INCREASING STUDENT LEARNING IN EARTH SCIENCE: USING PROJECT-BASED LEARNING

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PROJECT

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Department of Teacher Education
Statement of Problem

When compared to other developed nations around the world, science education in America is consistently rated as insufficient. If the citizens of America are to remain competitive in the world economy, focus on learning scientific skills needs to be a priority in public education. However, many of the standards used in science education focus on content knowledge instead of the attainment of practical skills and the development of scientific thinking.

Sources of Data

An evaluation of research from the areas of education and psychology, including researchers such as John Bridgeland (Bridgeland, Diluliio, & Morrison, 2006), Yaron Dopplet (2003), Paul Kirschner (Kirschner, Sweller, & Clark, 2006), Thom Markham (Markham, Larmer, & Ravitz, 2003), and David Moursund (2003) was utilized.
Conclusions Reached

One strategy that focuses on the learning of students and the application of scientific skill sets is Project-Based Learning. This work provides a curriculum guide for teaching California Geology utilizing the Project-Based Learning strategies.

______________________________, Committee Chair
Rita Johnson, Ed.D.

______________________________
Date
DEDICATION

This project is dedicated to the millions teachers in America who sacrifice much of who they are to help young people learn and apply the skills needed to be citizens and life-long learners.
ACKNOWLEDGMENTS

I would like to thank the faculty and staff of the Department of Teacher Education at California State University, Sacramento. This process has been a culmination of the many lessons that I have learned while under your tutelage. Without your patience and guidance this project would have happened.

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Chapter 1

INTRODUCTION

Statement of the Problem

The 1983 National Assessment of Educational Progress (NAEP) report found that student performance in science had declined since 1970 (Ralph & Keller, 1994). More current NAEP reports have found that the science abilities of 12th graders have continued to decrease between 1996 to 2005 (Snyder, Dillow, & National Center for Education Statistics, 2010). Furthermore, according to the U.S. Department of Education, the results of the 2006 Program of International Student Assessment (PISA) found that students in the United States scored below average in science literacy. When this result is compared to other industrialized nations in the Organization for Economic Cooperation and Development (OECD), students in the United States rank 16 out of 30 (Baldi, Jin, Skemer, Green, & Herget, 2007). These findings are important; more college graduates in scientific fields of study will be needed to keep the United States economy competitive in the global market (Tietjen-Smith, Davis, Williams, Anderson, Balkin, & Waller, 2009). Without science education that is capable of engaging students in scientific disciplines and promoting long-term learning of scientific concepts, the ultimate success of the American state and economy may suffer.

Purpose of the Project

The purpose of the project is to create a Project-Based Learning (PBL) curriculum, based on the California science content standards, that will guide students
in learning that “the geology of California underlies the state’s wealth of natural resources as well as its natural hazards” (Burton & Ong, 2003, p. 52). As such, the curriculum for the project is designed so that students will work more autonomously to construct their own learning experience, thus culminating in a realistic, student-generated product (Moursund, 2003; Thomas, 2000).

Significance of the Project

The degree to which a student learns depends on the planned outcome and purpose of the lesson (Watson, 2010). At present, the desired outcome for science instruction is often short sighted; students are expected to score well on end-of-the-year standardized tests or simply pass the course to earn credit towards graduation. As such, current science curriculum and instruction guides students to achieve these short-term aims. Students are not being challenged enough in class; they are not being expected to learn scientific concepts. The curriculum project is developed to provide a way for teachers to meet the demands of standardized testing. Furthermore, the purpose of the project is to challenge students cognitively and to evoke long-term learning of scientific concepts and “to build such 21st century skills as collaboration, communication, critical thinking, and the use of technology, which will serve them well in the workplace and life” (Larmer & Mergendoller, 2010).

As with any PBL endeavor, this project allows students to: (a) focus on the central concepts of a discipline; (b) engage in learning experiences that involve them in complex, real-world projects through which they develop and apply skills and knowledge; (c) learn to draw from several information sources and disciplines in order
to solve problems; (d) learn which curricular outcomes can be identified up-front, and which outcomes of the student's learning process are neither predetermined nor fully predictable; and (e) learn how to manage and allocate resources, such as time and materials (Moursund, 2003)

Limitations

The outcome of this project is based on one teacher’s pedagogy and was implemented in one teacher’s classroom. As such, alterations of the curriculum may be necessary for success in other learning environments. Furthermore, the author is aware that other pedagogies, such as the inquiry approach, could be used by teachers to achieve similar results.

Theoretical Basis of the Project

Too often, academic performance is used to quantify student success. But what good is test performance if the student does not incorporate the instruction into long-term learning? More to the point, how effective are limited summative tests in science education if, according to Bentley, Ebert, & Ebert (2000) science is something that cannot be seen, but is instead a way of thinking? Scientific thought is not learned from memorizing facts and theories or by observing demonstrations, but is instead learned from engaging in scientific activities that force a student to think like a scientist (Piaget, 1973). Unfortunately, direct instruction, such as lecturing, is the most common method of teaching science (Colley, 2005). This creates an environment where the teacher, or the textbook, becomes the ultimate source for answers, thus limiting problem-solving opportunities for students. “What is desired is that the
teacher ceases being a lecture, satisfied with transmitting ready-made solutions; his role should rather be that of a mentor stimulating initiative research” (Piaget, 1973, p 16).

