five interactions that students had with their notebook that showed how their analysis of content had increased. The identified spaces for students were a space for student-directed resemiotization (or a multimodality space), space to draw upon multiple language resources, space to bridge spatial and temporal ideas from inquiry investigations, space to access and extend science understandings, and space to reveal the student's understanding (Wilmes, 2020). The open-formatted notebook is most usable by the student when they were able to focus on their storyline and explain a concept on a page. The findings showed that during inquiry activities, the three focus students did best when they were interacting with their notebooks to understand two concepts. The connecting of main ideas together was only assessed outside of their notebooks and not seen as an important interaction within the notebook (Wilmes, 2020).

METHODOLOGY

Introduction

Students have done activities, learned how to solve problems, and created conclusions after doing labs. The purpose of this research was to look at how giving students structured time to make reflections in their notebook would support their continued synthesis of chemistry knowledge. Prior to taking this course, students took fill in the blank or copy style notes. Their notebooks in chemistry were open-format notebooks, or reflective style, that allow for a more student-focused concept to be shown. The daily activities of class discourse, group discourse, activities, and conclusions were reflected in their notebook. To show connections between concepts, the students created an end of the unit graphical organizer. Every page in the notebook had an outline to give it structure and organization to support students.

Participants

The original plan was to compare two groups of students of general chemistry courses. The unique challenges of getting new students at semester (due to COVID schedules) and a new second semester time schedule, pushed the study to include three courses of both general chemistry and a Career Technical Education (CTE) chemistry course. The inclusion of all chemistry courses taught was done in case too many students were moved around during the study. During the duration of the study, the CTE chemistry course was taught the same as the general chemistry course. There were 11 students switched during the study. The switching was only from being in person hybrid

to online teaching. No students were added during the study. Four students were new to the courses and the teacher at the beginning of the study.

The first period course was used as the comparison with no treatment done. Three of the new students to the course were within this class. One student was removed from each group due to school policy of not needing to turn in work. Both of these students withdrew within two months of this study to an online school due to surgery and health reasons. All activities and grades were done as previously done in the first semester for first period. The third and seventh period classes were given the treatment of additional organized and structured time. There are slight differences between the two groups, but both have about half male and half female as seen in Table 1. The largest difference between the comparison group to the treatment is number of sophomores to juniors. The comparison group has more mature students as a group (30.6% juniors). There are little differences, but overall the groups are similar besides the treatment being researched.

Table 1: Participant Demographics

Period	1 st Comparison	3 rd Treatment	7 th Treatment	3 rd & 7 th Full Treatment
Course	General chemistry	General chemistry	CTE chemistry	General & CTE chemistry
Students	~~36~~ 35	27	~~37~~ 36	~~64~~ 63
Males	15 (41.7%)	11 (40.7%)	24 (64.9%)	35 (54.7%)
Females	21 (58.3%)	16 (59.3%)	13 (35.1%)	29 (45.3%)
10 th graders	25 (69.4%)	22 (81.5%)	37 (100%)	59 (92.2%)
11 th graders	11 (30.6%)	5 (18.5%)	0	5 (7.8%)
Ethnic Groups	10 groups	5 groups	7 groups	8 groups
Educational Groups	6 groups 14 students	3 groups 10 students	4 groups 7 students	5 groups 17 students
Class Average	80.3 %	78.9%	82.0%	80.6%

Grade Range	100.8% - 60.1%	99.2% - 47.9%	100.6% - 48.9%	100.6% - 47.9%
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Making certain that all students were given strong strategies to learn the material was considered in the formation of the research project. I felt that removing activities or holding back educational opportunities were not fair for the comparison course. The comparison class followed the original format of the notebook so they saw no change. The alteration was on time and additional reflection with structure that was not done prior to this unit. Students were told that their work was being collected for a research project and asked if anyone wanted to opt out of the project. All students and parents were told that a change in the format of this unit was being analyzed for a research project without personal details being kept. No students, nor any parents, asked to be removed from the unit of study. The research methodology received an exemption from Montana State University's Institutional Review Board (Appendix A).

Intervention

The bonding unit, or unit 5, started on January 5th, 2021 and continued for five weeks to end on February 3rd. All classes received the same materials of instruction, unit phenomenon, unit Science and Engineering Practices (SEP) 6 and 7 focus, and weekly online surveys. The third and seventh period courses received an organized reflection time towards their graphical organizer and early rubric directions. The notebook outline stayed the same for each group (Appendix B). A reminder was given to the first period class at the end of the week to write in their graphical organizer (first image in Appendix C). A more detailed, focused on review questions time was used on the third and seventh

period classes (four images after first in Appendix C). Figure 1 shows an example of the two different presentations to students. On the left, you see a direction to reflect while the treatment (right) slide gives direct reflection questions pertaining to the activities of the week. The rubric listed on the bottom of the treatment slide is shown on table 3.

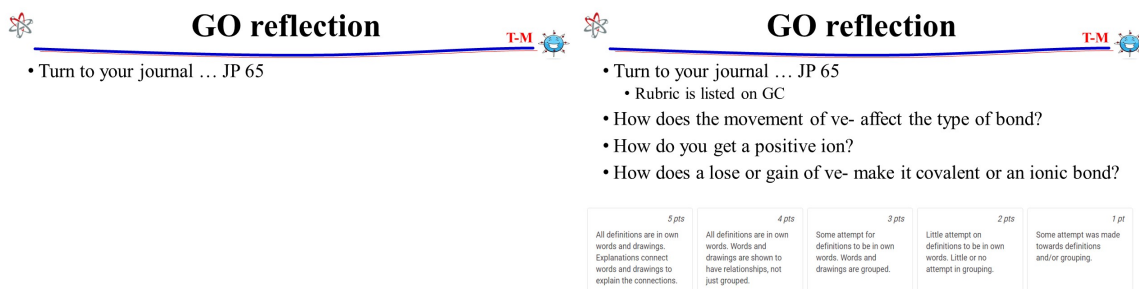


Figure 1: Slide Options during Research

The graphical organizer slide was shown at the end of class for five to ten minutes. If a student asked a question, the bottom white area was used to address their question. No questions about their graphical organizer or any portion of their notes was ignored. A timeline of when each treatment and class focus is listed in Table 2. The treatment for third and seventh periods is underlined in the table. All assignments that were digitally collected are listed in italics in Table 2. The journal page (JP) is listed in parenthesis as JP since the class calls their notebook a journal.

Table 2: Study Timeline

Week	Monday	Tuesday	Wednesday
1	Jan 4 No School	Jan 5 <i>PreGO</i> JP setup (JP 65-69) SEP 6/7 (JP 69) <i>Tech Scavenger Hunt</i> <i>Decode Ions WS</i>	Jan 6 <i>Decode Ions WS</i> Cont. Conductivity Virtual Lab (JP 71) <u>JP 71 & 65 Reflection</u> <u>GC Weekly Survey</u>
2	Jan 11	Jan 12 <i>Sugar & Salt</i>	Jan 13 <i>Sugar & Salt CER Quiz</i>

	<i>HW 5.1 DUE</i> (JP 67) Conductivity Virtual Lab Cont. (JP 75)	Virtual Lab (JP 75) Lewis Diagrams (JP 75) <i>Making Molecules WS</i>	<i>SEP 6/7 Check-In</i> (JP 69) <u>JP 75 & 65 Reflection</u> GC Weekly Survey
3	Jan 18 No School	Jan 19 <i>HW 5.2 DUE</i> (JP 73) Lewis Structures (JP 75) Polarity (JP 79) <u>JP 75 Reflection</u>	Jan 20 VSEPR Models (JP 79) <i>Polarity & VSEPR WS</i> <i>Molecules Quiz</i> <u>JP 79 & 65 Reflection</u> GC Weekly Survey
4	Jan 25 <i>HW 5.3 DUE</i> (JP 77) Naming Molecules (JP 81)	Jan 26 Naming Compounds (JP 81) IMF & H Bonds (JP 81) <i>Chemical Names WS</i>	Jan 27 <i>SEP 6/7 Research</i> (JP 69) Given Test Review WS <u>JP 81 & 65 Reflection</u> GC Weekly Survey
5	Feb 1 <i>SEP 6/7</i> (JP 69) Test Review WS	Feb 2 Review Day <i>Test Review WS</i> Kahoot! <i>All classes- Graphical Organizer</i> (JP 65)	Feb 3 <i>Unit 5 Test</i> GC GO Survey
6	Feb 8 No School	Feb 9 Test Make-Up Unit 6 starts	Feb 10 Most Missed Questions reviewed <i>Free Response Test</i> Late Work DUE

Key: *Assignments turned in are italicized*; Treatment is underlined

Data Collection

To be able to get a holistic view with details a mixed-methods research process was used. All assignments were collected but only their pre-graphical organizer, unit test score, graphical organizer journal page, and free response test scores were used in the study. Both of the graphical organizers were graded using a rubric. The rubric shown in Table 3 shows how the five points were determined (also bottom of treatment slides

Figure 1). All class assignments are worth a multiple of five points. This rubric was used to keep the five-point assignment consistent. Per student request, there was not a focus on definitions since they were on previous pages. The graphical organizer details were graded based on their own words.

Table 3: Graphic Organizer Rubric

Amazing 5 points	Good 4 points	Satisfactory 3 points	Missing 2 points	Tried 1 point
All definitions are in own words and drawings. Explanations connect words and drawings to explain the connections.	All definitions are in own words. Words and drawings are shown to have relationships, not just grouped.	Some attempt for definitions to be in own words. Words and drawings are grouped.	Little attempt on definitions to be in own words. Little or no attempt in grouping.	Some attempt was made towards definitions and/or grouping.

All assignment scores were collected as a value, on time or late, listed as not turned in, or listed as excused. Independent samples t-tests were calculated to evaluate the significance of the differences between the comparison class and the treatment group. The variance was used to list if there was a significant difference between the groups. The calculated t-test were only one measured tool to compare the groups. The comparison of means, quartiles, survey responses, and turned in work were all used to show a more realistic picture of the results.

During the study, a school policy against severe depression was used to help students that were struggling. This strategy included removing some classwork for students after the teacher had a conversation with the student about the learned material. The school strategy was implemented two weeks into the study. Two students were removed from the study because they were both a part of this group. COVID related variables were introduced during the study but impacted all classes. These variables were

not the focus of the study but were measured so they could be addressed in the conclusion and reflection of the study.

A Likert-style survey was given to students every week with a slightly different survey the last week. The survey covered a six-point option to show if a student agreed or disagreed and to what level. The survey questions were created to show details on how students felt about their learning and the process of learning. The last survey included the graphical organizer towards their test. This question was only included at the end since first period did not have weekly reflections towards the graphical organizer.

The opinion of the students is just as important, if not more, than their actual work. If students do not see the importance or feel that the notebook is helpful, they will not continue to use these ideas in class or in their future classes. A student survey (Appendix D) was completed every week as a reflection piece. The questions had values to give their opinions a quantitative value to show change overtime. To get more details on how they felt these changes had impacted them, an interview was given. The interview questions (Appendix E) were a starting point in the interviews. Students interviewed were given a sheet (Appendix F) to get their ideas on paper. The Zoom interview was done around the student's schedule, which was typically during lunch. All interviews were completed within two weeks of the unit test.

The teacher needed to keep track of how their time was spent towards addressing changes to measure the impact on the teacher. An observation sheet (Appendix G) was used to keep track of how students were working within the class period and how their time was spent. This sheet was altered after the first day. The original form had room for

details on time in groups. This was removed and replaced with no talking in groups. After the first observation, the lack of discourse within a group was obvious. Keeping track of the lack of discourse was added to see how that related to student feelings in their survey.

