Students in today’s classrooms spend a lot of time using technology by listening to music, texting, watching videos, and using social media applications. Some theorize that student attention spans have lessened to a dismal amount due to the impact of technology. Students tend to engage in technology applications (apps) when the option is offered through an assignment or when it is incorporated into a lesson.

During the COVID-19 pandemic in the 2020–2021 school year, many schools turned to virtual or online teaching and learning. While many teachers engaged in synchronous teaching, some teachers taught asynchronous classes where students learned during their preferred time rather than at a set time. Asynchronous learning tends to work better for older students or students who are in high school and spend a lot of time online. Teenagers in the United States are spending an average of nine hours per day using media (Common Sense Media 2018). Videos, social media, music, and games can influence how children and adolescents feel, learn, think, and act (Healthychildren.org 2018). With this in mind, if a portion of a student’s time in the online environment can be spent engaged in learning, it could lead to increased positive feelings toward education.

Integrating science into the online environment is a natural bridge between a student’s educational world and their technology world. When students are science journaling, they collect evidence about what they observe (i.e., plants, trees, animals, the Moon, clouds, insects, their location, chemical changes, lab results, microscope slides) and what they experience (e.g., weather, heat, smell, reaction). Teachers then guide students to connect their collected data and knowledge with their interests. This leads to authentic experiences and true learning.

Students can draw, find pictures online, make videos, or take pictures that match their data to demonstrate their learning about what they have seen and experienced. They can research, write stories, or find quotes that support their findings in science. There are many science topics students can journal about to engage in learning. Although a basic Word document could be used, there are numerous free apps that would be beneficial to creating an online science journal that is user-friendly. With an abundance of apps available, it can be overwhelming to sort through all of them to know which ones may work best for your students.
Merging science journaling and technology

Many educators have been using multiple apps to create amazing projects for years. In 2013 Kulowiec coined the term “app smashing” to describe this process. App smashing is simply defined as using multiple apps to create projects or complete tasks (Kulowiec 2013). App smashing for science journaling may include using Google Drive, Tiny Scanner, Camera, Adobe Premiere Clip, Snipping Tool, and/or Day One if you are a PC or an Android user. If you are using a Mac, iPad, or iPhone, many of the same apps can be used in a science journal. There are often many choices if you do not like one app in particular or you are more comfortable using a different app. Many high school students will know apps they may want to use in their online science journal such as TikTok, Instagram, and YouTube.

Planning a science journaling project requires an initial time investment just like any other project you plan for your students. Technology can also be intimidating to new users or feel like an overwhelming task; however, numerous resources are available. Seek out teachers on your campus or in your district who have already integrated technology into their classrooms and check with your school district to see if there is an educational technology person on staff who can help you get started. There are many websites with ideas, suggestions, and projects already developed. Students can upload and add to their science journals in a variety of ways and individualize their journals to reflect their discoveries, thoughts, feelings, and questions. The cross-curricular possibilities are numerous, and this can be a semester or yearlong project that incites passion in students. Their work can easily be shared with their peers and their parents. Integrating students’ interests in technology will help them grow academically and socially.

Science journaling works for students at all levels of science and is an excellent way to differentiate assignments to meet students’ needs. It can be open-ended or be very prescriptive depending on the level and the teacher’s objective. Collaborative journals can be kept for younger students, secondary students will most likely want to have individual journals. Teachers can make assignments as challenging or rigorous as they like. Referring to Bloom’s taxonomy, assignments can incorporate more than one level to attain higher-order thinking about the content. High school science courses typically include chemistry, biology, and physics.

Chemistry

Chemistry requires generating hypotheses and conducting experiments that include labs, chemicals, and safety measures. This curriculum creates an abundance of material that could go into a science journal. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices and lends itself to the NGSS guidelines of questioning and defining problems (NGSS 2013). The teacher can design and organize a template for the use of an online science journal to reflect investigations that are descriptive, comparative, or experimental when planning activities in a chemistry course. Recording this information categorically in an online science journal requires extended engagement that a worksheet does not provide. It also allows for a progression of thoughts rather than being a one-time event.

