

## **How 7th Grade Students are Using Resources for Learning in an Online Science Course**

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In this study, 7th grade students were observed completing a series of lessons in an online science course to explore their thinking and strategies for: (1) using curriculum resources for learning, (2) developing thinking and strategies for self-assessing “assessment readiness”, and (3) exploring the relationship between resource use and student grade in science, end-of-lesson assessment score, and student learning style. A convergent-parallel mixed methods research design was used to collect both qualitative and quantitative data in the same phase of this study, in order to merge the results and gain a greater understanding of student learning in the online environment. Observations of students completing lessons online, survey, and interview data were collected. Qualitative results indicate that students demonstrated various levels of meta-cognitive strategy use in choosing online curriculum resources and in determining their readiness for lesson assessment. Quantitative results indicated that resource use was higher for multi-media learning resources and lower for notes-based resources. Use of at least 70% of lesson resources overall showed a relationship with a higher student grade in science and higher end-of-lesson assessment score. Student learning style showed mixed results related to resource use. Continued mixed-methods research observing student learning in the online environment is needed to better understand the individual student experience of learning online, and to inform specific interventions within the online learning environment to support learning as students transition into more effective self-directed learners.

## INTRODUCTION

Online and distance environments can support effective student learning in many ways. The purpose of this study was to observe students completing a series of lessons in the online learning environment in order to explore what can be learned about how students are using online lesson resources for learning when they are choosing them as self-directed learners.

## LITERATURE REVIEW

### Support & Engagement Factors

Cavanaugh and Blomeyer (2007) summarized student characteristics, course design factors, and instructional factors that impact K-12 student success with online learning. Course design factors included a structured course design with clear expectations and study guides, study-skill development, models of portfolios, meaningful curriculum, and opportunities to collaborate with peers. Instructional factors included guidance for learning in the virtual setting and for use of online tools, and frequent and timely response to student questions. Ongoing communication and feedback were deemed especially helpful for students who had learning disabilities and attention deficits. Student characteristics related to success included self-discipline and self-motivation, having developed effective strategies as learners in traditional educational settings, and learning styles that include abstract conceptualization and reflective observation. Gladwell (2000) used the success of the Sesame Street television show in teaching literacy to preschool children through the distance learning media of television to explain that in order for something (learning) to “stick” (be memorable), the messenger (format of the message) and the message (content) had to be appealing to the learner so that the student’s attention was held long enough to learn the material. When the message was clear, preschoolers attended to the information even with toys in the room competing for their attention, but if preschoolers couldn’t make sense of the message they turned their attention to something else (Gladwell, 2000). For effective learning to “stick” with students, students needed an environment in which to practice using what they were learning across many contexts, get timely feedback on their learning process and progress, and “have time to reflect on the feedback they receive, make adjustments, and try again” (Project 2061, 2012, p.1).

### **Scaffolding and Support Strategies**

Bransford, Brown, Cocking, Donovan, and Pelligrino (2000) explained several key shifts in the learning sciences related to student learning: the meaning of “knowing” has shifted from being able to remember and repeat information to being able to find and use it” (p. 5). Especially in helping students take control of their own learning, students “must learn to recognize when they understand, and when they need more information,” a process supported by metacognition or the ability of students to “predict their performances on various tasks and to monitor their current levels of mastery and understanding” (p. 9). Shannon (2008) studied the effects of teaching high school chemistry on students’ metacognitive strategies and assessing their own learning style. His results indicated that there was a significant relationship between student use of metacognitive strategies, student learning, and self-assessment behaviors. Wang, Peng, Huang, Hou, and Wang (2008) reported that the level of learning strategy is one of the most important factors impacting learning outcomes, followed by learner motivation and willingness to apply effort to learning.

Research has shown a number of benefits of virtual learning for students choosing online learning options. Freeman and Crawford (2008) reported success with online learning providing scaffolding of subject matter instruction for English as Second Language (ESL) learners. Igo, Riccomini, Bruning, and Pope (2006) found that students with learning disabilities preferred copying and pasting notes from web sources. They found that typing or handwriting notes was distracting to the learning process and that the best learning gains came from studying the notes after identifying key information to be learned. They also discovered that writing or typing notes “verbatim” resulted in more shallow processing of information than paraphrasing main ideas into their own words. Copying and pasting notes to review also got students past the concerns of spelling and grammar and handwriting readability that can be distracting for them when taking notes. This process also decreased study time overall, adding an element of motivation for use. Research has also uncovered a number of challenges students face with online learning as they transition from a largely teacher-led learning environment into the self-directed learning role within the online environment. Some students are choosing online learning for credit recovery or because they were “unable or unwilling to function in a more traditional classroom environment,” which is the “exact opposite of the population that research says tends to thrive in the distance environment” (Huett, Moller, Foshay & Coleman, 2008, p. 64). Winters, Greene, and Costich (2008) found that while students may “view support tools as aiding their self-directed learning, they did not always use them,” and students have a “poor calibration

between what they think they do and what they actually do” (p. 430). A second outcome from their study supported the use of mixed-methods research design to gain a more “accurate measure” of students’ self-directed learning activities than using just one type of data. Mistler-Jackson and Butler-Songer (2000) studied curricular features offered by Internet technologies for learning science and reported that students are not “spending much of their time on understanding or evaluating the information they retrieve (higher order thinking skills), but instead on finding quick answers and making shallow interpretations of their findings” (p. 2). When teachers scaffolded content into three phases (introductory, development of expertise, and sharing), students achieved content learning benefits, increased self-efficacy, and increased motivation to spend time on task. Butcher and Sumner (2011) found that students are not usually successful in using metacognitive strategies on their own, especially when learning in an online environment: “highly contextualized and personal support, like prompting from a human tutor – can significantly increase students’ success in regulating their learning strategies such as monitoring progress towards learning goals, and coordinating information from (multiple) sources” (p. 10).