“Project-based learning is a comprehensive, constructivist-based approach that engages students in the investigation of authentic problems” (Seo, Templeton, & Pellegrino, 2008, p. 261). PBL promotes student learning and enables students in the connection of knowledge, skills, values and attitudes; thus constructing knowledge through a variety of learning experiences (Cheng, Lam, & Chan, 2008). This in turn makes PBL an effective strategy for teaching students. It has been successfully implemented in all levels of education, from preschools to graduate programs. PBL has been shown to increase all students’ satisfaction and motivation to learn. Demoff (2002) found that students in a PBL class were absent less often than students in a traditional lecture class for the same subject and time frame. When tested for content and knowledge, students who learn in a PBL classroom perform better or comparable to students taught in a traditional classroom (Demoff, 2002; Prince & Felder, 2007; Thomas, 2000). Furthermore, it was found that students in PBL classes had similar gains in test performance as students in traditional classes, but their confidence with the materials and feelings of success were higher than those in the traditional classes (Demoff, 2002; Kucharski, Rust, & Ring, 2005). PBL does not just help average and gifted student learn it can also be beneficial to English Learners (EL). EL students face many difficulties learning in English-only classrooms, but PBL has been shown to
help them learn in mainstream classes by allowing them to obtain new information in a real-world context (Kuamoo, 2004).

By providing students with opportunities to construct their own learning through real-world projects that encourage the development of social skills and problem solving, teachers are able to promote student learning along with academic performance. In this way, PBL science education can produce the qualified graduates needed to compete in the global economy.

Definition of Terms

*Formative Assessment*: all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities (Taras, 2009, p. 61).

*Project-Based Learning (PBL)*: a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks (Markham et al., 2003, p. 4).

*Summative Assessment*: Evaluation at the conclusion of a lesson or an activity to determine or judge student skills and knowledge (Taras, 2009, p.61).

Organization of Project

The first chapter introduces the project. It includes the statement of the problem, the purpose and significance of this project, theories that support the use of PBL, limitations of the project, and definition of terms.
The second chapter reviews literature that is relevant to this project. It focuses on the history of PBL, the components and implementation of PBL, and evidence of the effectiveness of PBL.

The third chapter discusses the methods the author used to create the curriculum. It explains the development of the curriculum and how it was implemented in the classroom. The fourth chapter discusses the author’s conclusions about the effectiveness of the curriculum. It also included recommendations to maximize effectiveness of the curriculum.

Following the fourth chapter is the Appendix with the curriculum overview, lesson plans, and handouts for the curriculum. Following the Appendix is a list of references the author used in the development of this project.
Chapter 2
LITERATURE REVIEW

Introduction

There is currently a disconnect between the purpose and outcomes of the instructional practices in American education. The purpose of education is for students to learn from the instruction. True learning requires a holistic approach to education, beyond mere lecturing, “research in neuroscience and psychology has extended cognitive and behavioral models of learning – which support traditional direct instruction – to show that knowledge, thinking, doing, and the contexts for learning are inextricably tied” (Markham et al., 2003, p. 3). However, the outcome often being measured in classrooms across the country today is not learning; but merely academic performance, measured through written summative or standardized tests.

Testing in and of itself is not a detriment to education. Tests can serve as a means of assessing how much information a student has absorbed. Studies even show that “between 2002 (or later in many states) and 2008, many more states showed gains than declines at all three achievement levels analyzed” (Chudowsky, Chudowsky, & Kober, 2010, p. 6). Many teachers have even stated that “the tests provide useful data, the testing regime helps create a road map for instruction, standards and tests don’t sap creativity or hinder collaboration, and the accountability imposed by the testing regime is useful” (Buck, Ritter, Jensen, & Rose, 2010, p. 51). Nonetheless, testing should not define education, but serve as a narrow, limited tool to measure student performance. Academic performance, as measured by standardized tests, has
improved in the recent years. However, the question must be asked, do current instructional practices allow students to internalize a lesson and use the information being conveyed to change their thinking or behavior? Does current instructional practice allow for students to truly learn the curriculum?

Although test scores have increased in the recent years, other factors that determine the effectiveness of American education show far different results. For instance, “almost one-third of all public high school students fail to graduate” (Bridgeland, Dilulio, & Morison, 2006, p. 1). Low graduation rates are but one sign of the catastrophic failure of the modern educational system. With a narrow focus on student test scores, long-term learning of the curriculum becomes a distant concern of schools and school districts. “Forty five percent [of dropouts] said they started high school poorly prepared by their earlier schooling” (Bridgeland et al., 2006, p. iii). In other words, nearly half of students dropping out of high school, or about one-sixth of the entire student population, are leaving school because they failed to learn the curriculum in previous grades. These findings serve as clear evidence that an educational system that focuses entirely on test performance as an indication of the success of students, teachers, and schools ultimately fails at its purposes to cultivate civic responsibility and economic efficiency (Carpenter, 2005).