Biology

Many states have adopted the NGSS standards. However, in states that have not adopted the standards, biology is a standalone course in high school. Biology provides a vast opportunity for science journaling as a standalone course or as part of the life science domain of performance expectations in LS3 Heredity: Inheritance and Variation of Traits and LS4 Biological Evolution: Unity and Diversity in the NGSS high school standards. Using a standalone biology course as an example, the content focuses on patterns, processes, and relationships of living organisms through four main concepts. The four main concepts are biological structures, functions, and processes; mechanisms of genetics; biological evolution; and interdependence within environmental systems. The biology teacher can use this information to create the sections in the science journal template for this course based on the four main concepts listed above. Patterns, processes, and relationships can all be used as part of the investigation into each of these concepts. The concepts of genetics and body structures provide students with a multitude of appropriate pictures and videos that could be used in the online science journal. Students could personalize the assignments by including their eye color, blood types, and other personal traits or characteristics as part of their labs or observations.

Physics

If physics is taught as a standalone course, students study a variety of natural phenomena that includes laws of motion, changes within physical systems and conservation of energy and momentum, forces, characteristics and behavior of waves, and electricity and magnetism. Those phenomena would each be sections in an online science journal. Students would record data to look for patterns, identify trends, and make models that would all be documented in their journal. When the teacher looks at the curriculum as a whole and how it is divided into topics or performance expectations, it helps the teacher in the development of what sections the online science journal should contain. Creating the assignments for the topics or performance expectations would be the same lessons and assignments they would do in the course but adapted to be completed in the online science journal.
Reasons to use online science journals

Scientific methods of investigation are descriptive, comparative, or experimental and are applicable to the natural world around us and our understanding of our world. Recording the results of scientific inquiry and learning in an online science journal at the secondary level allows for the analysis of hypotheses, data, and experiments for comparison and reviewing that students who are disorganized or have special needs often struggle with. Science journal templates that have clear directions, examples, or resources can benefit disorganized, struggling, or special needs students by providing them with the tools they need to be successful. Science journaling allows students to collect cumulative data and information and build on previous learning, as Jean Piaget suggests with the learning theory of constructivism. Broadly stated, constructivism means the learner constructs new knowledge to integrate with previous knowledge to adjust or make sense of their world. According to Piaget (Fulbrook 2019), the Formal Operational Stage begins at about age 11 and goes into adulthood or until the person enters the next stage. This is the stage where abstract thought develops, as does logic and the ability to do hypothesis testing (Fulbrook 2019). Because students are in this stage, it seems a logical parallel to create and record information in an online science journal to continually construct knowledge and reflect on it.

If secondary teachers spend the time to build the template for an online science journal, it can create long-term learning and help students become better problem solvers. Once the template is developed, it can be used for all students from year to year with updates as needed. Students can see evidence of their growth and make connections that otherwise might be lost when topics are compartmentalized rather than an ongoing collaboration of learning experiences in which the activities can easily be revisited at any time. Students using online science journals will be more organized and can submit assignments easier than keeping up with physical notebooks or worksheets. Additionally, students who engage in assignments using technology are better prepared for the workforce that continues to technologically advance.

Creating an online journal

Some trial and error is required when setting up an online journal. However, making digital corrections or adjustments are much easier to make compared to making adjustments or corrections on paper copies. Figure 1 shows samples from a teacher-designed online science journal for Biology I. The teacher created this online journal in Google Classroom. Many school districts and teachers were already using Google Classroom as a resource before the COVID-19 pandemic, but the online learning environment is becoming even more predominant because of safety protocols, fewer copies to make, and ease of access.

The teacher made the template available to all students in their biology course by sharing their biology folder in their Google drive via an email invitation with a link. Each student...
then downloaded the template in the folder. Students saved the template to their computer, then opened the Word document and enabled editing. The students began by personalizing the template of their online science journal, including naming their journal as the teacher directed. (For example, the teacher may instructed students to save their journal as their last name and class period, such as Harris_1, which means the student’s last name is Harris and they are in the teacher’s first period class.) After setting up the basics of their science journal in their own Google drive, the students shared their journal with the teacher by emailing them a link to their journal by using the share option, copying the link, and sending it to the teacher. The student and teacher were the only ones who could access that student’s journal, which ensured that other students were not copying work from others. As each student completed assignments, entered data, and made conclusions from labs and/or experiments, the journal updated immediately so the teacher could see what the student had done.