Triangulation Matrix

This mixed-method research study focused on how organization of a notebook effected the synthesis of chemistry knowledge. Quantitative measurements were taken in the form of student surveys, graphical organizer, notebook checks, teacher observation sheet, and assessments (lab quiz, multiple choice quiz, unit assessment, and free response assessment). Qualitative measurements were taken through student interviews, teacher observation sheet, and assessments. Table 4 shows how each data collected related to part of the research questions. Some of the tools used allowed for a change over time to be shown.

Table 4: Research Matrix

Question	Data Collection					
	Interviews	Student Surveys	Pre & Post GO	Notebook Scores	Observation Time Sheet	Assessment Scores
Notebook Organization synthesize chemistry	A	# Δ	#	# Δ	A #	A #
Reflections & summaries	A	# Δ	#	# Δ	A	# Δ
Discourse support self-regulation	A	# Δ	#	#	A #	A
GO support self-reflection	A	# Δ	#	#	A	#
Teacher Impact					#	

Key: A = qualitative data; # = quantitative data; Δ = change over time

Ensuring the validity of data collected was addressed within the department group, known as the chemistry Professional Learning Committee (PLC). Prior to each unit, the four PLC members create the unit test and free response test. The test is given on the online platform Edulastic. The test score percentage was created through Edulastic but given points by the PLC team based on how many points, or partial points, a question was worth. The PLC team created a rubric for the free response. After the test was given, the PLC team meet with examples of different scores. During the sharing process, the PLC would calibrate on a five, four, three, two, one, and zero score. The journal pages (JP), graphical organizer (GO), CER, and Tool were unique to one teacher. The teacher created multiple examples of each score to share with a member of the PLC. Following the same calibration process, the two followed the rubric and agreed on scores.

DATA ANALYSIS

Impact of Reflections & Summaries

Implementing reflections and summaries from activities impacted knowledge synthesis. Both groups used reflections within their journal pages. Number 11 on the weekly survey asked students about their addition of reflection from activities to be placed in their journal. The comparison group ranged from 3.79 to 4.50 while the treatment group showed 3.51 to 4.69. The reflection questions were always in the middle of the responses from students. Students surveyed showed a positive perception to reflecting.

The assessment on summaries was the CER from the sugar and salt lab. There was not a significant difference between the groups (-0.8613 p-value not beyond the 1.9917 value). Looking further into the CER data, the lack of work turned in stood out. The comparison group had a lack of 10 students, or 27.8%, not turning in their reflection while the treatment group lacked 11 students, or 17.5%. The treatment was not the only factor in the lack of turn in but it showed a strong difference between the two groups. Outside of this research time, the comparison group was similar to the treatment in turn-in. This difference was not common with other units.

Within the student interviews, questions four and six showed the details of why reflecting helped students synthesize their chemistry knowledge. One of the treatment students said, "The part of the notes that makes me feel more confident is seeing how I understand what I learn and being able to write it down with lots of colors and models. The reflections of activity help me see where I'm still lost." All students interviewed

reported this sentiment. Not one of the students interviewed listed reflections as a pointless idea. One of the comparison group students said, “It helps. I mean showing that I understand it is what I see when I can complete it (reflection)”. The other comparison student said, “I love taking pics of the keywords to help me with the reflections.” This showed that even without the additional time for graphical organizers, there was reflection happening.

The range of scores on the graphical organizer showed that the treatment group was a little higher in making the connections in their graphical organizer, but not a significant difference. Figure 1 shows a boxplot of graphical organizer scores. The treatment group (red) had a higher amount of five scores, 37% turn in earned a five while the comparison group was 35%. The five is only earned when a student can make connections (rubric listed in table 3). Even though there was no significant difference between the scores, the difference between the number of scores of five shows stronger connection. The lack of significance shows that the treatment is not enough to support the student in making the graphical organizer. The comparison group had a higher amount of non-turn with 16 students or 44.4%, which was higher than their lack of turn in on the CER assessment. The treatment group had a 33.3% (21 students) lack of turn in. When including the student turn in as a value, the additional weekly reflections helped students make connections with their work.

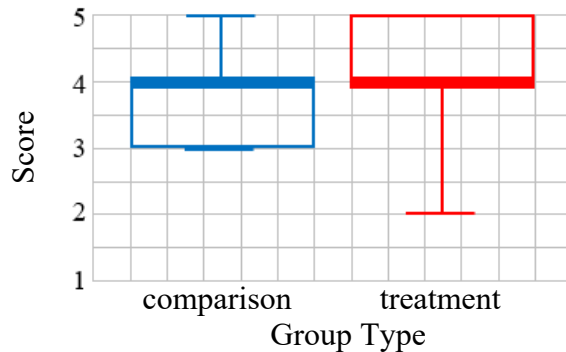


Figure 2: Graphical Organizer Scores; (N blue-comparison=20; N red-treatment=41)

Notebook page scores, or journal pages (JP), was the first sign of reflections in students' journals. Out of three-journal page check-ins during the research, students in the treatment group turned in more frequently with 17.5%, 23.8%, and 20.6% not turning in the checks. The comparison group turned in their journal pages with less overall frequency with 13.9%, 27.8%, and 33.3% not turned in. The first journal page check did not include reflections. Performing a paired t-test on these six values showed that the differences were not a significant difference (1.8523 p-value not beyond the 2.776 value with four degrees of freedom). When the first journal page check is removed, the independent t-test also showed no significant difference (1.649 p-value not beyond the 4.303 value).

The trend of how the journal page turn-ins went showed a difference. Both groups turned in the first journal page the most, the journal page without any reflections. The other two journal pages included reflections and summaries. Without the additional class time and conversation that the treatment gave students, they were turned in less often in the comparison group. The treatment group turned those pages in almost as much as the

initial page. The lack of difference in the journal page they turned in showed that it is more likely to have not been turned in due to an apathy level instead of not being able to understand the differences.

The teacher observations supported the same view on the treatment that the journal page turn in showed. On the day of summary additions to the graphical organizer, more students were writing in their journal. The comparison was given the same amount of time to make reflections without guided support. In the same time frame, no students were noticed to be writing in their journal. During the third week, some students appeared to be writing in their journal for the first five minutes of the ten-minute reflection period. On the last week of treatment, the day before their unit test, the comparison group only spent 6 minutes going over their graphical organizers with little to no questions asked on the connections. The treatment groups both spent more time revising their graphical organizer by asking questions to total 10 minutes and 14 minutes. These times were spent on the graphical organizer, which focused on connections and summaries, outside of the test review questions.

The additional focus and organizational support within the unit became routine for the treatment group. They had details already on the graphical organizer. The additional time was used to add details to make their organizers stronger. The comparison group had time given to them but without support on the organization of their graphical organizer it became free time. This difference in time showed that a structured time made the graphical organizer a routine that could be added to during the unit instead of an overwhelming unit summary. The treatment group spent their time revising and making

stronger connections between concepts on their graphical organizer. The types of questions that the treatment group asked showed that they were going deeper into how the concepts were related.

Impact of Discourse & Self-Regulation

Scientific discourse with Ms. Herrington did support self-regulation but classmate discourse did not support self-regulation within groups. The observations by the teacher showed that most students did not participate in active group discourse. The number of questions asked during a week ranged greatly for both groups. The comparison group ranged three question to fifteen during conversations. The treatment group was slightly higher with five to twenty-three questions. Once these students were put into their groups to discuss concepts, a silence fell over them. A few students would ask the teacher a question when the teacher joined their group, but they were not talking to each other.

The lack of discourse within groups showed how students did not trust their community as a support to learn. The learning community created within a class was never made online, no matter how the teacher tried to get students to talk in their groups. This was a common issue at the school site and PLC. A computer community was never established due to students focusing on getting work done and only trusting the teacher as the source of knowledge. Students mostly tuned off their video feeds when in groups making discourse in the group impossible. A school policy allowed this since so many students had bad WIFI connections. Every student had a moment when the screen skipped, the sound did not work, or it froze. The school policy pointed out that bad WIFI connections were not supposed to hurt a student's ability to turn in work for their grade.

The largest single impact on a student's ability to learn was removed with the WIFI issues since they did not actively participate in a group discourse. A few students did participate in a group discourse because they know the benefits of talking with peers. This was a small number of students in both the treatment and comparison groups.

The time each group used in the beginning of class showed a self-regulation on how students felt. The observations (appendix J) showed a decrease in time for the treatment groups. When the teacher asked warm-up style questions for the first five minutes of class, the comparison group took longer. Students had to answer the question with explanation, not just an answer. The treatment group was able to answer the questions quicker because they could explain their answers. The comparison group struggled with the explanations, as seen in Table 5. The times did show a significant difference (2.8552 p-value beyond the 1.711 value of 24 degrees of freedom). Students were getting stronger on self-regulating if they knew the full concept, not just the answer. The treatment was a good start to get students to recognize if they could reflect on the main ideas of the week, not just the answers as seen in the difference in times.

Table 5: Warm-Up Time

Question	Minutes Spent				
	Wk 1	Wk 2	Wk 3	Wk 4	Wk 5
Comparison AVG	22	9	21	24.7	23
Treatment AVG	14.5	7	16.75	15.2	17.5

The student surveys showed a large disregard to discourse in class. Question fifteen was always in the top two for both groups. Most students felt that asking their

teacher helped them in their journal. The question asked on the survey reflected the journal page listing from Ms H (teacher). Students marked this high because they felt the conversations about that page and being given the page helped guide them. On the other end was question 13. Every single week, question 13 was in the lowest three liked questions. The treatment group found the discourse a little more helpful than the comparison group. In the treatment group, the use of drawing was lower than discourse. The comparison group placed it in their lowest two while the treatment placed it in the lowest three.

The surveys also showed that students were not self-regulating. Question ten in the survey addressed how often they ask a question when journaling. The treatment group placed this question every week in their lowest two spots. The comparison group placed this in their lowest two or three over the five weeks. Both the discourse and self-regulation were the lowest values in the survey. When asked about this topic in the interviews, all students responded that it felt like an odd practice on Zoom.

When asked if talking in their group gave them ideas, one student said, “Yes, but only if it was my friend.” A follow up asking them if they felt it was pointless to talk in the groups, a shrug and a shaking of the head occurred. The student did say that when talking with the teacher, “yeah that helps especially with ideas”. Another comparison group student said, “not really, because we don’t talk”, when asked if talking in groups helps. This data shows the impact of online habits over typical in class and at school habits. The other interviewed students, all in the treatment group, were even split from

discourse in groups being pointless to “no it is not pointless. Sharing ideas helps people think more on something and understand the concept better.”

The score on the graphical organizer shows an overall self-regulation on not turned in work. Students who felt like they did not know how to show connections or did not understand the work, tended to not turn in the graphical organizer. The comparison group went from an average of 2.34 to 4.10 on the graphical organizer while 44.4% did not turn in the final graphical organizer from an original 11.1%. The treatment group had a 33.3% lack of turn in from an original 6.3% on the pre-graphical organizer. Only a few students in both groups came on after school to ask additional questions. There was little to no self-regulation to improve their work.

The number of students that turned in the pre-graphical organizer was very low. This was due to students feeling like just turning in anything would give them points. The final graphical organizer only received points based on content. The turn in dates also had an impact. The pre-graphical organizer was due in the first week of the second semester. This was a time when students were starting off fresh with little to no stress of work completion piling up on them. The due date of the graphical organizer was near the test, later in the semester meaning students were becoming overwhelmed with assignments at school beyond this class. The turn in improved outside of the research time because this became a target by the teacher and students were finding the value in the work. The teacher pointing out the importance and students using their previous graphical organizers showed the importance of the graphical organizer to most students.