In order to better understand the individual student experience of learning online and the extent to which these types of factors impact individual student learning success, researchers need more insight into how students are personalizing their own learning experience through their choice and use of resources in the online curriculum. One way to gain this insight is to “virtually” observe students completing online lessons and collect data on student use of resources and thinking strategies for choosing and using lesson resources for learning. Collecting both qualitative and quantitative data provides a more complete picture of student resource use and helps researchers better determine the effectiveness of resource use and thinking strategies in choosing resources for learning. With a more complete picture of resource use and its impact on student learning outcomes, it becomes clear where gaps exist for students learning online, so that more effective learning interventions can be planned and implemented.

## METHODS

### Overview

A convergent parallel mixed methods research design was used (Creswell & Plano-Clark, 2011) where qualitative and quantitative data were collected in parallel, analyzed separately, and then merged for interpretation and discussion. Data were collected in April and May 2013 from students before the end of the semester. The quantitative data collected included:

1. A list of asynchronous resources used by each student in each lesson;
2. end-of-lesson assessment scores;
3. prior semester Science grades;
4. the student's primary learning style (category) as measured using the Visual, Aural, Read/Write, and Kinesthetic (VARK) Learning Styles Inventory, which was a tool that was recommended for teachers to use as a part of this particular virtual school program (Fleming, 2012); and
5. survey items where students rated themselves on learning-related traits (pre-study).

The qualitative data included answers to open-ended questions on a pre-study survey about their decision making process as they completed a lesson, and explanations of resource use during and following lesson observations. In the interpretation stage, the quantitative measures were compared with qualitative data to create a more complete picture of how lesson resources were used by students and to determine if there were patterns for how students were using the resources to achieve successful (or unsuccessful) learning of lesson objectives. An additional goal was to directly compare the findings from the two types of data for corroboration and validation purposes.

## **Research Questions**

### ***Mixed Methods Research Question:***

1. To what extent do the qualitative results converge with the quantitative results to enhance understanding of the student use of asynchronous resources?

### ***Qualitative Research Questions:***

1. How were students using the asynchronous resources in each lesson?
2. How did students know when they had completed their learning and were ready for the end-of-lesson assessment?
3. How did students describe their learning process?

### ***Quantitative Research Questions:***

1. To what extent were asynchronous lesson resources being used by students in each lesson?
2. To what extent did use of lesson resources correlate with the student's performance on the end-of-lesson assessment?
3. To what extent did the use of resources correlate with the Science grade from 1st semester? To what extent did students with different grades in Science utilize the resources differently?
4. To what extent did student use of resources correlate with student learning style, as measured by the Student Learning Styles (VARK) survey at the beginning of the year?

## Setting

This study took place in the 2012-13 school year in an online science course. The study included eleven students from the course. Students had their own login and password and could access the web-based program curriculum at any time, from any place. Students who started at the beginning of the year and stayed on-track with their lessons had four to five total lessons per day. At approximately one attendance hour per lesson, plus 30 minutes of required PE activity time – students spent approximately five to six hours per day on a complete day's learning. Though the program recommended that students have access to a Learning Coach (usually a parent) throughout each learning day to establish and support a daily learning routine and to focus student effort on learning and strengthen academic performance, seven of the participants worked at home on their own one or more days per week while their parents were at work. The student population of the online course was considered heterogeneous which, combined with the small sample size, was why more descriptive statistics were used to analyze the results from this study.

## Participants

The study began on March 22, 2013, with a student email that described the study and a follow-up phone contact regarding interest in participating. For students who participated in the study, informed consent procedures were followed. Due to the time considerations of eight school weeks remaining in the semester at that point, and the fact that the target lessons for observation were in mid-Unit 4, (with Unit 5 still needed to be completed before the end of the semester), 20 students were selected from a larger pool of 47 students who met the following criteria:

- Whatever grade students earned in science first semester, they were still carrying that same letter grade at mid-second semester. It was felt that this would be a stronger more valid and reliable representation of the “grade-level group” differences in resource use and learning strategy use (“above average” students with grades of A/B in Science and “average to below-average” students with grades of C/D/F in Science)
- The students had not yet completed the first lesson in the observed lesson series (Unit 4, Lessons 5-9)

From the initial identified population of students: four students with a grade of “A”, two students with a grade of “B”, one student with a grade of “C”, three students with a grade of “D”, and one student with a grade of “F” (11 total) were included in the study (seven female, four male). All students who began the study completed the study. A maximal variation sampling strategy was chosen because it was hypothesized that students with

different grades in science would come to the study with varying degrees of success in their first semester of science. This might include having different strategies for using the learning resources in the lessons, which would provide a more complete and complex picture of diversity of resource use across the 7th grade science student population.