Consistency is key for students to journal and to meet expectations. In the template, the teacher will set up each unit and each section in that unit in a specific format that they repeatedly use. For example, after the initial title page of the journal and table of contents, the teacher will set up the unit and the sections within the units that will be covered. The units can be set up easily by following the NGSS standards using the core ideas and performance expectations. As an example, in the life science domain, the first disciplinary core idea is HS-LS1 From Molecules to Organisms: Structures and Processes; therefore, the first unit would be called From Molecules to Organisms. The performance expectations, HS-LS1 through HS-LS7, would be the sections in that unit. Those sections would contain the assignments the teacher wants students to complete.

Specifically, the first performance expectation HS-LS1-1 Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells (NGSS 2013) would be the first section or topic in the unit and would contain an overview, assignment information, and requirements for the section that the teacher had previously set up in the template. To be more specific, when the students go to this performance expectation in their science journal, they would see information and the parts of the assignment that must be completed, starting with an introduction where the teacher has input a brief introduction of the topic for this section, followed by a daily objective of what students are supposed to learn.

Next, students would see an investigations/hypotheses/essential question listed, then followed by the materials needed, procedure, data/observation/examination portion to explain the directions of what needs to be done, the results they obtained, and finally, an area to record their conclusion. The teacher can give students a choice in how they demonstrate their learning in the data/observation/examination section and/or in the conclusion section. Students could choose to make a table, write notes, draw a picture, make a short video, or take pictures of the ex-
periment as it is being conducted. Regardless of their choice, they would upload it to their science journal using their Google drive and any other apps that are deemed appropriate. In the conclusion portion, there are also many options for demonstrating their learning that the teacher could offer students as a choice in how to complete the assignment or experiment.

Each of the performance expectations would be labeled as the next section of the unit, just as they are in the standards created by the NGSS for this domain. To be clear, the next part of the unit From Molecules to Organism would be exactly as stated in the NGSS standard HS-LS1-2 Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. Teachers would again start with listing the introduction portion of the assignment, which could include excerpts from the student textbook and clarification statements from the NGSS performance expectations.

A science journal could be created for any of the high school NGSS domains or in a standalone science course following this prescriptive explanation of how to set up the journal. The units are always the big ideas or the disciplinary core ideas. The topics or performance expectations are the sections in that unit. The teacher can make any changes, additions, or deletions to the template to make it align with their course and students’ needs. A good way for teachers to see if science journaling is a good tool for learning for their students is to experiment by piloting the online science journal in one of their class periods. This would ensure they are comfortable with the technology and process before trying it in all of their classes. This allows them to make any changes and detect any obstacles that may interfere with students’ ability to complete their journals. It also allows the teacher to try out apps such as Read&Write or Speechify that are designed to help students with dyslexia, autism, or ADHD.

One of the benefits of having students keep an online science journal is the teacher can see what students are putting in their journals in real time, either in class or at their convenience. Teachers can assign the topics or performance expectations to be completed in class or outside class, depending on the topic and what materials are needed to complete the assignment. If students do not have internet or a computer available at home, the teacher can have students complete the science journal during class time. Also, many school libraries and computer labs are open before and after school where students can use school computers and the internet when needed.

Assessment

When grading student journals, teachers have many options. The teacher can give completion or participation grades, grading only the students’ conclusion section and launching or opening an embedded test in the students’ journals given through a Google form or the Quizizz app during class time. There are also traditional ways to gauge student learning and mastery through a reflection paper, an exit ticket, or a test. All of these can be completed in class after a particular point of completion in the journal.

In Figure 1, the teacher added several additional blank slides to continue the table of contents, but only one is shown for demonstration purposes. Students would keep up with their completed assignments by putting it in the table of contents to make it easy for the teacher to locate and grade. Students can also refer to it at a later time to review.

The example slides in Figure 1 demonstrate a working science journal used in a Biology I course. Some of the benefits of the online science journal are the ability for students to personalize this through pictures, drawings, and videos of their assignments. This allows the student to take ownership of their learning with minimal teacher guidance. Additionally, students who have choices in how they complete assignments are more engaged in activities than those who do not (Parker et al. 2017). Even though many students have natural curiosities in the area of science, the more engagement and choice they have, the more likely they are to take ownership of their learning. This results in a deeper understanding of concepts.

REFERENCES


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