Journal page 81 was all summary on the combined concepts. This page was meant to support self-regulation on how they have connected steps before the final graphical organizer. The comparison group had a 66.7% turn in rate while the treatment group had 77.8%. The number of revisions seen over the unit showed a similar story. Thirty-seven revisions were done in the comparison group and 86 revisions in the treatment group. There was a slight increase in turn in and revisions in the treatment group. Students were improving on their work.

The free response of the unit assessment did not follow the same trend as the journal page 81 turn in. The comparison group had an 83.3% turn in with a strong average of 8.9 out of 10. Their range was from a low six to a high ten. Their free response was done at a higher rate than their unit test. The treatment group had a slightly lower average of 8.17 out of 10. The largest difference was they had a 68.3% turn in rate with a range of one to eleven. The quality of free responses did show a check from students. The treatment group left parts of the two questions blank if they did not know. The comparison group gave answers to try and earn points. The free response showed that students did self-regulate by only answering questions they knew, if they were in the treatment group. Many of the comparison group gave answers that earned no points.

Impact of Graphical Organizer

Students using graphical organizers were able to self-reflect on their knowledge. Question 16 on a student survey asked students to list if they felt a graphical organizer would help. Students in the treatment group gave an average four score (4.26 average with a range of 4.09 to 4.40) while the comparison group was slightly lower with 3.97

(range of 3.77 to 4.30). The comparison surveys had the lowest score on the last week, which showed a downward trend. At the end of the treatment period, both groups listed a favorable use of graphical organizers. The comparison group listed 3.65 and the treatment group was 4.10. The next question showed a larger impact. Question 17 asked if they felt it had no impact. Both groups listed it in the bottom three (bottom two for treatment) out of sixteen questions.

The change of scores of the graphical organizers showed a significant difference between the groups (-3.5425 p-value beyond the 2.0010 value with 59 degrees of freedom). The range of change in the treatment group was larger than the comparison group (seen in Figure 2). Looking beyond the scores, but how students turned in their graphical organizers, comparison had 44.4% not turn in while the treatment had 33.3%. For those that turned in the graphical organizer, scores were strong in both groups. This showed that the graphical organizer helped their metacognition.

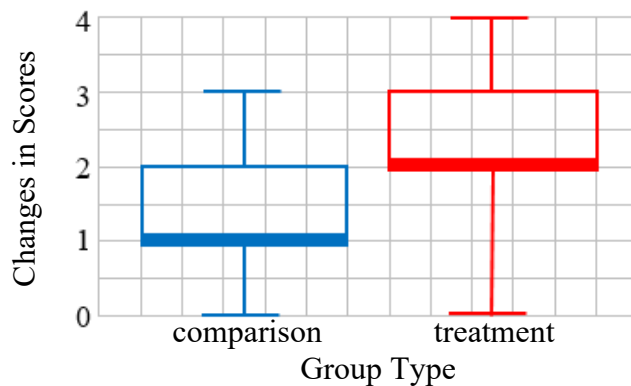


Figure 3: Difference between Pre & GO; (N blue-comparison = 20; N red-treatment = 41)

Students gave more details within their interviews. A treatment student said, “I do see problems when I write. Umm ... the ones that I can’t explain that I wrote”. This

student went further with how the treatment helped. “The questions has helped show me like what I should know. They remind me of the weekly check-ins we did earlier. The reminders help me to remember.” This student showed that the questions are getting to the thought process the student needed to utilize to answer the problem. A comparison student showed how the metacognition can be overwhelming if not addressed at each step. “No, too over whelming. I’m not doing it cause ... since I’m not sure what to do.” When asked further on the graphical organizer, the student said, “the time has not really helped cause it isn’t enough.” The other comparison student explained, “the graphical organizer is not really helpful. I just write definitions and a few problems. I find the review questions more helpful because I feel like I can answer them.” All students showed that the practice of working problems helped, but only the treatment students found a connection to the graphical organizer as a tool to help them.

After watching the different groups, the treatment group found the questions supporting their metacognition. The questions were posed to help them make connections. The comparison group saw the graphical organizer as a task to do on their own. Without the questions posed to help direct them, they ignored the graphical organizer. During the observation periods, no students appeared to write on their graphical organizer in class. At the end of the unit, they wrote but the first three weeks they ignored the time. The treatment group used the beginning of all three-week’s times. Both groups appeared to ignore the time on the fourth week. Students asked about their CER during that time. Students were focused on explaining their work within their CER assessment instead of on their graphical organizer.

Impact on Teacher

Implementing the additional time, organization, and questions did not impact the teacher's lesson work. The additional time that was spent on the treatment details was only a few minutes. During the class period, notes were made on how an activity could be made to a concept. The last day of the week, these details were turned into guiding questions asked during the treatment. The time spent grading work, creating activities, and making lessons took the majority of focus. A teacher copy of the journal was kept and updated during the class. This became a very valuable detail when looking for journal page connections. The time spent making the journal was very small since it was done during lesson planning.

The teacher's copy of the journal was the most useful piece to keep connections and the organization straight. The teacher was able to flip to different pages and make those pages listed in the lesson to help direct students. This connection to previous pages made the journal a useful tool to students. Students would add to a previous page when they realized they needed to add details to the previous comment. During these connections, students saw how the journal is filled with their comments to their future self more than they are simply details rewritten from a book. Only during the relooking at pages, did students see a good value on their comments.

Near the end of the treatment, a student asked if they could get an image of every outline. This student had lost their journal. Due to this fear, the teacher had kept their own copy. A digital copy had not been kept prior to this question. The class was polled to see if they want a digital reference in their classroom accounts. Most students requested

the digital copy. At the end of every lesson was a copy of all journal pages for that unit. At the end of the unit, and end of the treatment, a reference of every outline for each page in the unit was placed on their google classroom account. The small additional time made it easier for the teacher to lesson future days. Students could reference what details should be placed where without the details that are expected to be shown to earn their score.

Impact of the Notebook

The organization of a student's notebook helped students synthesize their chemistry knowledge. During the research gathered, a lack of work being turned in, mostly due to the unique online school year was observed. First, the data on the lack of assignments turned in showed a range. Out of three-journal page check-ins during the research, students in the treatment group turned in more frequently with 26.2%, 23.1%, and 24.6% not turning in the checks. The comparison group turned in their journal pages with less overall frequency with 13.7%, 27.8%, and 33.3% not turned in. The first journal page check was not including reflections. Performing an independent t-test on these six values showed that the differences were not a significant difference (0.0428 p-value not beyond the 2.776 value). When the first journal page check is removed, the independent t-test also showed no significant difference (1.649 p-value not beyond the 4.303 value).

The scores do not simply reflect only the variable of the journal pages. After talking with two students in the comparison group, I heard many frustrations that I saw in class. Both students felt that there was never a pointless part of their journal reflections. A common trend of not knowing what to put in their journal pages was seen. One student

said, “I just write definitions and a few problems” when asked what they do in their journal pages. The other student said, “Morning starters all at once, I explain and expand on like the Roman numerals means metals”. Both of these comments showed me that without a stronger organization on their pages meant they wrote what they thought was important but not necessarily connected to the full unit.

Test scores show one perspective, while student perceptions show a different story. On the student survey, both groups felt that their journal pages had organized their thoughts with a strong 4 out of 6 during the five-week check (comparison ranged 3.91-4.78 while treatment ranged 4.07-4.43). The lack of difference in these questions reflects that both groups had a basic organization given. The difference can be seen when they make connections in the unit graphical organizer. The treatment group had a top 2-survey response with using their journal for studying while the comparison group listed their usage in the top three. The average scale values were very similar with comparison at 4.77 and treatment at 4.90. Following student feelings from the survey, a high frequency of high values was seen in the treatment group.

Looking at the treatment between the groups was evident in the pre and post versions of their graphical organizers. An independent t-test showed that there was significant difference (-3.5425 p-value beyond the 2.0010 value with 59 degrees of freedom) in their improvements of their organizers. The average pre graphical organizer was 2.34 and 1.95 from the groups, which focused on a few terms they remembered without any connections. Overall, the comparison group turned in stronger pre-graphical organizers than the treatment group.

The unit test scores showed a slight increase for the treatment group. There was no significant difference between the groups in their test scores (-1.919 p-value not beyond the 1.985 value with 94 degrees of freedom). The range of scores was very similar while the treatment had more scores in the eighties. This gave a higher average to the treatment. There were a few low scores in both groups, which pulled the overall average down. The third quartile of the treatment group shows that a large number of higher scores were very close at 89.5. The comparison group had a third quartile of 86. Both groups had an average near 80. The treatment was at 82.06% while the comparison group had 78.26%. The overall test score was not significantly different but that is only part of the picture.

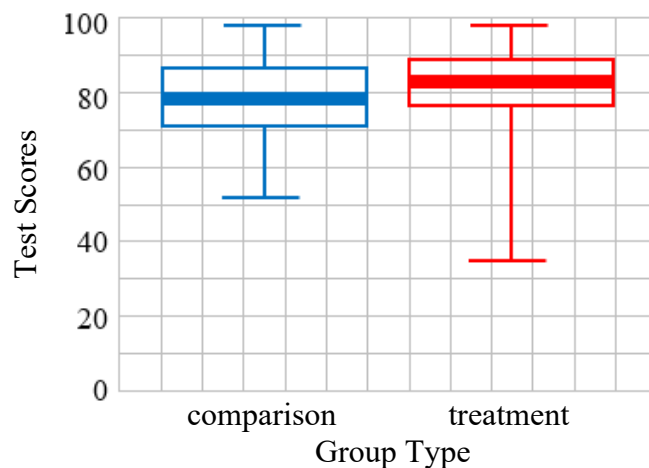


Figure 4: Test Scores; (N blue-comparison=34; N red-treatment=63)

CLAIM, EVIDENCE, & REASONING

Claims

In my question on organization in a notebook helping students make connections, it was found that students felt better about their understanding by looking at their ability to write in their journal pages as reflection notes and an overall graphical organizer. The number of students who turned in their graphical organizer in the comparison group (72.2% and 66.7%) compared to the treatment group (73.8% and 76.9%) showed how much it helped. Students will need continued support in moving away from a copy and paste style note to reflective notes. The more the teacher referenced a previous page, the more students used their journal. This needs to become a routine that starts in the first semester and continues to become stronger in the second semester.

Students addressed my reflections and summary question by answering survey question #11 with a positive response. The student responses towards using summaries in their journals was always a positively answered question in the middle of all questions. Students in the treatment group responded during the interviews on how the reflection helped show them where they were lost.

The discourse and self-regulation was found to be low due more to the current school situation than the treatment. Student turn-ins were very low during this research. Even though the turn-in was low, students who were on Zoom gained the ideas. The power of including the main ideas and reflection in class was lost to some students in their interviews and surveys. The scores in their work showed that the discussions helped even if they did not turn in the work. When students had individual conversations with

the teacher, the knowledge had been gained through the conversations done by classmates in a full class discussion. The journal pages are more valuable than the graphical organizer when they are summed up in understanding.

In my question on a graphical organizer supporting metacognition, it was found that the comparison group changed significantly less than the treatment group (-3.5425 p-value beyond the 2.0010 value with 59 degrees of freedom). The treatment group became stronger in their depth of explanations on their graphical organizers, which also made them more confident in turning in their work. The graphical organizer was turned in more in the treatment group (66.7%) compared to the comparison group (55.6%).