A dramatic shift in the instruction of students is needed to realign the measured outcomes of education with its fundamental purpose. There is no one solution to this problem. However, adopting a variety of teaching methodologies that focus on student learning would significantly assist in the transition. One form of pedagogy that
accomplishes this is Project-based Learning (PBL). “PBL is a potentially powerful means to produce relevant and rigorous learning” (Harada, Kirio, & Yamamoto, 2008, p. 14). PBL provides a more holistic instructional strategy (Railsbeck, 2002) compared to traditional direct instruction methods. Furthermore, PBL is a teaching methodology that addresses the five suggested actions to improve student success in school, as purposed by Bridgeland et al. (2006).

The disconnect in education runs like a vein through all levels and all disciplines; but the ultimate focus of this project is to demonstrate how PBL can benefit science education. The reason for this focus is that, when compared to other industrialized nations, the performance of American students in science, as measured by indices such as the NAEP and PSIA, consistently falls short (Ravitch & Cortese, 2009). Furthermore, when this result is compared to other industrialized nations in the Organization for Economic Cooperation and Development (OECD), students in the United States ranked 16 out of 30 (Baldi et al., 2007). These findings are important, because “for the United States to successfully compete in a global economy, universities must produce qualified graduates in the sciences” (Tietjen-Smith et al., 2009). If the educational system fails to engage students in scientific disciplines and promote long-term learning of scientific concepts, the ultimate success of the American state and economy may suffer.

What is Project-Based Learning?

Project-Based Learning has ties to socio-constructivism and other activity-based approaches which emphasize an “understanding of learning that stresses the
importance of constructing knowledge based on previous knowledge” (Zembylas, 2005, p. 2). As a result, PBL shares similarities with other pedagogies, such as problem-based learning, inquiry-based learning, case-based learning, and action learning. The modern concept of PBL is often attributed to John Dewey and his protégé William H. Kilpatrick, who pioneered the idea of the project method in which the learning of the student was achieved through experiential processes. However, the roots of PBL reach far deeper.

The project as a method of institutionalized instruction is not a child of the industrial and progressive education movement that arose in the United States at the end of the 19th century. Rather it grew out of the architectural and engineering education movement that began in Italy during the late 16th century. (Knoll, 1997, p. 60)

The modern concept of PBL can be defined “as a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products” (Markham et al., 2003, p. 4). To accomplish this result, PBL lessons share common characteristics; they should: (a) use realistic and challenging problems that elicit active and constructive processes of knowledge and skill acquisition in learners; (b) the inclusion of small group, collaborative work and ample opportunities for interaction, communication, and cooperation; and (c) encourage learners to set their own goals and provide of guidance for students to take more responsibility for their own learning activities and processes (Moursund, 2003).
Benefits of Project-Based Learning

The use of PBL as a pedagogical tool in modern education is still in the developmental stage. Even still, as it pertains to the American education system’s current goal of student performance as measured by standardized tests, “based on evidence gathered over the past ten years, PBL appears to be an equivalent or slightly better model for producing gains in academic achievement” (Markham et al., 2003, p. 6). When the focus is shifted to the education system’s underlying purpose of facilitating long-term student learning “evidence shows that PBL enhances the quality of learning and leads to higher-level cognitive development through students’ engagement with complex, novel problems” (Markham et al., 2003, p. 6). Furthermore, the various characteristics that shape PBL address each of the suggested five actions to improve student success and decrease the number of high school dropouts developed by Bridgeland et al. (2006).

Making School More Engaging

Keeping students engaged is a critical factor for science instructors. Forty-seven percent of high school dropouts saying they did so because they were bored with school (Bridgeland et al., 2006). “Students who drop out claim that the curriculum is disconnected from real life…” (Harada, 2008, p. 14). Students want to see the connection between school and work. However, in today’s educational environment, instruction tends to focus on preparing students for a battery of standardized tests given towards the end of the year, because, politically, that is how the success of the student, school and teacher is measured. Therefore, science
instruction is generally presented in a drill-and-practice format, which frequently tests students on how well they have retained factual knowledge. Although this format may help prepare students for standardized tests, it does very little to keep students engaged or promote learning in students.

“[A] benefit of using PBL is that it motivates and invites those students who struggle with boredom from traditional school assignments . . . [S]tudents become engaged, self-motivated, and persistent in discovering answers to their questions” (Seo, Tepleton, & Pellegrino, 2008, p. 261). PBL has been shown to increase all students’ satisfaction and motivation to learn. For instance, Demoff (2002) found that students in her PBL class were absent less often than students in a traditional lecture class for the same subject and time frame. Likewise, in a comparative study among engineering students, Mills & Treagust (2003) concluded that “students who participate in [PBL] are generally motivated by it and demonstrate better teamwork and communication skills. They have a better understanding of the application of their knowledge in practice, and the complexities of other issues involved in professional practice” (p. 12). The reason for this can be best summed up by Wilhelm, Sherrod, & Walters (2008), whose research found that “environments rich in projects allow students to (a) engage in contextualized problem solving, (b) make connections within and across disciplines, (c) develop reasoning skills, and (d) accurately represent and communicate concepts” (p. 232).