### **Completing a Typical Lesson in the Online Environment**

To complete a typical science lesson, a student selected the lesson link in his/her planner, and a lesson “window” opened up. Each lesson followed the same basic format, allowing the student to:

1. read over some background-building text, objectives, and key words;
2. click on links to view video clips to build background knowledge, and can click on additional links for resources such as graphic organizers;
3. read and answer two to four higher-order questions to begin connecting ideas from the lesson or making deeper level connections, which serves as a “self-assessment of learning” tool, followed by a link to view the correct answers; and
4. complete a five to six question multiple choice formative assessment (graded but not part of science grade) or a more summative five to seven question “quiz” covering material from three to four lessons (graded and becomes a part of science grade).

Nothing about the lesson completion process for students changed while students were being observed during this study, except that the student first entered the researcher’s Blackboard-Elluminate synchronous lesson room, selected the “Share Screen – Desktop” option which opened up a viewing window for the researcher to see what the student saw on his/her monitor, and then the student clicked on the lesson link and began the lesson. The student’s lesson completion progress was observed and recorded by the researcher, and the student was asked to “explain out loud” his/her process for going through the lesson. The planned observational script (Appendix A) lists the statements that were made during the observation, as a guide for the observational process. If a student did not reveal his/her thinking or reasoning process during the lesson, the researcher asked questions during the lesson and at the end of the observation, according to the planned observational script. When the student completed the lesson and took the end of lesson assessment, the researcher asked the planned observational script post-lesson questions and recorded the answers. Then the student was thanked, the next lesson observation day and time was established, and the student exited the synchronous lesson room. Following the last lesson observation, the researcher asked the end-of-study questions and recorded the answers, according to the planned observational script (Appendix A).

## Data Collection

**Qualitative Data and Validity.** Each student completed a “Reflection on Learning” survey (Appendix B) in which they rated twenty-seven statements and answered six open-ended questions about themselves as online learners and their learning process. The survey information provided more specific qualitative data on each student’s learning process, capturing specific information that would not likely be observed or questioned adequately during the observed lessons, as well as student self-ratings on items related to student motivation and self-efficacy. Lesson observations and notes were recorded and transcribed. Students also answered a series of questions about their use of resources during the lesson observation. These statements were organized, transcribed, and coded into three overall themes representing the Central Phenomenon as the type of metacognitive awareness that students demonstrated about their own knowledge and thinking (Appendix C).

Data were validated in the following ways:

1. The researcher worked with a group of three middle school online science teachers from the virtual school program who were familiar with the Science curriculum and online student learning processes. They agreed to review student statements about their learning, to reach a consensual validation of themes.
2. The researcher took the transcribed qualitative statements from students and assembled them for review by the team onto Microsoft Word documents. The researcher explained the three levels of metacognitive processing that appeared to be indicated from student statements about their learning processes. The teachers understood the meaning of and differences between the themes.
3. All statements were reviewed by the team and compared to the groupings that had been created by the researcher, based upon the themes. One teacher identified two statements in one grouping that should be moved to another grouping, and one statement in a second grouping that should be moved to another grouping – and all teachers and the researcher came to agreement that the statements made by students were at that point grouped in ways that supported the themes of different levels of metacognitive processing by students.

**Quantitative Data and Inter-rater Reliability.** Student information obtained from the Learning Management System included: end of lesson assessment scores, prior semester Science course grade, and VARK Student Learning Style Inventory results. Quantitative data was also collected from the 27 “rated” answers from the “learning reflection” student survey. Additionally, recorded observations provided quantitative data about the number and type of resources used per student, and by all students per lesson. Virtual school science teachers reviewed 10% of the 55 total recorded observations and completed the tracking sheet for resource use in lessons to



provide reliability and validity for the tracking sheet used by the researcher as a data collection instrument. Inter-rater reliability for the teachers coding 10% of lessons ranged from 75-81% with an average of 78%.

**Mixed Methods Data.** The qualitative themes that emerged from the qualitative data indicated that students described three levels of metacognitive processing or thinking about their learning process and use of lesson resources for learning in the self-directed online environment. As is explained in the Results and Discussion section, students indicated that their lesson resource use (and self- assessment of readiness for lesson assessment) was based on one of the following (Appendix C):

- A basic awareness that focused on using a resource to gain knowledge
- A slightly more sophisticated awareness of lesson resource used where students indicated specific thinking about how they used the resource to gain the knowledge
- A strategic process for determining which resources would be best to use, and how to best use the resource, for learning

The qualitative data of varying levels of metacognitive thinking strategies was combined with the quantitative data collected to create a more complete picture of how students were using the resources to achieve learning, as well as areas where resources were not being used as effectively for learning. In terms of validity and reliability of the overall data collection process used, students reported that they were not distracted by the observation process, that their observed lesson completion process was similar to their usual process, and that there was nothing else they needed the researcher to know about their participation in the research study process.