The impact on the teacher was low in time but strong in making better questions. The teacher found little to no time was needed to make the treatment group material from the comparison slides. The power of creating the different reflective and guiding questions helped make stronger support for both groups. The teacher found that they had to not use these treatment questions within the research time. The big impact on the teacher was to use these questions as starting questions the next day to continue reflecting in student journal pages.

Value of Study

Supporting students to go to higher levels of learning are well documented in the practices of science, as outlined in the Next Generation Science Standards. Students are very used to the tell and practice (T&P) learning style. The number of focus students used during the beginning portion of the class in their journal shows this focus. To improve their long-term memory, more drawings and models in their journals were needed. The

organization of their journal supported students to include drawings and models. Students started to include more drawings, models, and connections within their journals.

The teacher having an organized journal allowed for more connections within the journal to happen. The more students had outlines given in their journal and guided questions, the easier the graphical organizer appeared for students. The continued use of graphical organizers will help support the use of more drawings and models. This additional drawing will continue to improve students' long-term memory of a concept. When students retain more of the concept, they will be able to make more connections in later ideas and connect back to previous pages in their journal. A continued balance of using some T&P structure with drawing will allow students to bridge their ideas and their science practices.

The data gathered showed that the students found value and used that value to learn chemistry. The use of their journal has seemed more important this school year than any year in the past. The lack of discourse in groups due to being online, shows an additional need for helping students make connections. The treatment forced that group to have discourse. When students are face-to-face there will be more discourse, as has been seen in both groups after the research timeline. The journal needs to have an organization that supports the active learning process for students. When students saw value in their journal, the turn in increased.

Consideration for Future Research

The treatment of using questions to organize reflections towards making a graphical organizer can be a continued focus to study. This crazy year brought many new

variables but also removed variables. The question on what caused the changes in scores will future studies for the teacher. The lack of in class discourse made the treatment questions a combination of graphical organizer time and purposeful discourse. The next step is to look at a full year of organizing their notebook. This will allow the unfamiliarity of a notebook to not be a major variable within a study.

Moving Forward

This year has been hard. This year has been really hard on hands-on, science practice focused classes. The focus on organizing journals showed a strain on students who just wanted to get through the class. After this research period, the teacher saw far more work turned in and stronger journal pages. The switching of students, losing a student teacher, losing an hour of instruction each week, and finding out that school continued online all impacted the data. Moving forward, the teacher kept on the students to make these habits and routines within the class. Even if a student did not turn in the work, a positive movement forward in their understanding and lack of fear was seen.

A strong collaboration with colleagues will be implemented on the journal focus. The current PLC focuses on content for a unit test. The organization of the journal will become a focus so all students can improve on their organization. The graphical organizer instruction is not done but a good start. The next step is to turn the graphical organizer into a weekly update. This weekly update will be graded to show progress, not just a final evaluation of a page. Turning the graphical organizer into a drawn version of a table of contents is the next goal.

One detail that the teacher never felt right creating was a table of contents. This seemed to be a page wasted in a journal since it was never referred to. The referencing was partially due to the teacher not referring to it beyond the student's use. The addition of journal pages on a graphical organizer would give the page an additional level of organization to help students make even more connections. The time to work on this in class will only be able to work when students are physically in class. The online platform used at this school did not support letting students have the last ten minutes to work on updating their journal.

While in class, a teacher has control and can physically walk around to give helpful redirecting when needed. The online platform allowed students to literally log off when they were done. This additional time in class will not be lost when students are in person. The time must be found in class since the journal organization helped students and lowered the fear of learning chemistry. The focus on adding to the graphical organizer page will go beyond a wrap up of the day. This reflection work can become the exit ticket for the class on physically in class days.

Success in Stoichiometry

The professional growth that the teacher looked for with this research was within the stoichiometry portion of the pollution unit (unit 7). The original goal for this research project was to support students within moles and stoichiometry. The teacher was able to make comments on warm-up questions like reread over journal page 19 at the beginning of class. This showed promising results because every student that was new to the teacher, asked their group what was on that page. Instead of the teacher answering the

comment, a few students were chosen to read the main comments they listed. Journal page 19 covered conversions and significant figures. This showed a promising start to the current unit.

The one variable that this research project wanted to include but lacked due to the circumstances of time and a world event was student buy in. Within the stoichiometry work, students referred back to previous pages like 19. The more students looked at their previous work, the stronger their current reflections became. This was not measured within this research but could be a future research topic to measure. A student was able to recognize the difference between a T&P note from previous classes to a reflective note that included comments from their current understanding to their future self. They modeled to themselves what they needed to add to a page so they could continue to move forward in their understanding.

Looking towards the future and forward to face-to-face classes, the journal will be continued with reflective notes. This research has shown how helpful rubrics for both the teacher and student are on Google classroom. A simplified rubric will start in the beginning of the year to help guide students away from traditional copy and paste information towards reflective notes. The impact on teacher time was low when a rubric was used since there was no wasted time explaining why they earned a score. The rubric gave the teacher more time to list what additions the student needed to bring in my connections. This rubric will give a goal for their organization and help them get stronger.

This research showed the importance of written out questions. Even though the teacher might say the question, students rely on seeing the question. Looking forward to a new start, the journal reflection questions that were used to guide the treatment will become starter questions the next day. A new idea came in reflecting on this research. Students need to be given more time in mental time to think on their notes and ideas. A routine of asking how their journal page shows the answers to these reflective questions will move the teacher away from practice problems at the beginning to reflective additions to journals with practice problems. The beginning of class will connect their new insights on how the given practice problem is addressed or needs more reflection in their journal page. The student comment of just writing a few problems out will no longer be their goal because they will see how their journal connects to their understanding of the practice problem.

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APPENDICES

APPENDIX A

IRB EXEMPTION



**INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165**

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MEMORANDUM

TO: Kendia Herrington and Walter Woolbaugh

FROM: Mark Quinn *Mark Quinn cy*
Chair, Institutional Review Board for the Protection of Human Subjects

DATE: October 12, 2020

RE: "The Effects of Incorporating Organization in Notebooks to Synthesize Knowledge in a High School Chemistry Class" [KH101220-EX]

The above research, described in your submission of October 9, 2020, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- ☒ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- ☒ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation; and (iii) the information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by section 16.111(a)(7).
- ☐ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- ☐ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- ☐ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- ☐ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B

NOTEBOOK PAGE OUTLINE SLIDES



Journal



•Pg 65 – Unit 5: Bonding

- UEQ: Why are some molecules and compounds used that make up your favorite tools?

- | | |
|----------------------|---------------------|
| • Valence electrons | • Molecules |
| • Cations | • Covalent bond |
| • Anions | • Ionic bond |
| • Ionic compounds | • Metallic bond |
| • Covalent compounds | • Electronegativity |
| • VSEPR | • Chemical formula |
| • IMF | • Polarity |
| • H-bonds | |

Unit 5: Bonding

65

Why are some molecules and compounds used that make up your favorite tools?



ChemisTRY Journal



•HW 5.1 ... Due Monday

- JP 67
- Textbook pgs 187-198
- Keep a RL/preview log

•Reading log

- Quick look on page for main topics
- Look at problems solved for thought process
- New idea on already known vocab

Vocab

Additional

Question(s)

definition

Why does it not make

sense ... including math



Phenomenon



- JP 69
- Page for notes and ideas
- SEP 6 & 7
 - SEP 6 – you choose the **format**
 - SEP 7 – must have **evidence**
 - JP 8 & 9 for details

Within Tool		69
Key Points SEP: 6 & 7	Qs / Unknowns	
Why are some molecules and compounds used that make up my favorite tool?		
Compound Molecule Evidence of Use		



Journal



- JP 71 – Bonds
 - How does the movement of
electrons affect the molecule?
- Primary bonds
 - Covalent
 - Ionic
 - Metallic – keep small

Bonds			71
Covalent	Ionic	Metallic	
How does the movement of electrons affect the molecule?			
PT – M & NM Cations Anions			



ChemisTRY Journal



- HW 5.2 ... Due Tuesday
 - JP 73
 - Textbook pgs 201-3; 232-244
 - Keep a RL/preview log

Vocab

Additional

Question(s)

definition

Why does it not make

sense ... including math

- Reading log
 - Quick look on page for main topics
 - Look at problems solved for thought process
 - New idea on already known vocab



Journal



- JP 75 – Molecules & Compounds

- How does the bond impact the substance?

- Differences

- Lewis diagrams & structures
- Molecules & properties
 - mp, strength, etc. – sugar activity
- Compounds
 - mp, strength, etc. – salt activity

Molecules & Compounds 75

**Molecules
& properties**

**Compounds &
properties**

**How does the bond impact
the substance?**

Lewis structures



ChemisTRY Journal



- HW 5.3 ... Due Monday
 - JP 77
 - Textbook pgs 253-66
 - Keep a RL/preview log
- Reading log
 - Quick look on page for main topics
 - Look at problems solved for thought process
 - New idea on already known vocab

Vocab

Additional

Question(s)

definition

Why does it not make

sense ... including math



Journal



- JP 79 – Molecular Shapes
 - How does the bond impact the substance?
- Drawings
 - Lewis structures
 - VSEPR shape – explain HOW you know that shape
 - Molecule polar or nonpolar?

Molecular Shapes 79

**VSEPR
Shapes**

Polarity

How does the unbonded
paired electrons affect their
shape?

**Lewis structures &
VSEPR**



Journal



- JP 81 – Chemical Names
 - How does the name differ by the type of bond within?
- Examples
 - Lots of examples from slide activity to help guide you
 - H Bonds will be for IMF

Chemical Names 81	
Compound Rules	Molecular Rules
How does the name differ by the type of bond within?	
Examples	H Bonds

APPENDIX C

TREATMENT SLIDES



GO reflection

T-M



- Turn to your journal ... JP 65



GO reflection

T-M



- Turn to your journal ... JP 65
 - Rubric is listed on GC
- How does the movement of ve^- affect the type of bond?
- How do you get a positive ion?
- How does a lose or gain of ve^- make it covalent or an ionic bond?

5 pts

All definitions are in own words and drawings. Explanations connect words and drawings to explain the connections.

4 pts

All definitions are in own words. Words and drawings are shown to have relationships, not just grouped.

3 pts

Some attempt for definitions to be in own words. Words and drawings are grouped.

2 pts

Little attempt on definitions to be in own words. Little or no attempt in grouping.

1 pt

Some attempt was made towards definitions and/or grouping.



GO reflection



- Turn to your journal ... JP 65
 - Rubric is listed on GC
- How are ve- used to make Lewis diagrams?
- How are M & NM used to figure out if the substance is a compound or molecule?
- What are the properties of compounds or molecules?

5 pts	4 pts	3 pts	2 pts	1 pt
All definitions are in own words and drawings. Explanations connect words and drawings to explain the connections.	All definitions are in own words. Words and drawings are shown to have relationships, not just grouped.	Some attempt for definitions to be in own words. Words and drawings are grouped.	Little attempt on definitions to be in own words. Little or no attempt in grouping.	Some attempt was made towards definitions and/or grouping.



GO reflection



- Turn to your journal ... JP 65
 - Rubric is listed on GC
- How are electronegativity values used to determine polarity?
- How are VSEPR shapes determined?
- How is the chemical formula determined from charges?