Besides its ability to allow students to make connections between what they are learning in school, and how to apply it in real-world contexts. PBL allows students
to experience a more democratic classroom; one in which they have input on classroom policies and instructional options. Benefits of such an environment have been shown to further engage students. Students in democratic classrooms demonstrate more responsible behavior in class as well as greater respect for themselves and others both inside and outside the classroom (Dawidowicz, 2008).

PBL engages students in such a manner by allowing students to pick their team members, having students design team contracts stipulating the expectations of each team member, and allowing for student creativity in the final rendition of the project product.

However, one should not equate autonomy with lack of structure. The degree of student autonomy a teacher allows should be carefully scaffolded and constantly assessed. According to Bridgeland et al. (2006), 38% of students who dropped out of school stated that one of the reasons they failed to graduate was that they “had too much freedom and not enough rules in their lives” and wanted “greater supervision and classroom discipline” (p. iv).

*Helping Struggling Learners*

PBL instruction is better suited for the cognitive abilities of many students. According to Piaget’s theory of cognitive development, children pass through four stages of development sensory motor, preoperational, concrete operational, and formal operational (Slavin, 2003). Although Piaget gave age ranges for these developmental stages, they are “relative – not absolute – and depend on the factors of the child’s background experiences with the environment, broad, yet undefined, maturational
aspects, as well as cultural and societal patterns transmitted to the child by family and school” (Heyl, 2008, p. 9). Most science instruction is heavily based in the formal operational realm, which involves abstract thinking and hypothetical reasoning. Yet, according to Heyl (2008), 50% of students 16 or older still function at Piaget’s concrete operational stage. It is a stage where individuals are able to think logically, but the ability to do so often requires opportunities for specific examples or experiential interactions. As a result, the majority of all high school students struggle in school and are unable to be academically successful because their brains have not yet created neural pathways to allow for higher level abstract thinking. In order to engage all students, instruction should focus on the concrete operational stage; a student at this stage “can form concepts, see relationships, and solve problems, but only as long as they involve objects and situations that are familiar” (Slavin, 2003, p. 36). PBL can help students struggling with scientific concepts by providing them with concrete data and requiring them to use that data to develop creative solutions to their problems.

PBL is also proven to benefit English Learners (EL) and at-risk students. EL students face many difficulties learning in English only classrooms. But PBL has been shown to help EL students learn in mainstream classes by allowing them to obtain new information in real world context (Kuamoo, 2004). Learning content in a way that mimics the world outside of the classroom is important for EL students, because it enables them to realize that what they are learning is relevant and useful. This increases EL students’ motivation to learn, resulting in increased learning. Low
achieving and at-risk students benefit from learning in an environment that simulates real-world situations (which PBL offers) and makes content meaningful (Carr & Jitendra, 2000). Dopplet (2003) found that when PBL was implemented in classes with low achieving students they were more successful, which increased their confidence and helped them succeed in school. Dopplet summarized “three years of activities show an increase in the number of pupils who were low-achievers at the end of the junior high school and completed high school with the fulfillment of the precondition for admission to further education…” (Dropplet, 203, p. 269). Green (1998) had similar results when he implemented PBL in his G.E.D. classes. After implementing PBL instruction he found an increase in student involvement in the class, increased learning of required content and skill, and, perhaps most importantly, increased completion of the course. Low achieving and at-risk students need to feel successful at least once before they will be able to believe they can learn. PBL offers students a chance to be successful and can motivate them to become interested in learning.

PBL further assists struggling students by requiring that they work with other students in a team environment. Using Vygotsky’s concept of the zone of proximal development (ZPD) in PBL, team members become peer-teachers helping struggling students to not only better learn the concepts being taught, but also further develop autonomy in the context of collaborative learning (Harland, 2003).
Improving School Climate

Creating a positive school climate, which “exists when all students feel comfortable, wanted, valued, accepted, and secure in an environment where they can interact with caring people they trust” (Wilkins, 2008, p. 16), is critical to improving student learning. This is in accordance with Maslow’s hierarchy of needs theory, which states that a person must satisfy their deficiency needs (physiological, safety, and esteem needs) before they are motivated to satisfy their growth needs, such as education. Consequently, before a student is motivated to do well academically, she or he must feel as though they belong and are accepted in the school environment (Slavin, 2003).

By requiring students to work closely with their peers, students are able to develop a supportive community that improves the school climate for each individual. In a study by Knapp (2009), when students used PBL methods, “members of every team attributed their team’s success to the team’s ability to develop a collaborative climate in which the members became familiar with each other and their preferred work styles, and learned to work together” (p. 141). Although evidence suggests that cooperative learning improves school climate for students “there is evidence that it may have negative results when students acquire misconceptions or incomplete or disorganized knowledge” (Kirschner, Sweller, & Clark, 2006, p. 84). PBL and all cooperative learning techniques, require that teachers and staff be trained in how to monitor group learning: “It was found that schools with better preparation for
cooperative learning outperformed other schools in educational outcomes in cooperative learning” (Cheng, Lam, & Chan, 2008, p. 218).