## RESULTS

### Qualitative Data Analysis

Initially, the themes identified from this small sample of students, who were selected for maximal variance, were not clear. In reviewing related research, Flavell (1979) and Shannon (2008) conducted studies that identified differences in student thinking and awareness of learning processes similar to what was observed in this sample of student data, and their categories of metacognitive thinking were organized into themes as follows:

- Awareness of Knowledge – an understanding of what one does and does not know, and what one wants to know
- Awareness of Thinking – an understanding of cognitive tasks and the nature of what is required to complete them
- Awareness of Thinking Strategies – an understanding of approaches to (self) directed learning

The above themes were used to address the three qualitative research questions in this study:

1. How are students using the asynchronous resources in each lesson?
2. How do students know when they have completed their learning and are ready for the end-of-lesson assessment?
3. How do students describe the specific steps of their learning process?

Table 1 presents data on student statements indicating how they determined their readiness for lesson assessment.

**Table 1**  
**Student Self-Determination of Assessment Readiness**

How did you determine you were ready to take the Assessment?	Students with A/B Grades N=29 answers	Students with C/D/F Grades N=25 answers
Identified readiness primarily as getting to the assessment in the lesson	3 (10%)	2 (8%)
Identified primarily thoughts/feelings used to determine readiness	7 (24%)	10 (40%)
Identified specific steps (strategies) that were used to determine readiness or feelings of readiness	19 (66%)	13 (53%)

Below are examples of student responses to identifying assessment readiness primarily as getting to the assessment in the lesson:

- “I just go along with the lesson and get as much information as possible and then I take the quick check.”
- “Well I had read everything and I watched all the videos and I did the assessment.”
- “Well I watched all the videos and read most of the book...”

Below are examples of student responses to identifying assessment readiness primarily as thoughts/feelings that were used to determine readiness:

- “Before I decided I wanted to make sure that I got everything out of it and thought about how I was doing.”
- “...I feel that I’m ready...(couldn’t understand)”
- “I thought about it but I thought they were easier and I thought I had it down. Um, I said pull everything out of your mind and put it onto the page.”
- “Because um I didn’t get a perfect score on my review but I thought that I did good, pretty good.”

And finally, the examples below are ones that students identify as specific steps (strategies) that were used to determine readiness or feeling of readiness:

- “Um, well after gathering all the info that I learned, and reading at the text and looking at all the examples, I knew it so I thought I was ready. I did know this was a quiz. Used Crossword puzzle b/c thought it was good to review the vocab and understand the quiz better and questions.”
- “I thought I was ready to do it b/c of all the notes I took and I copied down and I thought it would be easy - got a good score on the BPOP quiz - and review Q’s - so safe to go on to the assessment.”
- “I had gone through all the reading I had to do, I did all the videos, I did the review thing I thought I had an idea of what was going on in the lesson.”
- “When I got most of the answers right on my Brainpop quiz.”

Table 2 presents steps that students reported using for their learning, as represented by their answers from the pre-study survey. Each row represents an open-ended question asked in the survey, and the columns represent the answers given by students (grouped when possible) and are represented by dividing students into two categories based upon their grade in Science (A/B and C/D/F).

**Table 2**  
Student Reported Data from the Reflection of Learning Survey

Student Journey of Learning		
Students with Grade of A, B	Step in the Process	Students with Grades of C, D, F
3/6 eat breakfast	Getting Themselves Ready for Learning	3/5 eat breakfast
2/6 review past lessons		1/5 review the upcoming lesson
2/6 review the upcoming lesson		2/5 just get started on the lesson
3/6 just get started on the work		2/5 do something unrelated (www.lumosity.com, listen to music, get comfortable)

Table 2, Continued

Student Journey of Learning		
Students with Grade of A, B	Step in the Process	Students with Grades of C, D, F
2/6 write key words & objectives	Completing a Typical Lesson	
1/6 reads through the lesson		1/5 write key words and objectives
2/6 take notes		4/5 use most of the resources/links
2/6 complete all lesson activities		3/5 watch videos
1/6 "I just do it"		1/5 reads the book
2/6 watch videos		1/5 goes back and uses the resources
1/6 use (interactive) gizmos		1/5 uses review quizzes and activities
2/6 review		
4/6 finish lesson & take assessment		
2/6 when done with lesson		How students know when they are ready to take the Lesson Assessment
1/6 "feel confident"	2/5 "feel confident, ready"	
4/6 "feel they understand/know"	2/5 understand/learned the material	
3/6 review lesson to self-assess understanding	3/5 use review/scores	
1/6 uses review score		
1/6 "feel disappointed"	What students do when their Assessment Score is not as high as Expected	1/5 "gets sad" because I have high expectations for myself at the beginning of the lesson
2/6 review for understanding		
1/6 works harder		
3/6 "redo/ask for a redo"		
1/6 "if it's above a 'C' I just leave it"		4/5 use teacher comments to redo/ask for redo