5 pts	4 pts	3 pts	2 pts	1 pt
All definitions are in own words and drawings. Explanations connect words and drawings to explain the connections.	All definitions are in own words. Words and drawings are shown to have relationships, not just grouped.	Some attempt for definitions to be in own words. Words and drawings are grouped.	Little attempt on definitions to be in own words. Little or no attempt in grouping.	Some attempt was made towards definitions and/or grouping.



GO reflection

T-M



- Turn to your journal ... JP 65
 - Rubric is listed on GC
- How does water connect with other water?
- How do you name covalent compounds/molecules?
- How do you name ionic compounds/compounds?

5 pts

All definitions are in own words and drawings. Explanations connect words and drawings to explain the connections.

4 pts

All definitions are in own words. Words and drawings are shown to have relationships, not just grouped.

3 pts

Some attempt for definitions to be in own words. Words and drawings are grouped.

2 pts

Little attempt on definitions to be in own words. Little or no attempt in grouping.

1 pt

Some attempt was made towards definitions and/or grouping.

APPENDIX D

WEEKLY STUDENT SURVEY



All about You

Chemistry reflection to help Herrington on her masters - thank you!

* Required

Chemistry Period *

☐ 1st period
☐ 3rd period
☐ 7th period
☐ Other: _____

First Name *

Your answer _____

Last Name *

Your answer _____

Weekly Reflection

Now I will get info about how you feel this week went for you & how you did this week.

I find use in my journal/notebook. *

Choose

I used my Journal pages (JP) this week. *

Choose

My Journal pages (JP) help me organize my thoughts. *

Choose

1 - strongly disagree
 2 - disagree
 3 - mostly disagree
 4 - mostly agree
 5 - agree
 6 - strongly agree

I did not add color in my Journal pages (JP). *

Choose

I added color in my Journal pages (JP) to help organize my thoughts. *

Choose

I did not add drawings in my Journal pages (JP). *

Choose

I added drawings in my Journal pages (JP) to help organize my thoughts. *

Choose

When writing in my Journal pages (JP), I can see that I learned a concept. *

Choose

When I write in my Journal pages (JP), it helps me to see where I am confused. *

Choose

I asked for help after thinking about writing in my Journal pages (JP). *

Choose

I was able to reflect in my Journal pages (JP) on my own. *

Choose

I reflected on the given Journal page (JP) for the day during class. *

Choose

Talking in my group helped me reflect in my Journal pages (JP). *

Choose

I turned to a page in my Journal and reflected without Ms H directing me to do so. *

Choose

Ms H giving me JP Listings in the lesson helps me use my Journal. *

Choose

I think the end of the unit graphical organizer (GO) will help me connect concepts and review. *

Choose

[Back](#)
[Submit](#)

APPENDIX E

END STUDENT SURVEY



All about You

* Required

Unit Reflection

Now I will get info about how you feel this unit will and went for you.

I find use in my journal/notebook. *

Choose ▾

I used my journal pages (JP) this unit. *

Choose ▾

My journal pages (JP) help me organize my thoughts. *

Choose ▾

I used color in my journal pages (JP) to help organize my thoughts. *

Choose ▾

I used drawings in my journal pages (JP) to help organize my thoughts. *

Choose ▾

When writing in my journal pages (JP), I can see that I learned a concept. *

Choose ▾

When I write in my journal pages (JP), it helped me to see where I was confused. *

Choose ▾

I asked for help after thinking about writing in my Journal pages (JP). *

Choose ▾

I was able to reflect in my journal pages (JP) on my own. *

Choose ▾

I reflected on the given journal page (JP) for the day during class. *

Choose ▾

Talking in my group helped me reflect in my journal pages (JP). *

Choose ▾

I turned to a page in my journal and reflected without Ms H directing me to do so. *

Choose ▾

Creating the unit graphical organizer (GO) helped me connect concepts and review. *

Choose ▾

I think the graphical organizer (GO) has no impact on my understanding of the unit. *

Choose ▾

The graphical organizer (GO) helped me understand the concept connections to the unit practice. *

Choose ▾

Back Submit

APPENDIX F

WEEKLY OBSERVATION SHEET

*Shorthand Key: S = student; TCH = teacher; J = journal; JP = journal page; Q = question; GO = graphical organizer

[illegible]

APPENDIX G

INTERVIEW QUESTIONS SHEET

Student Reflections – Chemistry

1. How are you doing this week?
2. Did you feel like you could attack your test last semester?
3. Did you feel like you could attack your test today?
4. How do you feel that taking notes in chemistry helps you understand?
 - a. What portion of taking notes makes you feel more confident?
 - b. What portion of writing in your journal do you feel is pointless?
5. How does the organization of your journal pages (JP) help you in chemistry?
6. How does the reflections of activities help you in chemistry?
7. How does talking out ideas help you in writing in journal pages in chemistry?
 - a. Does talking in your group give you ideas?
 - b. Does talking in groups feel pointless?
 - c. Does talking with Ms H give you ideas?
8. How does writing out graphical organizers (GO) help you in writing in journal pages in chemistry?
9. Has the weekly reflection on the JP 65 (Unit's GO page) helped you organize your thoughts?
10. What do you wish was done differently in your journal?
11. Do you think you will continue to take reflective notes after this class?
 - a. What type of classes are you most likely to take reflective notes in?
12. Any additional ideas on the previous questions you want to ask me?

Thanks for taking the time to complete this and talk with me!

APPENDIX H

STUDENT SURVEY RESULTS

Week	Question																			
	1-Find Use in JP	2-Use JP this week	3-JP organized thoughts	4-No color in JP	5-Added color in JP	6-No drawing in JP	7-Added drawing in JP	8-JP in writing = learned	9-JP showed confusion	10-Asked Q after JP	11-JP reflection on own	12-Wrote in JP	13-Discourse so JP	14-Used and JP	15-Ms H directed-JP	16-GO will help	17-Creating GO helped	18-GO no impact	19-JP used in studying	20-GO helped connect
1	4.39	4.48	3.91	3.58	3.30	3.39	3.45	4.03	3.85	2.76	3.79	3.82	2.18	3.82	4.94	3.82				
2	4.67	4.78	4.78	3.22	3.89	3.56	3.67	4.89	4.22	3.67	4.11	4.00	2.67	3.78	5.22	4.00				
3	4.70	4.90	4.60	3.80	3.90	3.30	3.90	4.60	4.60	3.60	4.20	4.70	2.30	4.10	5.20	4.30				
4	4.57	4.93	4.40	3.67	3.13	3.67	3.40	4.40	4.07	2.97	4.13	4.20	2.70	4.17	4.93	3.77				
5	5.23	5.08	4.73		3.69		4.12	4.65	4.50	3.27	4.50	4.58	2.38	4.42			3.65	3.42	4.77	4.04
T1	4.41	4.18	4.10	3.46	3.36	3.13	3.79	4.20	3.87	2.52	3.75	3.51	3.05	3.57	4.95	4.21				
T2	4.64	5.36	4.18	3.45	3.73	2.45	4.64	4.95	3.64	2.55	4.64	4.36	3.18	3.91	5.36	4.09				
T3	4.53	4.80	4.07	3.60	3.33	3.07	3.80	4.33	4.13	2.73	3.93	3.87	3.93	4.20	5.07	4.40				
T4	4.60	4.85	4.29	3.44	3.65	2.81	4.15	4.56	4.27	2.63	4.25	4.31	3.38	4.08	4.92	4.35				
T5	4.76	4.96	4.43		3.78		4.20	4.33	4.20	2.84	4.25	4.27	3.69	3.78			4.10	3.33	4.90	4.76

Red = top 2 for that week; Yellow = low 2 for that week; Gray = not asked that week

APPENDIX I

UNIT 5 SUMMARY SCORES

Stat & Group	Assignment									
	PreGO	GO	RW	JP 71	JP 75	JP 81	Tool	CER	Test	Free Resp
AVG	2.34	3.75	4.78	4.16	4.27	4.04	16.73	13.73	77.32	8.9
n	32	20	29	31	26	24	22	26	34	30
NO	4	16	7	5	10	12	14	10	2	6
Min	1	3	3	2	3	3	12	3	52	6
Max	4	5	5	5	5	6	20	20	98	10
Q1	2	3	5	4	4	3	14	9.25	73	8
Q2	2	4	5	4	4	4	16	15.5	77	9
Q3	3	4	5	5	5	5	20	18.75	83	10
Rev					2	1	2	15		
T-AVG	1.95	4.32	4.85	3.87	4.37	4.35	18.06	14.76	82.06	8.17
T-n	59	41	42	46	48	47	37	52	62	41
T-NO	4	22	21	17	15	16	26	11	1	22
T-Min	1	2	3	3	2	2	14	5	34	1
T-Max	4	5	5	5	6	6	20	20	98	11
T-Q1	1	4	5	3	4	4	16	10.5	77	7.25
T-Q2	2	4	5	4	5	4	18	16	84	9.5
T-Q3	2	5	5	5	5	5	20	19	89.5	10
T-Rev				4	2		4	34		

APPENDIX J

OBSERVATIONAL DATA RESULTS

Topic	Week Dates				
	1: 1/5, 6	2: 1/11, 12, 13	3: 1/19, 20	4: 1/25, 26, 27	5: 2/1, 2, 3
Discourse Asked	3 9	6 23	3 5	15 18	7 13
Discourse follow-up	1 12	5 19	1 1	10 12	7 6
Discourse not in group	0 0	all all	all most	singles	singles
Discourse class notes	Not many Qs but self working Asked about previous JP	Lots on starter; Few GC Qs Students in cars; Lots Qs on CER and slides	Couple email Qs; After school Qs Qs on quiz; After school Qs	Few writing during starter Lots writing during starter; More Qs - singles	After school +1 hr Not many outside setup
JP used	9 8	10 7	few few	3 most	most some
JP class notes	20 min; 24 min 8-12; 19-19	9; lots lewis 7; lots lewis	21; 21 Good reflecting chunk 22-12; 14-19 10 min drawing JP 75	26; 23; 25 19-13; 13-14; 18-14	23 Lots of flipping in test 18-17 Few flips
GO used	0 8	0 9	some most	all all	n/a
GO class notes	No writing in time 5-lots of writing; 6-not as much	No writing in time Lots during time	1 st 5 min reflected 1 st 5 min reflected	Not many, working on GC Not many, working on GC	Overview-6 min no Qs Overview-10-14 lots of Qs
Changes		*Started adding JP#s on slides		*PLC-put in single groups to increase dialog in ALL chemistry classes	