**Improving Student-Teacher Relations**

When students develop a positive relationship with just one adult outside of the home environment, they are more likely to remain in school and be motivated to succeed academically (Reed, McMillan, & McBee, 1995). For high school students who choose to drop out, “only 41 percent said they could talk to an adult in school about personal problems” (Azzam, 2007, p. 92). Traditional teaching practices, such as direct instruction or lecturing, do not help foster significant relationships between students and teachers.

In PBL “as the role of the student and his or her learning changes, the teacher has to change to become a facilitator who helps students build their own knowledge base” (Seo et al., 2008, p. 261). This changing of roles allows the teacher to have more authentic time and communication with students, often facilitating a more genuine student-teacher relationship.

Furthermore, projects allow for students to collaborate with adults and organizations outside of the classroom environment to work towards a creative solution. “Possibilities include partnerships or associations with other classrooms, other schools, working professional, and mentorships with community organizations” (Markham et al., 2003, p. 21). Along with developing relationships with adult mentors in whom they might confide and keep them from dropping out, project feedback from
expert adult mentors is especially meaningful to students because of the source (Larmer & Mergendoller, 2010).

Improving Communication

A positive school environment is important, but academic success does not solely take place at school. A student’s home environment affects how successful the student will be at school as well. It is often the case that students lack motivation for academic success because such a philosophy does not follow them outside of the school environment (Milne & Plourde, 2006). One reason for this may be different cultural beliefs; some cultures do not place a high value on a formal education or believe it is only for people of a certain status. Another reason for this disconnect can be attributed to a breakdown in communication between school and home. Bridgeland et al. (2006) reported that “fewer than half of students said that their schools contacted them or their parents when they were absent or had dropped out” (p. v). Sometimes this communication breakdown is a result of a language barrier; the family of the student does not speak English. Other times it is because information is not given to the student’s family by the school. Whatever the cause, engaging the parents of students is critical in eliciting motivation for academic success.

However, in traditional educational practices, parents have a limited role in the instruction of their children. Other than teacher or school communication about the student’s behavior or performance, for the most part parents are not integrated into instruction.
PBL not only fosters communication with parents, it integrates parent involvement in the undertaking of the project. Like most school assignments, parental assistance is thoroughly encouraged as students work on their project. However, beyond parents helping their student complete the project, parents can be incorporated in a variety of ways in a PBL lesson. Parents may have expertise in the field that is being studied, or parents can be used as “liaisons and get them involved in making community connections and finding out where in the community the project could take place” (Markham et al., 2003, p. 163). Besides bringing parents into the classroom as topic experts to serve as a resource for students, parents can also be used in the assessment portion of the project. Often “an audience of parents, community members, or expert adults for a final presentation raises the stakes for students and elicits the best performances” (Markham et al., 2003, p. 15).

Parts of the Project-Based Learning Curriculum

In their text *Project-based learning handbook: A guide to standards’-focused project based learning for middle and high school teachers*, Markham et al. (2003) identified the five phases of a PBL curriculum: (a) developing learning outcomes, (b) crafting the driving question, (c) planning the assessment, (d) mapping the project, and (e) managing the process.

*Developing Learning Outcomes*

In the beginning of the project the teacher, perhaps with student involvement and input, develops the project idea. This does not include simply developing a topic or theme for the project, but also evaluating the overarching purpose of the project,
based on the interests of the students and ultimately what students should have learned by the end of the project (Markham et al., 2003). In this first phase, the teacher should consider the scope and audience of the project, along with the level of student autonomy. In addition, as American education remains standards-based, the teacher would also consider which state standards should or will be addressed during the project. However, the power of PBL lies in its ability to address more than just academic performance. “A project should give students opportunities to build such 21st century skills as collaboration, communication, critical thinking, and the use of technology, which will serve them well in the workplace and life” (Larmer & Mergendoller, 2010, p. 36). Finally, in the initial planning of the project, the teacher must put thought into how best to structure the learning environment so that the overall learning outcomes can be achieved by all students.

Crafting the Driving Question

In the second phase of developing a PBL curriculum, the teacher develops the project’s driving question. “The driving question should be provocative, open-ended, complex, and linked to the core of what you want students to learn” (Larmer & Mergendoller, 2010, p. 36). The purpose of the driving question is to make a project intriguing, complex and problematic (Markham et al., 2003). The driving question goes to the heart of the topic, and should address fundamentally why the students are doing the project; many times driving questions can be developed from real-world dilemmas that students find interesting.
Planning the Assessments

Before teachers can start planning what specific lessons or activities to be used in the development of a project, thought needs to be given to the learning outcomes and how student success in reaching these outcomes will be assessed. The third phase of planning a project is planning authentic assessments. Assessments should be developed that not only measure the knowledge students acquire during the project, but also “evaluate the skills necessary for higher-order thinking, the tasks required for students to produce a quality product, and the method of disciplined inquiry through which students integrate content and process to produce useful knowledge” (Markham et al., 2003, p. 45). “With real inquiry comes innovation – a new answer to a driving question, a new product, or an individually generated solution to a problem” (Larmer & Mergendoller, 2010, p. 37). Typically, teachers use rubrics in the assessment of project products and processes because they lay out the specific expectations of an assignment but do not stymie inquiry (Maxwell, 2010).