**Table 2, Continued**

No children are distracting me	What students report makes them a Successful Online Learner	
I feel I can pay attention to what I'm doing, therefore I am doing better		
I love to read and be on a computer and online learning is both of those		I get motivated by my parents
I study hard		I follow the rules, learn efficiently, and I love learning
My parents have high expectations - they expect 100% 'A'		I read webmails, go to the Message Board, and attend synchronous lessons
Use teacher comments to guide work		I go over the lessons and try to get my best grade - if I don't, I try to redo the lesson.
Go to synchronous lessons before unit exams		
Successfully complete lessons and remember what I'm learning		
4/6 work or study harder	What students do when Learning is not successful for Them	4/5 review/study
3/6 try to bring grade up		2/5 go back and use the book
1/6 reviews for understanding		1/5 reads the book pages and (watches) videos "over and over"
1/6 asks Learning Coach for help		1/5 starts taking detailed notes
1/6 explains it's being bored or tired		1/5 asks Learning Coach for help

It was anticipated at the outset of the study that students who earned grades of A and B in their science course may be using lesson resources or learning processes differently than students who were earning grades of C, D, and F in science. At first glance, both groups of students appeared to be using similar processes throughout each stage of the learning process. However, upon closer inspection, A/B students are engaging in more activities to recall prior learning and set expectations for what they would be learning before they begin the lesson. They also identified a wider variety of resource use within lessons, and they indicated use of resources that led to spending more time with the curriculum concepts during learning (virtual manipulative activities, note-taking, reviewing learning) which may have led to better learning and remembering of concepts. When assessment

scores were lower than expected, A/B students reported more instances of “working harder” and “reviewing for understand what was missed.” This could be interpreted as attempts to correct “incorrectly learned” material from the lesson. These were examples of skills indicated at the higher “Awareness of Thinking” and “Awareness of Thinking Strategies” metacognitive levels. Students with grades of C/D/F reported resource use as “using most of the activities,” but this was not consistent with what was observed in the lessons. Students with grades of C/D/F in science were using 40-50% of resources overall. When learning did not go well for them, they were more likely to just “redo it” than to identify a need to go back and review the material for understanding. Students in the C/D/F group also reported going back to use the book, taking notes, and reading the book and watching videos “over and over” – which may indicate less effective metacognitive strategy awareness and use in the initial learning attempt.

### Quantitative Data Analysis

The quantitative data collected included student observations of resource use, student grades in science, student end-of-lesson assessment scores, and student learning style. Analyses of the quantitative data were completed in order to answer the research questions which are used below to organize the results.

1. To what extent are asynchronous lesson resources being used by students in each lesson?

Table 3 presents the frequency of resource use from the lesson observations.

A majority of students were using the media-rich science videos, which demonstrated and explained key lesson concepts and vocabulary, and were using the self-check and review activities to self-assess their learning before taking the lesson assessment. Many of the activities in the second row of the table were activities that engaged students in making a personal connection to lesson material and in spending more time working with key concepts and constructing learning through taking notes and using tables to compare and contrast learning. Use of these resources was related to students with higher grades in science and higher end-of-lesson assessment scores.

1. To what extent does the use of resources correlate with the science grade from 1st semester? To what extent are the students who have different grades utilizing the resources differently?

Students with science grades of “A” used an average of 70% of available resources across all five observed lessons (Table 4).

**Table 3**  
**Frequency of Resources Used by Students across all Observed Lessons**

Online Curriculum Resources Used by Students		
Used by 0-3 Students	Objectives	Create a Graphic Organizer
	Make it Personal	Complete a practice lab activity
	Venn Diagram	Extra Questions
	Additional Vocabulary	Virtual Explore Activity
	Study the Figure...	
Used by 4-7 Students	Read Text Pages	Brainstorming Activity
	Text Questions	Copy and Complete Table
	Video Review Quiz	Key Words
	Describe a Time...	Virtual Manipulation Activity
	Graphic Organizer	Crossword Puzzle
Used by 8-11 Students	Watch a video	Review Self-Check
	Narrated slideshow	Review Quizzes

Students with grades lower than an “A” used 40-51% of available lesson resources for learning. Within these general trends, there was one “A” student who used an average of 60% of resources (much lower than other “A” students), and one “D” student who used an average of 67% resources (much higher than other students with grades below “A”). In using the observation data to explain this difference, the “A” student reported (and was observed) using a very structured, consistent approach to watching videos and stopping them to take notes and reading/taking notes, and getting structured support for his learning processes from his learning coach. The “D” student reported (and was observed) using many resources and taking notes but stated that she did not always understand what she was learning after using them, and did not appear to have much learning coach support. According to Cavanaugh and Blomeyer’s (2007) components of effective online learning, holding all other components equal (curriculum design and student characteristics), this may be an example where instructional support factors may have an impact in helping students become more effective learners through direct instruction of learning strategies for choosing and using lesson resources for learning.

3. To what extent does use of lesson resources correlate with the student’s performance on the end-of-lesson assessment?

The relationship between use of lesson resources and end-of-lesson assessment scores varied in largely the same pattern as the student’s science grade. The specific lesson resources that showed a relationship to end-of-lesson score were also the same as those that showed a relationship to student grade in science.