APPENDIX K
STUDENT SCORES

Main Assignment Scores and Basic stats for Comparison group

	Pre GO	GO	Test	Free Resp	JP 71	JP 75	JP 81	RW	Tool	CER
	3	3	83	8	4	4	4	5	16	3
	1	3	67	10	4	4	6	5	16	16
	4	3	74	8	4	5	4	5	20	18
	3	4	74	10	4	5	5	5	20	19
	3	4	97	7	4	5	4	5	14	5
	3	4	83	10	5	4	3	5	20	20
	2	4	83	9	3	3	5	5	12	6
	3	5	73	7	4	5	3	3.5	16	8
	2	5	56	8	5	4	5	5	20	14
	2	4	52	10	3	3	3	5	14	20
	2	3	84	10	3	5	4	3.5	20	10
	1	5	83	10	4	3	5	5	20	9
	3	3	73	9	5	5	4	5	20	20
	3	4	78	10	4	5	5	5	20	15
	3	3	81	6	4	5	4	5	20	20
	2	4	93	9	4	5	4	5	12	17
	2	4	70	11	5	3	3	5	12	5
	3	3	84	8	5	5	3	5	20	14
	2	4	78	10	5	3	4	5	12	16
	1	3	67	7	5	4	3	5	16	6
	2		85	10	3	4	3	3.5	12	18
	3		79		4	4	3	3	16	16
	3		66		4	4	5	5		19
	3		98		5	4	5	5		13
	2		75		4	5		5		20
	1		74		4	5		5		10
	3		82		2			5		
	3		76		4			5		
	2		64		5			5		
	2		87		5					
	1		61		5					
	2		75							
			76							
			98							
AVG	2.34	3.75	77.32	8.90	4.16	4.27	4.04	4.78	16.73	13.73
students	n = 32	n = 20	n = 34	n = 21	n = 31	n = 26	n = 12	n = 29	n = 22	n = 26
Not done	NO = 4	NO = 16	NO = 2	NO = 15	NO = 5	NO = 10	NO = 24	NO = 7	NO = 14	NO = 10
Q1	2	3	73	8	4	4	3	5	14	9.25
Q2	2	4	77	9	4	4	4	5	16	15.5
Q3	3	4	83	10	5	5	5	5	20	18.75
Range	1 to 4	3 to 5	52 to 98	6 to 10	2 to 5	3 to 5	3 to 6	3 to 5	12 to 20	3 to 20

Main Assignment Scores and Basic stats for Treatment group

	Pre GO	GO	Test	Free Resp	JP 71	JP 75	JP 81	RW	Tool	CER
	3	4	87	9	3	4	4	5	20	14
	4	5	87	10	4	5	5	5	20	9
	2	5	92	8	5	5	5	5	20	20
	2	4	81	10	3	3	3	3.5	14	10
	2	4	75	5	3	4	4	5	18	9
	2	4	88	10	3	5	3	3	18	5
	1	5	63	10	4	3	3	5	20	20
	2	4	79	5	3	4	5	5	20	12
	1	4	95	10	5	5	4	5	20	20
	3	5	70	8	5	4	4	5	20	19
	1	5	95	4	4	5	4	5	16	20
	1	5	89	3	4	4	4	5	20	17
	2	3	85	10	5	5	4	5	16	6
	1	4	90	3	4	5	3	5	18	18
	1	5	76	10	4	4	5	5	20	17
	2	5	97	8	4	4	5	5	16	18
	1	5	96	10	5	4	4	5	20	7
	2	5	74	11	4	6	5	5	16	19
	2	4	71	10	3	6	4	5	16	12
	1	3	80	10	3	5	5	5	20	10
	1	5	82	10	4	3	5	5	20	8
	2	4	80	10	3	5	3	5	16	8
	1	4	64	11	3	4	6	5	20	15
	1	5	85	3	4	5	5	5	20	13
	2	5	83	5	3	5	5	5	16	15
	4	4	69	7	5	3	4	5	16	20
	2	4	47	7	3	5	3	5	18	20
	2	4	64	10	3	4	4	5	16	9
	4	5	88	10	4	4	6	5	20	9
	4	5	85	10	3	6	3	5	20	20
	2	4	94	10	4	3	4	5	20	20
	2	5	89	9	3	5	5	5	16	16
	2	4	73	10	5	3	6	5	16	20
	2	5	78	8	5	5	5	5	16	8
	2	5	89	9	3	5	5	5	16	19
	1	3	94	10	4	4	5	5	16	20
	3	4	78	9	5	4	5	5		16
	2	4	80	8	3	5	5	5		14
	2	4	85	1	4	5	2	5		7
	2	2	83	8	5	5	4	5		14
	2	4	84	4	5	5	4	5		16
	2		74	10	3	4	4	5		18
	2		81		5	5	4	5		20
	2		82		5	5	4	5		18
	2		98		4	5	5	5		19
	2		84		3	4	5	5		17
	1		95		3	2	5	5		12
	1		84			2	5	5		16
	3		90			4		5		11
	2		94					3		18
	1		79					3		15
	2		98							
	3		93							
	1		89							
	2		90							
	3		98							
	1		87							
	2		34							
			87							
			79							
			75							
			68							
			67							
AVG	1.95	4.32	82.06	8.17	3.87	4.37	4.35	4.85	18.06	14.76
students	n = 58	n = 41	n = 63	n = 42	n = 59	n = 59	n = 39	n = 41	n = 36	n = 51
Not done	NO = 5	NO = 22	NO = 0	NO = 21	NO = 5	NO = 5	NO = 15	NO = 12	NO = 27	NO = 12
Q1	1	4	77	7.25	3	4	4	5	16	10.5
Q2	2	4	84	9.5	4	5	4	5	18	16
Q3	2	5	89.5	10	5	5	5	5	20	19
Range	1 to 4	2 to 5	34 to 98	1 to 11	3 to 5	2 to 6	2 to 6	3 to 5	14 to 20	5 to 20

APPENDIX L

COMPARISON STUDENT JOURNAL PAGE EXAMPLES

page 71

Bonds

When it comes to chemical bonding two types of bonds can occur known as covalent bonding & ionic bonding.

These bonding types use electrons differently to ensure all of the atoms have a full outer shell.

covalent bonding

- neither of the atoms will lose/gain an electron
- atoms share their electrons to make sure that they all have full outer shells

ionic bonding

- formed when atoms from one element give up their electrons to another element so that they both can have a full outer shell

Metallic character is the name given to the set of chemical properties associated w/ elements that are metals.

- chemical properties result from how readily metals lose their electrons to form cations.

How does the movement of electrons affect the molecule?

metals & non-metals on a periodic table

metals:

- highest degree of metallic behavior
- electrical conductivity is high
- very low electronegativity

non-metals:

- less/no metallic properties
- electrical conductivity is low
- very high electronegativity

cation

- cations are + charged
- usually formed by metal atoms
- attracted to the cathode
- form electrostatic interactions w/ anions to form i.c.

anion

- anions are - charged
- usually formed by non-metal atoms
- attracted to the anode
- form electrostatic interactions w/ cations to form i.c.

71

1/6/20

Li Mg N O F

nonmetals
metals
metalloids

Lithium has 3 protons & 3 electrons, if there were more electrons it would be a charged ion.

Side 3

How does the movement of electrons affect the molecule?

How are ions made from neutral atoms?

- When 1/2 electrons removed from a neutral atom, it can turn into a positively charged ion, when an atom gets 1 extra electron, it can become negatively charged.

Model 1

	Metal or nonmetal	Is the # of protons same in atom & ion?	# of electrons same in atom & ion?	How electrons same in atom & ion?
Lithium	metal	yes	yes	no
Magnesium	metal	yes	yes	no
Aluminum	metal	yes	yes	no
Fluorine	nonmetal	yes	yes	no
Oxygen	nonmetal	yes	yes	no
Nitrogen	nonmetal	yes	yes	no

Model 1 conversation:

1. Neutral atoms have the same protons and electrons, when ion is either - or +.
2. Ion charge is located in the top right corner of an ionic symbol.
3. There's nothing there → $\begin{matrix} 7 \\ 3 \end{matrix} \text{Li}^+$ (still up right).
4. Number of protons - number of electrons = charge.

Symbol	Ca^{2+}	S^{2-}	H^+	Al^{3+}	F^-
Atomic #	20	16	1	13	9
# of protons	20	16	1	13	9
# of electrons	18	18	0	10	10
# of valence electrons	8	8	0	8	8
Cation or anion	cation	anion	cation	cation	anion

Neutral Atom

loses electrons → cation (+)

gains electrons → anion (-)

To get charge = # Protons - # of Electrons

notes from Slide

Scored 4 Journal Page 71

Bonds

Covalent

A chemical bond

that involves the sharing of electron pairs between atoms

Ionic

Also known as

electrovalent bond.

type of linkage formed from the electrostatic attraction between oppositely charged ions in chemical compounds

Metallic

A type of chemical

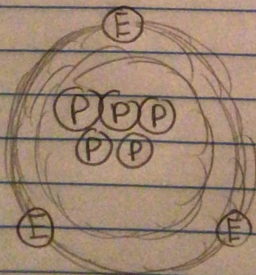
bonding that arises from the electrostatic attractive force

between conduction electrons & positively charged metal ions

How does the movement of electrons affect the molecule?

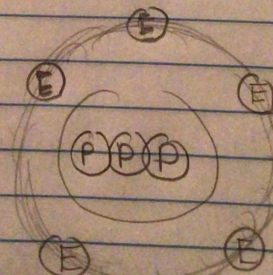
PT - M & NM Cations Anions

Cation



- Positively charged
- More protons than electrons

Anion



- Negatively charged
- More electrons than protons

Scored 3 Journal Page 71

Subatomic particles and Locations

Proton - Nucleus

Neutron - Nucleus

Electron - outer shells

• Li: 3 protons 4 neutrons 2, 1 electron

• F: 9 protons 10 neutrons 2, 7 electron

• Li: $2, 1 + 7 = 2, 8$ (Ne)• F: $2, 7 + 1 = 2, 8$ (Ne)

Electron = no change in mass or element

First shell 2 any shells after 8

APPENDIX M

TREATMENT STUDENT JOURNAL PAGE EXAMPLES

Scored 5 Journal Page 71

1-5-21

• Subatomic particles & locations:

protons, neutrons, & electrons

• Bohr model for...

- Li: $3p^+$ & $4n^0$... $2, 1e^-$

- F: $9p^+$ & $10n^0$... $2, 7e^-$

• How many electrons does the atom need to gain to become stable? Lose to become stable?

- Li: $2, 1+1 = 2, 8(N, e)$ $2, 1-1 = 2(He)$

- F: $2, 1+1 = 2, 8(N, e)$ $2, 7-7 = 2(He)$

Ionic compounds

- atoms transfer electrons
- formed between a metal and non-metal

Covalent compounds

- atoms share electrons
- formed between 2 non-metals

• they both result the same

• they're bonding lead to the creation of stable molecules

• Which subatomic particle can be gained or lost where the element and mass do not change? **electrons**

• If an atom loses 3 electrons, what is the ion's charge? $3+$

• If an atom gains 3 electrons, what is the ion's charge? $3-$

• What is the maximum amount of electrons gained or lost in the first few shells? $4e^-$

• What combination of charges are possible when you have 2 items? $+ \& +$ $+ \& -$ $- \& -$

Co $\begin{matrix} + & - \\ \text{---} & \text{---} \end{matrix}$ Conductive mixture Ionic 71
Non conductive covalent mixture

Bonds EQ: How does the movement of electrons affect the molecule?

Bohr model Combination of Bonds.

Li: $3p^1 4s^0$ 2, 1 + , +
 Li^+ cations + , -
 F: $2p^5 3s^2$ 2, 7 - -
 F^- anions. - -

Li: $2, 1 + 7 = 2, 8 (\text{Ne})$ $1, 1 - 1 = 2 (\text{He})$
 $2, 7 + 1 = 2, 8 (\text{Ne})$ Maximum amount of e- gained or lost in first case shells 4 e-

Covalent Electrons Check in # comes first when writing charge
 Can be shared between electron
 atoms. Share valence electrons. $(- -)$ 3- loss electrons
 (NM, NM) 3- + Gains Electrons
 2, 8, 8 All metals have different charges

Metal Ionic: Both types of
 Cations = + charged Ion Bonds Non metal
 anions = - charged Metal bonds. $(+ , -)$
 Non metal transfer electrons. (NM, NM)

Positive charge push away electrons Ionic Discussions
 Model 1:
 • Ions have different # of protons than Electrons while P & E are the same in neutral atoms.