The most efficient way of developing assessments, is to align the products the students will produce with the teacher’s desired outcomes and work backwards, by determining how the products created during the project will allow students to demonstrate their learning (Markham et al., 2003). Often, the project will result in a final summative culminating experience or product, but other formative assessments are needed to determine student progress on the project and identify misconceptions to ensure student success.
Mapping the Project

Once the teacher has accomplished the above task, she or he must next design the structure of the project. PBL teachers need to be organized and have clear goals for students, such as setting up benchmarks and timelines for the completion of the project (Moursund, 2003; Polman, 2000). Aside from simply being a sequence of activities, the project map must also include a support structure to direct students in the successful creation of their products.

The design of a project map may often resemble a storyboard for the project. It is a list of the tasks and activities involved in the project organized in a linear format, so that one task builds upon the previous task (Markham et al., 2003). During the development of the project map, the teacher has an opportunity to reassess the desired learning outcomes, plug in the designed assessments, and gather the resources needed to carry out the project.

Other parts of a PBL curriculum are also developed while the teacher is mapping the project. Teachers spend time developing an entry event, such as a video, a lively discussion, a guest speaker, a field trip, or a variety of other activities. The entry event “engages interest and initiates questioning” (Larmer & Mergendoller, 2010, p. 35) in order to develop within students a ‘need to know’.

Managing the Process

The final phase of a project is having the student do it. This part of the project is the most difficult to deconstruct and will most likely vary the most, as each teacher
has his or her own style and personalities. However, Markham et al. (2003) suggest a few key steps:

First, the teacher should share the project’s goals with the students. Teachers need to review and reinforce the expectations of the project to ensure students understand the scope and purpose of the project, since the students will be the ones undertaking the challenge of completing the project and creating the product (Markham et al., 2003). This may require the teacher to tailor the project to the needs and characteristics of the students. Parents also need to be notified of the project and its topic (Chard, 2001). Parents can be a great source of additional information on specific topics, sharing their expertise in various fields of study, and when aware of the project, parents can help students set goals and remind them of due dates.

Second, teachers need to focus the students on the problem-solving nature of the project. Often students get caught up in the creation of the finished product, but it is the journey to completing the project in which students learn. Providing artifacts such as know/need-to-know lists, learning logs and product briefs throughout the project can help focus students on the task-at-hand (Markham et al., 2003).

Third, the teacher should use the planned formative assessments as checkpoints during the project to dispel any misconceptions that may develop and ensure timely completion of the final product (Markham et al., 2003). It is important for the teacher to circulate and check in with both individual students and groups; this allows teachers to identify “teachable moments” (Moursund, 2003).
Finally, teachers need to allow for opportunities for evaluation and reflection throughout the project. “Students who have the opportunity to discuss, analyze, and reflect on their learning experiences are more likely to retain and use their knowledge and skills” (Markham et al., 2003, p. 101). Furthermore, “[f]ormalizing a process for feedback and revision during a project makes learning meaningful because it emphasizes that creating high-quality products and performances is an important purpose of the endeavor” (Larmer & Mergendoller, 2010, p. 37).

Challenges of Project-Based Learning

PBL has many benefits, such as promoting learning, engaging student interest, providing career-based problem solving opportunities, and improving parent communication. Still the pedagogy has its own set of limitations as well. Once the teacher is aware of the limitations of PBL, potential setbacks can be mitigated if not eliminated entirely.

Although students typically have a higher degree of autonomy in PBL curriculum, this does not mean that the implementation of projects should lack guidance. In Kirschner’s analysis of constructivist teaching methodologies, he found that “not only is unguided instruction normally less effective there is also evidence that it may have negative results when students acquire misconceptions or incomplete or disorganized knowledge” (Kirschner et al., 2006, p. 84). During PBL, a teacher should not be disengaged from the students as they work on the project. As stated above, the teacher should circulate and check in with individual and groups for student understanding; this allows teachers to identify “teachable moments” (Moursund,
Furthermore, throughout the project “scaffolding should be employed as a systemic approach to supporting the learners, focusing on the task, the environment, the learners and the (classroom) community” (ChanLin, 2008, p. 56).

Along with integrating structure with student autonomy, the general cognitive abilities of students need to be determined before using PBL curriculum. PBL may work well with older students, but the general level of autonomy and problem-solving abilities incorporated in PBL may strain a younger student’s cognitive load and end up being counter-productive. Research suggests that novice students benefit more from guided instructional procedures than relatively unguided instructional procedures used by advocates of constructivist methodologies (Pass, van Gog, & Sweller, 2010).

In addition to the instructional limitations, there are practical limitations of PBL as well. Teachers and administrators may feel PBL is too time-consuming, so that they cannot cover the entire required curriculum before state testing. Administrators may be opposed to the implementation of PBL in the classroom because of uncertainty of the effect PBL may have on the test scores (Houghton Mifflin, n.d.). However, these concerns appear to be unwarranted. As stated above, students who learn in a PBL classroom perform better or comparable to students taught in a traditional classroom, on test of content and knowledge (Demoff, 2002; Prince & Felder, 2007; Thomas, 2000).