**Table 4**  
**Percent (%) Use of Learning Resources per Student (by Grades in Science)**

Student in Study	Student Grade in Science	Lesson 5	Lesson 6	Lesson 7	Lesson 8	Lesson 9	Avg. % Resources used per student	Avg. % Resources used by Science Grade
1	A	73	85	80	86	82	81	(A) 70% average resources used
2	A	67	69	60	71	73	68	
3	A	67	46	77	64	45	60	
4	A	73	77	73	79	55	71	
5	B	27	46	53	64	36	45	(B) 41% resources used
6	B	10	31	40	43	27	36	
7	C	33	46	47	57	36	44	(C) 44% resources used
8	D	67	54	53	57	36	53	(D) 51% resources used
9	D	87	77	60	57	55	67	
10	D	33	31	20	43	36	33	
11	F	33	15	77	50	27	40	(F) 40% resources used

- Students with “A” grades averaged 87% end-of-lesson scores and 70% resource use.
  - Students with “B” grades averaged 75% end-of-lesson scores and 41% resource use.
  - Students “C”, “D”, and “F” grades averaged 62-66% end-of-lesson scores and 40-51% resource use.
4. To what extent does student use of resources correlate with student learning style, as measured by the Student Learning Styles (VARK) survey taken at the beginning of the year?
- Students with a Visual learning style comprised four of the six students with grades of “A” or “B” in science (Read-Write learners three of six) and were using more resources on average.
    - Resources used by this group included reading the text and taking notes. These resources provide more opportunities to work with concepts, construct understanding, making connections to prior learned information.



- Students with a Kinesthetic learning style comprised four of the five students with grades of “C”, “D”, or “F” in Science and resource use varied between high use and lowest use. These students were observed using more “connect/engage” activities, but not using them effectively. Sometimes a student just opened a resource, tried a few things, and closed it stating that they did not understand how to use it and participated in “skimming of the text” but not reading the text or taking notes.
  - These students were also going outside the curriculum to define words and get explanations of concepts (in 10 out of 25 lesson observations) and the words used in the definition were not consistent with the terms from the lesson or the assessment.

## DISCUSSION

In order to be successful as self-directed learners in the online learning environment, students need to develop the skills to self-monitor their own learning progress while also managing their learning environment and the use of resources within that environment (Shannon, 2008). From the results on the student survey and observed lesson completion, most students indicated some level of awareness of their learning and what steps they could take to improve learning, though all students may benefit from direct instruction in strategies to help them become more effective self-directed learners.

### Use of Resources

Overall, students using more resources for their learning earned higher end-of-lesson assessment scores and were able to identify and explain more specific examples of what they just learned when asked following their lesson completion. This supports recent learning sciences research regarding the impact of effective learning related to making sciences connections between new information being learned with prior learned information, spending enough time with concepts and skills in working memory to strengthen the learning connections, and having the motivation and goal orientation to persist in learning activities until learning is attained (Shannon, 2008; Project 2016, 2012). Along with skills in using resources for learning, these students also demonstrated more specific strategies when it came to using lesson resources to self-assess learning progress and determining when more learning was needed or when they were ready to take the assessment. Using an average of 70% of lesson resources was related to higher end-of-lesson assessment scores and higher grades in science, which was consistent with end-of-lesson assessment scores being one component of a student’s grade in science. It was not clear whether using more resources kept students engaged

in learning longer (long enough to make learning “stick”) or because students with higher grades were more internally motivated to persist in their learning efforts. In explaining their use of resources, all students were able to identify a reason for using or not using specific resources, though some reasons were more sophisticated and strategic than others. Further research into helping students understand the relationship between working with lesson concepts and targeted use of lesson resources to support learning may strengthen student success with self-directed use of lesson resources for learning in the online environment.

### **Learning Styles or Strategies Effect**

There appeared to be a “Learning Styles” effect. It is not clear, though, whether this difference is attributable to student learning styles, or to the use of learning strategies. For this study, learning styles were addressed because one of the diagnostic tools available to teachers to help personalize student learning at this virtual school program is the VARK Learning Styles Inventory. Thus, it was of interest to see if there was a relationship between the learning style identified for a student, using this tool, and his/her use of curriculum resources in lessons.

The relationship observed in the study was that “Read-Write” learners used more curriculum resources and earned higher grades compared to “Kinesthetic” learners. Kinesthetic style learners reported not always understanding how to use the resource for learning, and earned lower grades on end-of-lesson assessments. Specifically, the A/B/C students with a “Read-Write” learning style used more of the resources in the curriculum for their learning including reading the text and watching both science videos which presented multiple levels of learning details. Several of these students also took notes during the video. This provided many opportunities to work with the concepts in working memory in ways where they were “constructing” their learning of the material and connecting the current concepts to concepts already learned. Each of these components may have provided a cumulative effect to support learning at higher levels for these students. Conversely, there were more “Kinesthetic” style learners represented among the C/D/F students. This group of students was using fewer resources within the curriculum for learning (including not reading the text, not taking notes, and not watching the second science video because the concepts were confusing). Though there were interactive resources, they were not often selected. Not knowing how to use resources effectively for learning, they were using resources that were sometimes equally not helpful for learning lesson information, and the words used were not consistent with what was in the lesson or the assessment, putting these students at a greater disadvantage for learning success.

Continued research is needed to better understand how students are using resources in the online learning environment and to assess levels of engagement with online curriculum. With a better sense of how students are interacting with the online curriculum, we can begin assessing the effectiveness of various learning support interventions, measure differences in synchronous and asynchronous teacher support for learning, and look at the impact of peer learning activities on student learning success. As we get a better sense of how students are learning in the online environment, we can begin to strategize on how to better personalize student learning support.

