The Rise of Next Generation Science Standards
For many years there has been a push to shift styles of teaching from the traditional lecture type of classroom to a more hands-on approach for students. Kansas’ own state science standards previous to the Next Generation Science Standards (NGSS) included “Science as Inquiry” as a separate standard to be integrated into all others (KSDE 2007). In a similar fashion, the NGSS, which are developed from the National Research Council’s A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, require teachers to weave the practices used in science (e.g. asking questions, carrying out investigations, constructing explanations, etc.) throughout the curriculum.

In September 2014, the “Educators Evaluating the Quality of Instructional Products (EQuIP) Rubric for Lessons & Units: Science” was released to evaluate the alignment of lessons and/or units to NGSS and their inherent quality. Throughout the rubric, criteria that are indicative of a quality NGSS-aligned lesson go beyond demonstration of knowledge and require opportunities for students to make sense, develop explanations, and design solutions to experienced phenomena (Achieve 2014)—all being key components to the Scientific and Engineering Practices. In short, exploratory lessons and activities are the main focus.

Active Learning as the Curriculum Focus
Problem- and Project-based Learning are two terms that have been used—sometimes interchangeably—to describe curricula that focus on engaging students through individual or group investigations. Both exemplify forms of inquiry-based active learning, which sees the students questioning, observing, and analyzing the world around them (NRC 1996). Problem-based Learning is often guided by a teacher or tutor (Bédard et al 2012) and leads towards providing many different solutions for a given problem (Hmelo-Silver 2004). Whereas Project-based Learning allows the students to relish in increasing autonomy on developing and designing an investigation (Bédard et al 2012) that utilizes more methods and skills to arrive to a conclusion through more extensive testing (English and Kitsantas 2013). To paint a picture of distinction between Problem-based Learning and Project-based Learning, Problem can be viewed as a type of introductory activity or precursor to Project. Problem-based Learning can easily be incorporated into each lesson, but Project-based Learning will require more time and focus from the teacher and students. The Problem lessons can ease students into a mindset of asking questions and wondering about the world they observe.

Reasoning for a shift to pedagogy utilizing active learning is multifaceted, including an increase in science literacy and interest in science, technology, engineering, and mathematics (STEM) careers. Being scientifically literate goes beyond using reading strategies to comprehend science writings. Science
literacy also instills a different mindset that requires constant questioning and analyzing of information. Instead of rote memorization of things read or noted, students must be able to apply their knowledge to solving problems or designing investigations (NRC 2015). In the process of pursuing inquiry, the students must go deeper in their learning to strengthen their understanding in a particular topic or area of science. Framework for K-12 Science Education points towards a deeper knowledge as its goal and gives the indication that when students becomes experts, “[they] understand the core principles and theoretical constructs of their field, and they use them to make sense of new information or tackle novel problems,” whereas students with only a surface knowledge “tend to hold disconnected and even contradictory bits of knowledge as isolated facts and struggle to find a way to organize and integrate them” (NRC 2012). Therefore, students who are literate in science are comfortable and confident to use the skills and practices gained from their investigations and apply them throughout their science education career and even for individual and social purposes (AAAS 1993).

Many students may experience a disconnect between science learned in a classroom and science experienced in their personal lives. Throughout Framework there is an emphasis on equity in education, or a strive towards supporting all students to reach the same higher level of science knowledge. This approach goes beyond just educational equality by addressing and using the culture (social and educational) of each student to engage the learner. The use of “inclusive instructional strategies encompass a range of techniques and approaches that build on students’ interests and backgrounds so as to engage students more meaningfully and support them in sustained learning” (NRC 2015). As students become more engaged, application of their growing knowledge can be used to spark interest in pursuing higher learning and STEM careers (NRC 1996). By meeting students where they are with phenomena or problems they experience and observe, the content of their education becomes more practical and personal.

The Roles of Teacher and Project in the Classroom
When a classroom focused on active learning is helpful in building and establishing an environment that fosters deeper learning and interest, then a research project is a valuable tool used with the curriculum. A fully developed project that incorporates research, writing, and presenting into the inquiry process utilizes common scientific practices to develop scientific knowledge (Cervetti and Pearson 2012). Additionally, a study that spans across lessons (possibly across units) benefits students to form a better-developed project by allowing more time to analyze and test their design (Khourey-Bowers et al 2012). When students are able to experience the complete process of forming a plan to investigate and find a solution for a problem, they begin to take ownership of the project and, consequently, the learning. Moreover, outside review of their projects and additional opportunities to communicate their findings further motivates students to evaluate and reflect on their work (English and Kitsantas 2013). For this purpose, science fairs become instrumental in students’ scientific growth.

A class project does not need to be one project to which every student contributes, nor is it a narrow topic that each student must then develop and carry out his or her own research. Both types may restrict students from pursuing issues that pique their interest, and, thus, their motivation. Students should be posed a question or theme that is broad enough to allow multiple sub-questions or categories for exploration (Krajcik 2015). Along with their personally selected topic, students should be given the
autonomy to design and carry out their research in order to create an open and stress-reduced environment (Bédard et al. 2010). However, the students will need support as self-regulation in Project-based Learning is a learned process (English and Kitsantas 2013).

Carrying out an independent scientific investigation may be a new endeavor for a student. This is when the role of advisor, a characteristic of a Project-based Learning environment, is required. The teacher works to guide students into understanding and using the NGSS Scientific and Engineering Practices throughout their inquiry. Traditionally students have been instructed in utilizing the “Scientific Method” as a process to define, test, and evaluate a problem’s solution. However, this focus on a predetermined set list of steps in experimental design often overshadows the true aim of developing a deeper knowledge of science (NRC 2012). The Practices outline in Framework are not meant to be taught separate from science content, instead the Practices are meant to be used to aid students in researching and explaining phenomena (NRC 2000). The teacher does not direct students on how to develop and test ideas, but rather helps students naturally determine what information they need and what to do with it.
References