An additional issue may be that many students have not experienced a PBL classroom, and this can lead to discomfort and frustration. Students may even feel angry with the teacher, or they may feel like the teacher is not doing his or her job
because the teacher is not giving them answers to all of their questions (Wrigley, 1998). However, as students learn to become self guided and integrate intrinsic motivation this discomfort passes. Students become more comfortable with the structure and are eventually willing to work to meet higher expectations (Chard, 2000).

Finally, teachers often find it hard to diverge from their own teaching style. Many teachers teach the way they themselves learn best, or in the way they were taught. PBL often requires teachers to step out of their comfort zone, and some teachers may have a hard time releasing control of information and allowing students to develop their own knowledge (Houghton Mifflin, n.d.; Markham et al. 2003). In addition, not all projects may go according to plan. Perhaps they take more time than expected, or fail altogether. This can be disheartening to teachers trying PBL for the first or even second time. However, the more PBL is done in the classroom the better the teacher, and the projects, will become.

Conclusion

Students today are underperforming at record levels. In some school districts around the country, as many as “50 percent or more leave school without graduating” (Darling-Hammond & Ifill-Lynch, 2006, p. 8). Those students who are of low socioeconomic status have a more difficult time succeeding in a modern academic environment. However, disadvantaged students are not the only ones dropping out of school, gifted students also leave high school because they do not feel challenged enough in class (Bridgeland et al. 2006).
PBL helps all students learn from the low achieving to the gifted, from native English speakers to English Learners, by demonstrating the relevance of specific content to the real world and focusing on active learning. Schools and teachers should be focusing on ways to best facilitate learning in students; PBL offers a way to do so by engaging students and allowing them to apply their learned knowledge and skills through real-world problem solving projects. The feeling of success can be contagious, and once students know they can succeed, they are more likely to carry that feeling over to the other areas of learning thus allowing them to be successful in all aspects of their education.

The methods described above have been shown to be beneficial in increasing the motivation of students to perform well academically, graduate from high school, and move on to higher education. However, more research on how the methods directly affect school assessments, such as standardized test scores, is needed. Increasing student motivation may be an optimal goal, but if there is no significant improvement in standardized test scores, many of the methods will be usurped for those that can raise API and AYP scores. In spite of this reality, educators should not be discouraged to try any and all strategies they believe will help increase the success of their students. Every educator strives to inspire every student that she or he encounters, yet this is often accomplished one student at a time.
Chapter 3

METHODOLOGY

The curriculum for this lesson is designed around the five phases of a PBL curriculum, as laid out by Markham et al. (2003). Using the California content standard on California geology as a foundation, the focus for the curriculum is to facilitate student success in the following learning outcomes: (a) students work as teams to conduct research about California’s natural resources, economy and education, physical geography, and social diversity; (b) students synthesize information from their research; (c) students work together to compromise on a solution to the project challenge; (d) students create artifacts that easily communicate their decision; (e) students present their team consensus to an audience; and (f) students self-assess their performance individually and as a team.

The driving question for the curriculum is focused on the real-world fiscal crisis that consumes the state of California at the time of this paper. Throughout the project students will develop their own answers to the question: Is the concept of the state of California greater than the sum of its parts? To this end, students are challenged to equitably dissolve the state of California into smaller states. In the process of creating smaller, more fiscally manageable states, students will ponder at what point would the state of California lose the characteristics that presently define it? Working in teams, students will work through each objective, culminating in a final, individual report as well as a collaborative presentation and map of the newly-divided California.
Curriculum Implementation

When the author first conducted this project in his own classroom, the curriculum was implemented in the final three weeks of school. This time period was primarily chosen because it followed the annual STAR testing schedule. This allowed for more flexibility in the amount of material to be covered, allowing students to move at their own pace. It also allowed the author to extend the amount of time to work on the project as needed.

Learning Objectives and Assessments for Curriculum

While planning assessments and mapping the project, the author has identified seven learning objectives that are essential for students’ successful achievement of the project learning outcomes. Successful completion of the assessments for each of the objectives in the following sequence allows students to attain the desired learning outcomes while limiting confusion or misconceptions. A more formal sequence of events and written lesson plans for the project can be found in the Appendix.

Objective 1: Students Create Small Teams

To begin the project and assist students in satisfying the first learning outcome, individuals need to be grouped into small teams of four students. Giving each student a role of responsibility encourages equitable participation among the team members. Therefore, for this project students will decide an area of expertise for each member to focus on (natural resources, economy and education, physical geography, and social diversity), as well as develop a name for their team to facilitate a sense of team unity.
The formative assessment of this team building phase requires the teacher to inquire about the progress of each group and ask guiding questions as he or she walks around, observing the students during the class period. The summative assessment will be based on how the team develops their team contract, which should detail the responsibilities of each member and possible disciplinary consequences for a member’s failure to live up to the stated responsibilities (see Team Contract form in the Appendix).

Class time devoted to the completion of objective 1 is about 50 minutes. However, the teacher may need to extend the actual amount of time for the completing objective 1 depending on how quickly the students in each team can create an appropriately detailed contract; the instructor may need to guide teams through several versions of their contract before an acceptable draft is created.