Metallur:
 Lewis Diagram
 PH_3
 $\text{H} \text{---} \text{P} \text{---} \text{H}$
 $\text{H} \text{---} \text{P} \text{---} \text{H}$
 $\text{H} \text{---} \text{P} \text{---} \text{H}$

Bonds

Which subatomic particle can be gained or lost where the element and do not change? e^- electrons

If an atom loses 3 electrons, what's the ions charge? $3+$

If an atom gains 3 electrons, what's the ions charge? $3-$

What is the maximum amt of electrons gained or lost in the first few shells? $4e^-$

What comb of charges are possible when you have 2 items:
 $+$ and $+$ $+$ and $-$ $-$ and $-$

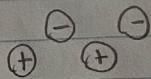
How is an atom different from an ion?

Charge ... atom (0); ion (+/-)

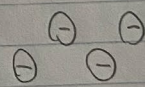
What is a definition? Simply - meaning of term

P+	n ^o	e ⁻	Symbol
14	14	14	Si
10	14	14	Ne ⁴⁻
14	14	10	Si ⁴⁺
14	14	18	Si ⁴⁻

Conductive;
ionic mix



nonconductive;
covalent mix



ionic (nm+m),
both types of ion bond

covalent (nm+nm),
Share-valence

Li_2O = ionic
 NaF = ionic
 BeS = ionic

PH_3 = covalent
 F_2 = covalent

Charges
 When
 added to
 water.

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Ionic

Metallic

PT ~ M ~ NM ~ Cations ~ Anions

- The only thing that should change is the number of electrons
- metal, +, cation, elements on the left of the PT, conductive
- nonmetal, -, anion, elements on the right of the PT, non-conductive
- When you add an electron you get a negative charge because electrons have a negative charge.
- charge possibilities $+8 + 1 + 8 - 1 - 8$
- Atom 0 charge; ion + or -

P^+	n^0	e^-	Symbol
14	14	14	Si
10	14	14	Ne^{4-}
14	14	10	Si^{4+}
14	14	18	Si^{4-}

← metal

← nonmetal

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Bonds

Bohr's model

Li 3p 4n ... 2, 1e⁻ ^{Left}

F 9p 8 10n ... 2, 7e⁻ ^{Left}

covalent	ionic	metallic
is a chemical bond that involves sharing electrons	When valence electrons of one atom are transferred permanently to another atom	Sharing of free electrons among a structure

Every atom wants to have full valence shell of electrons.

How does the movement of electron

metals - cation

nonmetals - anion

Neutrons and Protons are the same in ions. Electrons are the only ones that change

ex H^+

Si^{4+} cation = Metal

Si^{4-} anion - non Metal

metal $\rightarrow$ conductive

non-metal $\rightarrow$ non-conductive

Scored 3 Journal Page 71

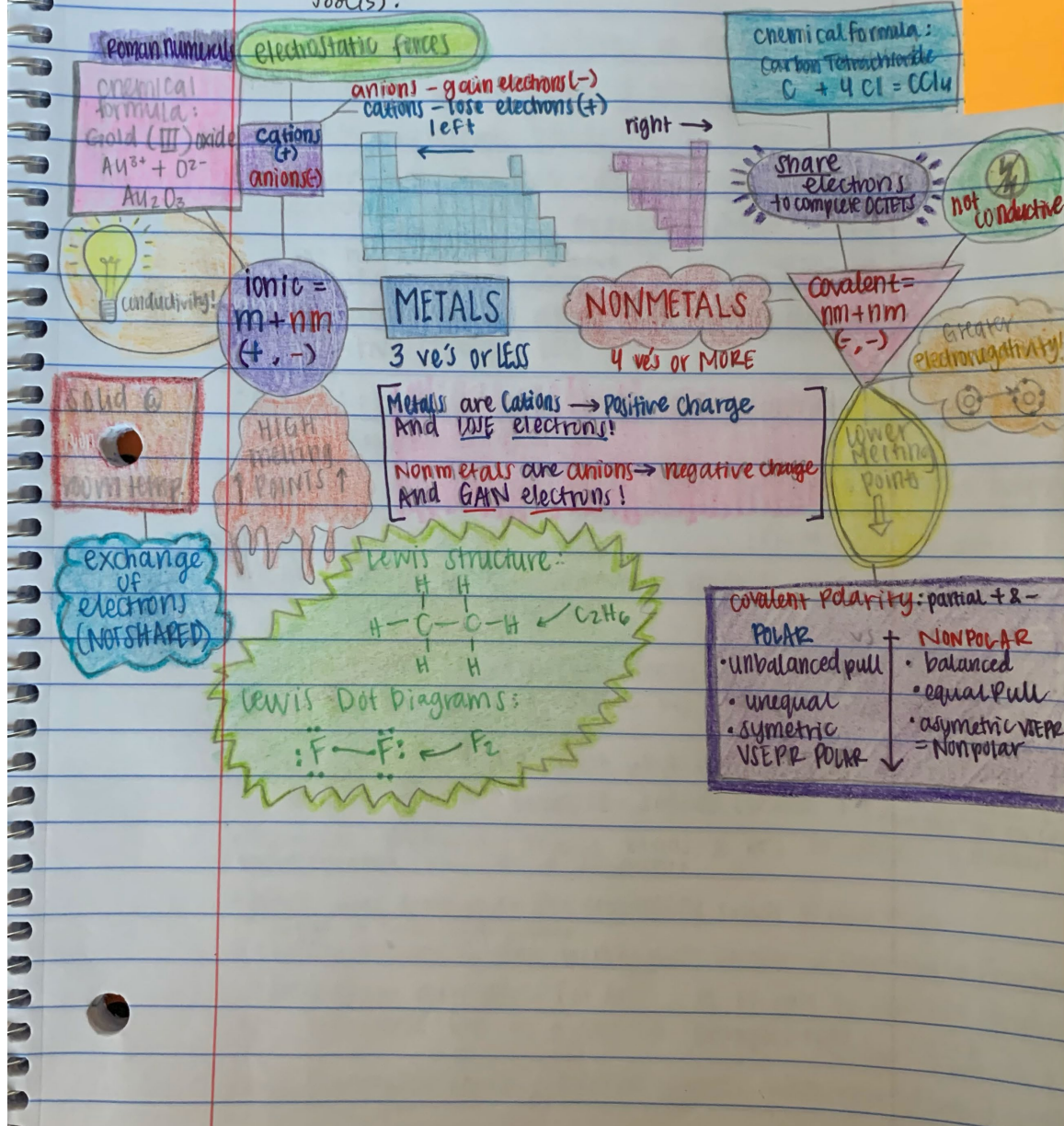
Cations are positive ions, and anions are negatively charged ions. Cations will always have more protons than electrons. Anions will always have more electrons than protons. The # difference between each particle is the net charge of an ion. However, when in ion notation, the charge is inverse to its net charge, as that is how many particles it has lost or gained. The particle that will always be gained or lost is the glorious electron.

APPENDIX N

COMPARISON STUDENT GO EXAMPLES

Unit 5 - Bonding

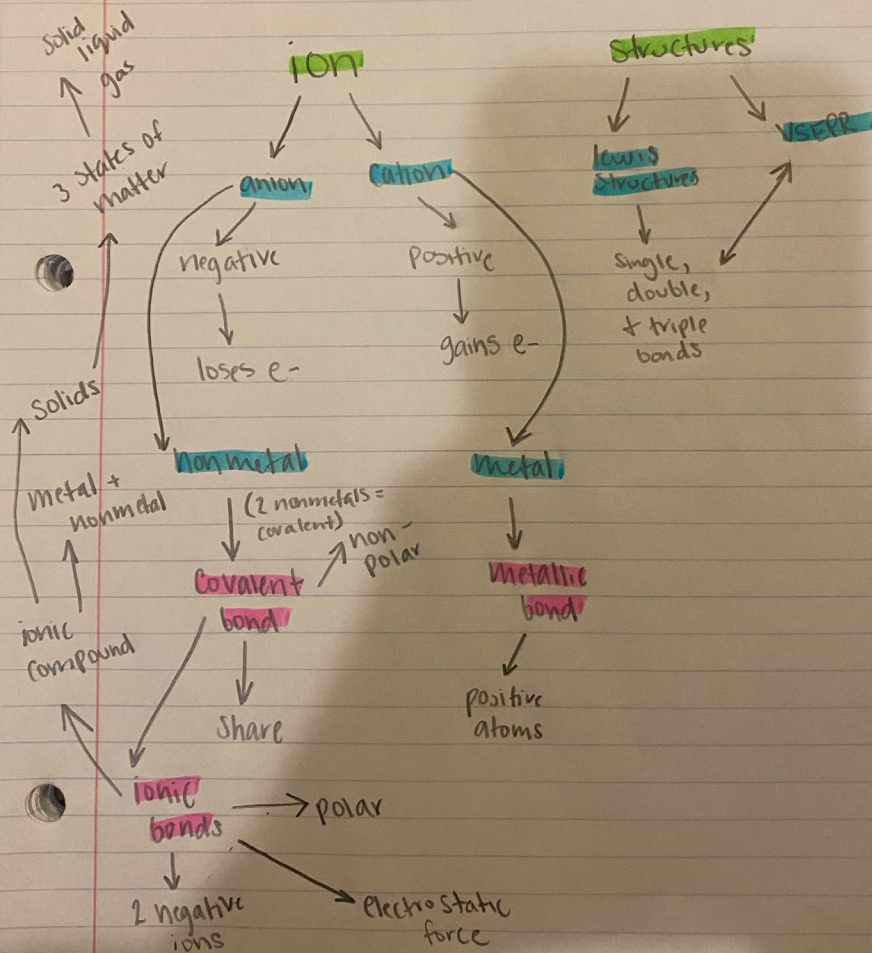
Why are some molecules and compounds used that make up my favorite tool(s)?

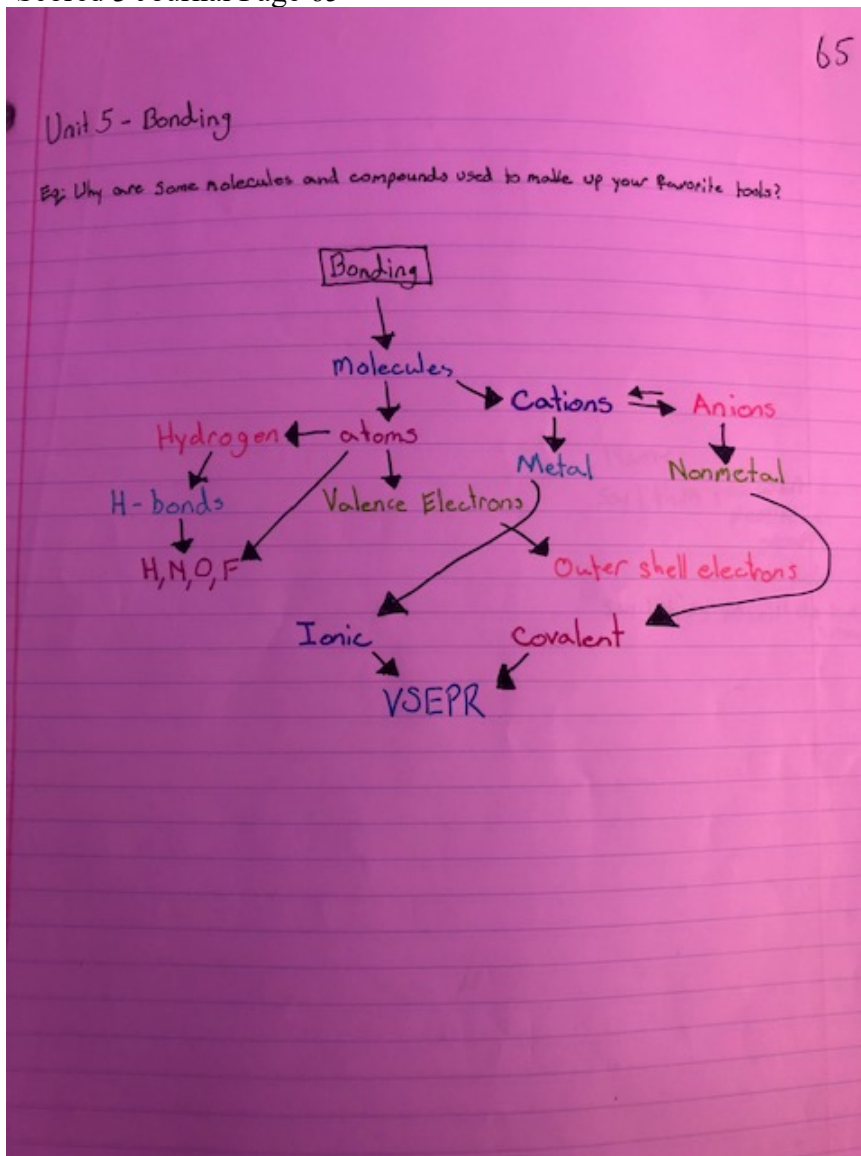


Graphic Organizer

Unit 5 - Bonding

eg: why are some molecules and compounds used that make up your favorite foods?