Along with gathering more quantitative data, teachers and curriculum designers can benefit from observing students learning in the online environment and from asking questions to learn more about how students are using course resources, making decisions about their learning, and determining their readiness for assessment. Curriculum designers can benefit from first-hand knowledge of how students are using the resources placed into the curriculum for learning, and what additional support tools might be needed to guide students in how to use resources more effectively. Involving “end users” (teachers and students) in this iterative development process can help bridge the gap between curriculum designers and curriculum users in how the curriculum is used for learning, and strengthen our ability to support virtual learning.

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## APPENDIX A PLANNED OBSERVATION SCRIPT PROTOCOL

### Planned Observation Script for use during Observation of Lessons

#### *Welcome & Introduction I will use before the Lesson begins:*

Good morning/afternoon,

Thank you for coming to the Livelesson room to work on your science lesson today. As I told you in the letter that you read about this research project, I am interested in seeing how students are using the learning resources in the curriculum.

So basically all you are going to do is go through the lesson like you usually would, but also “think aloud” about what you are doing, so I can understand your thinking and choices. For example, when you read the information on the pages of the lesson, I would like you to read them out loud. If you click on a resource and decide not to use it, let me know why you didn’t use it. It is important to try to do this lesson just like you would if you were doing any other lesson – try not to see me as a teacher, but just a research observer, learning how 7th grade science students learn online.

There is no “right” or “wrong” way to do this, and you are not earning any kind of grade for this – so please don’t be nervous. There are many learning resources available to students within each of the lessons in the courses, and I am trying to understand which ones are used by my students in 7th grade science – and how they are used in the learning process. I may ask you some questions as you go along, but I will try not to interrupt the flow of your learning. For example, I may ask you why you didn’t use a particular learning resource, just to understand your thinking. Just answer with whatever your thinking is, about the question.

I will be recording this session, so that I can go back over it for my research notes. Remember, all of this information will be kept confidential, and will not be used as a part of your science course. Are you ready to start?

*(I will either say “Good, okay then click on the lesson link and you can begin”...or answer questions that may be posed by the student first).*

**Sample Questions that may be asked by me during the Lesson**

- What are you learning in this lesson?
- I noticed you clicked on (that resource) and didn’t use it – can you tell me why?
- You downloaded the graphic organizer to fill out during the video – did you print it and fill it in, or fill it out online? Can you tell me about using it?
- How did you decide which resources to use and which not to use in this lesson?
- How did you know you were ready to take the assessment?

**After the lesson – and the student has completed the “quick check” assessment, I may ask:**

- Did you have the resources you needed for this lesson? Was there anything else that would have been helpful to you?
- Is there anything else you sometimes use or do that would have been helpful in learning today’s lesson (such as watching the pre-recorded LL video, found in the Science Teacher Message Board, “googling” information about lesson content)
- Why do you think you got the assessment score you did? Is it what you thought you would get?

**After the last lesson (the last of the series of 5 lessons for the study) is completed – but before I let the student go, I will ask these questions:**

- As you were doing these lessons in the Livelesson room with me observing, were you able to complete the learning you needed for each lesson (not distracted or too nervous)?
- Was the process you used for these lessons pretty close to what you did for all your lessons, or did you find yourself doing things differently because I was observing? Can you explain what you mean by that?
- Let’s go to the Science Teacher Message Board – can you tell me what areas you accessed on this board throughout the semester?
  - What resources did you use in that (those) areas?
  - Were they helpful? Would something else have been more helpful?

- Is there anything else you want me to know about your participation in this study?

I want to thank you for your time this semester, it has really been helpful to me in learning how the science resources were used by students this semester – and how we can perhaps improve them for next year. Have a great rest of the semester!

### APPENDIX B REFLECTION ON LEARNING STUDENT SURVEY

The following statements are to help you describe yourself as you see yourself as a learner in this program. Please respond to them as if you were describing yourself to yourself. Do not omit any item. Please read each statement carefully, then select one of the three responses to the right of the item. Thanks for your ratings to these statements.

Statement	Mostly False	Partly False Partly True	Mostly True
I like to read	1	2	3
I have ability to find the answers to questions	1	2	3
I would enjoy an opportunity to learn new skills	1	2	3
I do poorly on tests	1	2	3
Learning is easy for me	1	2	3
I enjoy learning with other people	1	2	3
Learning gives me a feeling of accomplishment	1	2	3
New subjects scare me	1	2	3
I do not think well	1	2	3
Math has practical applications for me	1	2	3
Studying is a waste of time	1	2	3
I am confident of my ability to work with numbers	1	2	3
I hate to read	1	2	3
Changing teachers concerns me	1	2	3
I have confidence in finding the answers to questions	1	2	3

**APPENDIX B, CONTINUED**

Statement	Mostly False	Partly False Partly True	Mostly True
I have good skills in using the computer for learning	1	2	3
I have good communication skills	1	2	3
I am confident of my ability to communicate ideas	1	2	3
I am confident of my computer skills	1	2	3
I feel at ease in the way I learn	1	2	3
Most people get ahead faster than I do	1	2	3
I find it difficult to learn new skills	1	2	3
Writing is usually a trying experience	1	2	3
The people at this school like me	1	2	3
I have trouble learning	1	2	3
I am confident in using effective strategies	1	2	3
I am confident in my reading ability	1	2	3