APPENDIX O

TREATMENT STUDENT GO EXAMPLES

Scored 5 Journal Page 65

• cation = atom that lost e^- ... making it positive
 • Anion = atom that has gained e^- ... making it negative
 • Electrostatic attraction holds **Ionic bonds** together

Ionic **covalent**

conductive nonconductive

1A (+) 2A 3A 4A 5A 6A 7A 8A (-)

4.0 3.5

Electronegativity

$4.0 - 2.1 = 1.9$ $+0.4$ or 0.5
 $3.5 - 2.1 = 1.4$ **Polar**

Unit 5: Bonding

UFG: Why are some molecules and compounds used that make up your favorite foods?

Ion **M - NM** **Ionic compound Names**
 LGS gains e^- **Li₂O** - Lithium oxide
 (4) cation anion (-) **Iron(II) oxide** -
 metals nonmetals (1) find the charge
 (+2) (-2) then balance it out to zero or for Fe^{2+}

atoms atoms
 Sharing of electrons Transfer of electron
 covalent bond Ionic bond

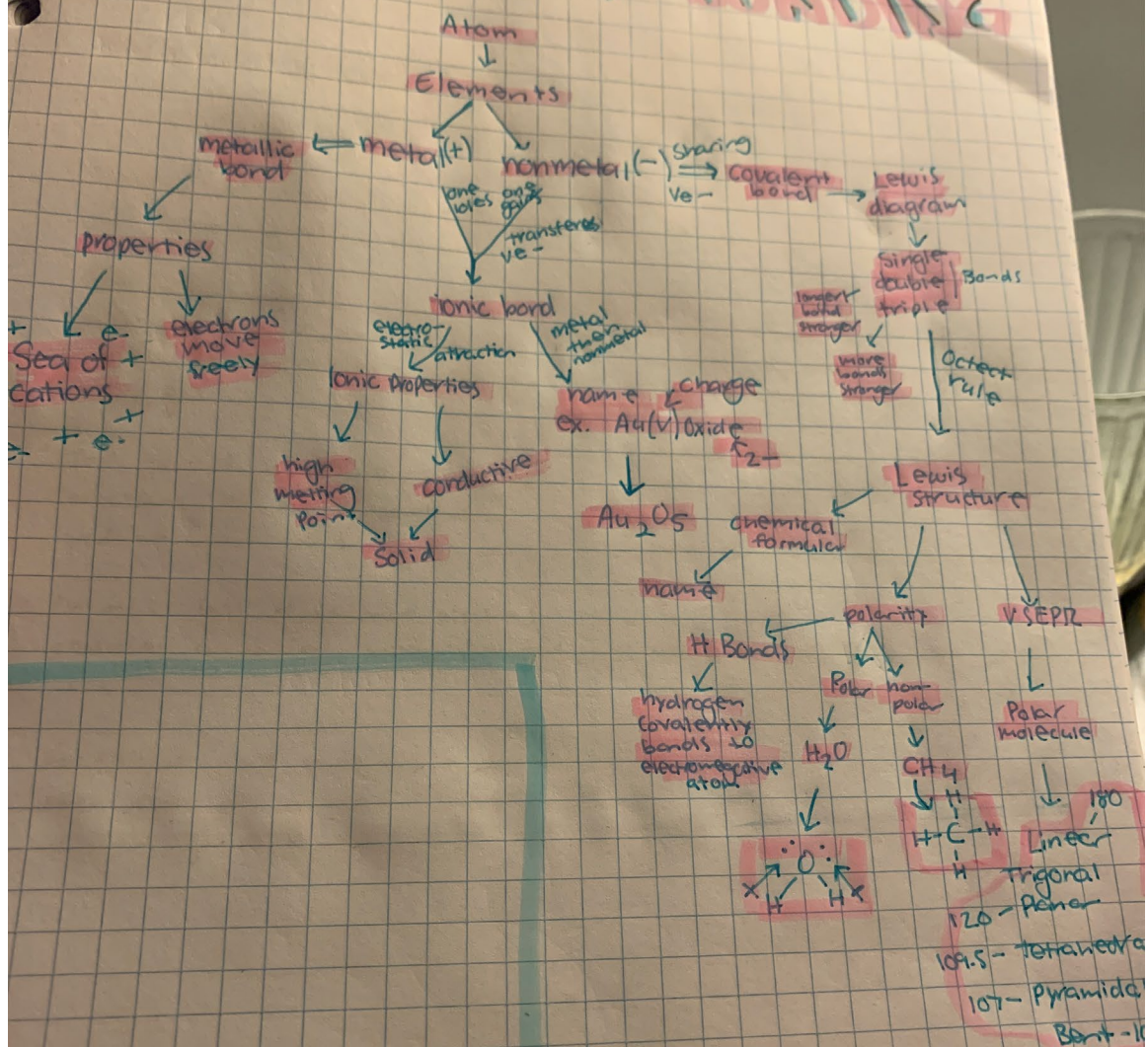
Lewis structure
 C_2H_6
 $H-C-C-H$ (simple)
 H H H H
 Total ve^- : $2(4) + 6(1) = 14 ve^-$

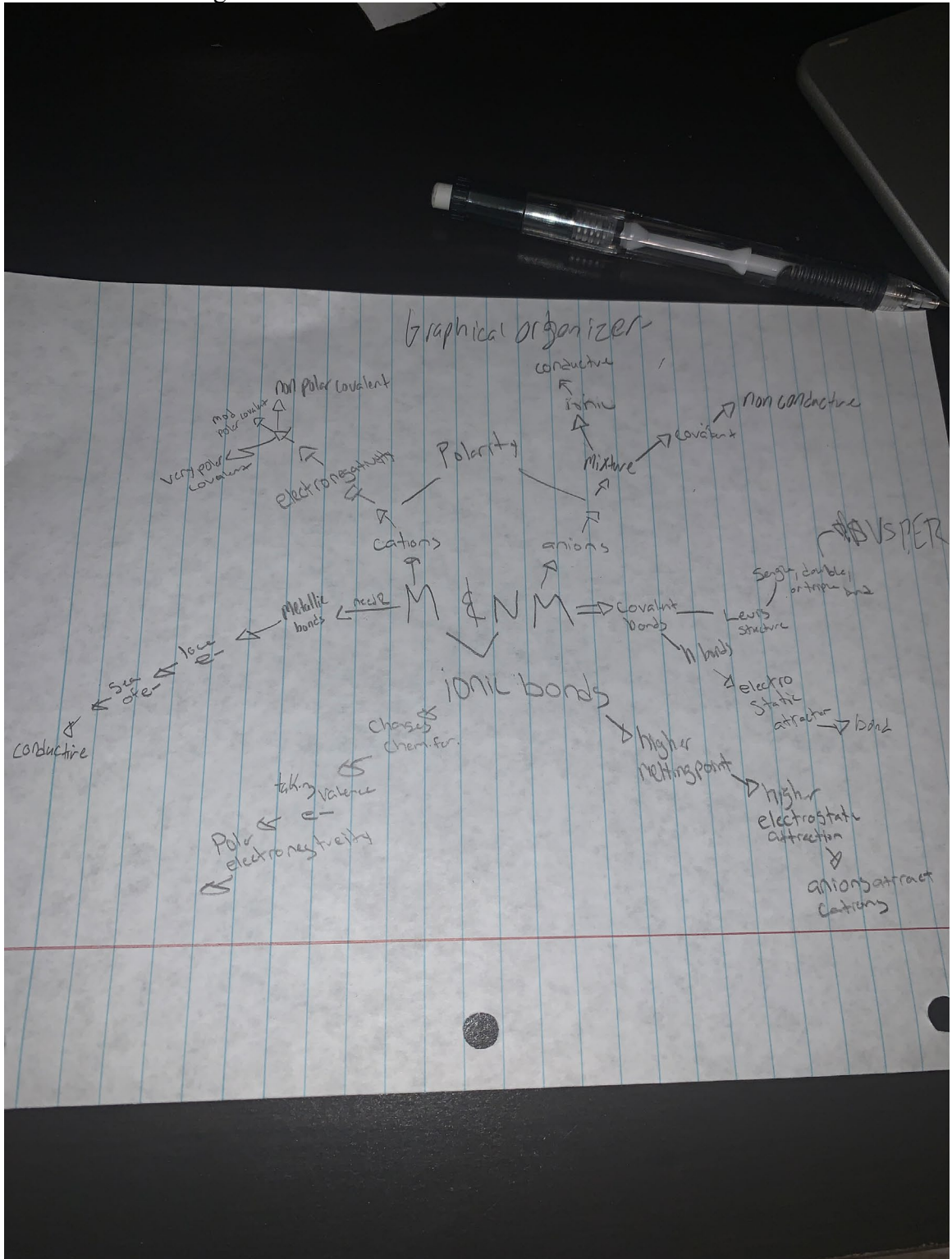
$C \equiv C$ $O=C=O$ double bonds

Ionic compounds are normally solids in physical state at a room temperature.

Molecular compounds are gases, liquid & low melting solids because covalent compounds are formed by nonmetals.

Why are some molecules and compounds used that make up your favorite tool?





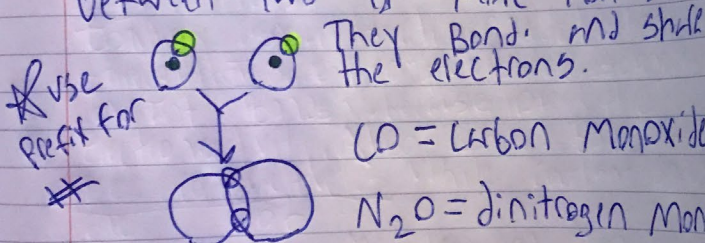
65 GO Reflection

How does water connect with other water?

- When water connects to other water it is called hydrogen bonding. **Hydrogen Bonds** form between hydrogen and oxygen atoms of nearby water molecules.

How do you name covalent compounds/molecules?

- **Covalent** compounds are formed between two or more non metals.



- How do you name **ionic** compounds?