**REFLECTIVE QUESTIONS**

Directions: Imagine that you are explaining some things about yourself to a friend – please describe to them the answers to these questions, as you would share with a friend:

1. As an online student, before I start my lessons I get myself ready for learning by...
2. While working on an online lesson, this is what I do to complete a typical lesson...
3. Describe to your friend how you know when you have completed a lesson, and are ready to take the assessment:
4. When you get your assessment score at the end of the lesson, describe what you do if your score isn't as high as you expected:
5. Describe what makes you a successful online learner:
6. Describe what you are doing when your online learning is *not* successful for you:



## APPENDIX C

### CENTRAL PHENOMENON AND THEMES FROM QUALITATIVE DATA

**Central Phenomenon** – as student statements were reviewed, there was a qualitative difference in the level of thinking and strategy use demonstrated as they made decisions for which lesson resources to use and why, and in their decisions about readiness for the end-of-lesson assessment.

This phenomenon was further divided into the following **Themes**:

- “Awareness of Knowledge” Level of Understanding – which is a level of understanding of what one does and does not know, and what one wants to know. A student at this metacognitive awareness level is focused on the material to be learned, and not as focused on the processes for learning the material.
- “Awareness of Thinking” Level of Understanding – which describes a level of understanding of cognitive tasks and the nature of what is required to complete them for learning. A student at this level demonstrates some awareness of thinking about his or her own learning strategies and how they may or may not be effective.
- “Awareness of Thinking Strategies” Level of Understanding – which describes a level of understanding of approaches to (self) directed learning used by students for learning. A student at this level demonstrates an awareness of several strategies for learning and the ability to adjust strategies to achieve different learning purposes or if the student self-assesses that more learning is needed.

**Examples of Student explanations related to these themes as they apply to use of lesson resources for learning:**

- a. Opening Paragraph (real world application of the overall lesson concept) and Lesson Objectives are used “in their head” by students to orient themselves to what is in the lesson, and what they will need to learn
- b. Key Words are defined using video and text resources, either in notes or “in their head” during the lesson and are by understood by students as terms to be learned during the lesson
- c. Think/Connect/Engage Activities – are used by a few students (mostly in their head but a couple of students do write in their notes) to activate prior learning and make a personal connection to what is about to be learned because it helps them remember
- d. BrainPOP videos are viewed by all students to understand lesson key words and concepts, for entertainment value as a learning resource, and for their visual demonstration and auditory explanation of how processes of Science work (i.e. changes of state, sublimation).

- e. Discovery Education videos - are viewed by a smaller % of students (they were reported by many students as often being harder to learn from because not all vocabulary and processes were explained, and ended up being more confusing to some students who chose to skip them) and are viewed to see processes demonstrated for visual support and auditory explanations.
- f. Teachlets (custom-created videos) – are viewed for learning information, for the ability to pause and take notes, and for the built-in learning checks
- g. Exploration & Gizmo (virtual manipulation) Activities – are used to choose different combinations of steps in a process and see the results, to try things “in a safe environment”, and because they help students learn better by showing the processes of the concepts. For students who chose to use it, it they reported it as an engaging activity.
- h. Graphic Organizers, Diagrams, Figures, and Charts – No graphic organizers were observed being downloaded and used to write notes, but students who used them in their head did report looking it over to see what the questions are, using the information in their head as a guide to what to look for in the videos, and as a review for what information has been learned. Venn Diagrams, Figures, and Charts were used (mostly in their head) to understand the differences and similarities of the concepts being compared and key ideas.
- i. Taking Notes – for students who took notes on paper or e-notes, they reported writing a title/date of lesson, defining key words, writing down different things in organized ways (using titles/subtitles), and gave examples of what was in their notes (words and processes defined, main idea of each paragraph, charts/diagrams copied and filled out, text questions answered, review questions and answers recorded). A few students reported reviewing notes before the end of lesson assessment and before tests.
- j. Crossword Puzzle Quiz Review - used by a few students to reinforce knowledge from previous lessons and review the vocabulary and definitions before the (3-lesson cumulative) quiz
- k. BrainPOP Quizzes and Lesson Review Questions & Answers – were used by many students to self-asses their understanding of the material and their readiness for the end-of-level assessment.
- l. Reading the E-Text or Textbook – for several students reading the text and taking notes was part of their learning routine, for a few students it was only used if the material was harder for them – and then it was read or skimmed only, with no notes taken.

- m. Text Questions – for several students writing down the Q/A was part of their learning routine; for other students who reported using them, they answered the questions in their head.

**Student reasons given for not using a lesson resource also indicate all three levels of metacognitive awareness:**

- a. lack of awareness that the resource was in the lesson
- b. technical challenges with using the resource
- c. lack of understanding of how to use the resource (effectively) for learning
- d. previous attempts at using the resource just weren't helpful for learning
- e. student doesn't enjoy the resource/activity (taking notes, using explore activities)
- f. for one optional practice lab that was assigned, students didn't have the supplies to do the lab and didn't have any advance notice to obtain them for the lesson