Objective 2: Students Appropriately Cite Their Sources of Information

Based on the author’s personal experience, as well as recognizing that Earth Science is traditionally a course for high school freshmen, most students presented with this project will be unfamiliar with the process and importance of using citations in their research. Therefore, it will be necessary for the teacher to instruct students on how to cite one’s sources to ensure that students can be successful in this aspect of the final report (see Lesson Plan in the Appendix).

The only formal instruction students need is one 30-minute lesson on the need for proper citation of information as well as how to cite one’s sources. A short quiz after the lesson will serve as a summative assessment for the degree of student
learning from the lesson. Instructors can conduct further assessment of students’
citation skills as they work on objective 3 by asking individuals to provide reference
information as a part of their daily reflection slips during the research portion of the
project. However, the final assessment of each student’s success in properly citing the
sources of their research will be when the teacher evaluates the reference lists students
generate at the end of the project.

Objective 3: Students Conduct Research

Due to the nature of the project, students need the most recent data about
California to develop their final report and map. Therefore, students will need
unfettered internet access for this portion of the project. However, from the author’s
personal experience, next to citing sources, students have the most difficulty with
conducting investigative research to find the evidence that is needed to provide
justification for their recommendations for the solution of the project’s challenge.

Because students frequently lack this skill, the teacher needs to guide students’
research more than if the project were used with upper classmen. Each teacher should
reflect on the needs and characteristics of her or his students to develop materials that
facilitate this guided research. Focus questions for each team member will greatly help
to narrow the student’s focus to topics that directly pertain to his or her role of
expertise. For examples of focus questions see the Appendix. It is also helpful for
students to have copies of a map of California to take notes on or to synthesize
information from their research (see Appendix). Depending on the research
capabilities of students and the time available for research, it may also be helpful to provide a list of web sites for students to visit while they research (see Appendix).

One of the greatest difficulties that arise during the research portion of the project is assessing student learning. Besides asking guiding questions of students as the teacher walks the room observing, the teacher can provide a more formal assessment of student success for objective 3 in the form of daily reflection slips. Reflection slips can require students to answer questions about their research for that day; or, they can require students to perform particular tasks and provide feedback. Examples of daily reflection slips can be found in the Appendix. Further assessment of each student’s learning during this objective will be evaluated in the research paper during objective 4.

Time devoted for objective 3 will vary depending on a variety of factors that need to be assessed by individual teachers. However, the author advises between 150-250 instructional minutes of research time for students. Encouraging students to work with others who have the same expertise role in the project and to share information may help to reduce the amount of actual computer/internet time needed by individual students.

Objective 4: Students’ Write Their Personal Solution to the Challenge

One of the learning goals for this project is for students to synthesize the information they pulled from their research. To assess the degree of this synthesis, each student is required to write a three page report regarding their own personal solution to the challenge of separating California into smaller states from the
viewpoint of their role of expertise. This also provides students an outlet to address the
driving question individually. Instructions for the report, along with a rubric to assist
with the evaluation of the report, can be found in the Appendix.

The author allowed for 100 minutes of class time for students to develop and
write their individual reports before moving on to the next objective. During this time,
students can also seek input on their reports from peers and the instructor. It is critical
for each student to have a clear understanding of his or her research and how it may be
integrated with the other team members’ research to assure the success of subsequent
learning outcomes. If the time in class is not sufficient for students to finish their
reports, students are encouraged to complete the assignment outside of class; either at
home or after school. Depending on the goals of the instructor, students may or may
not be required to complete the individual report portion of the project before moving
on to the team collaboration stage.

**Objective 5: Teams Reduce Findings and Create a Collaborative Solution to the
Project Challenge**

To satisfy the third and fourth project learning outcomes described in the
beginning of this chapter, objective 5 requires students to work together to develop a
common solution to the driving question. The summative assessment of objective 5 is
for students to create a large map of California, with the borders for the new, smaller
states delineated. Objective 5 specifically challenges students to develop new states as
equitably as possible in regards to each student’s role of expertise: natural resources,
economy & education opportunities, physical geography, and social diversity. To
verify how equally the new states were created, the map should include graphical representations of the data each student collected during his or her research. Along with the map, teams will also write a one page summary explaining their map and why they chose to divide California as they did. Instructions for the map and report, along with a rubric to assist with the teacher’s evaluation, can be found in the Appendix.

Teachers should only need to devote about 100 minutes of instructional time for students to complete objective 5. However, as the teacher observes students during this phase of the project, the teacher’s formative assessment may indicate if more time is required.

**Objective 6: Teams Present Their Project Solution to an Audience**

One of the benefits of PBL is its ability to improve communication, as students are asked to present and defend their findings to an audience (Larmer & Mergendoller, 2010; Markham et al., 2003). Using the completed products from the previous objective, teams will present their answer to the project’s driving question to their peers, the teacher, and hopefully parents and career professionals as well. A rubric for assessing each team’s presentation can be found in the Appendix. A summative assessment should be done by the teacher, but the audience should also be encouraged to take on the role of evaluator to elicit better performances by the students (Markham et al., 2003). For instance, students should be encouraged to ask questions of the team presenting, so that each member can take a role in defending their conclusions. Class time devoted to objective 6 will depend on how many teams there are in the class. A typical presentation for this project should last no longer than 10 minutes.
Objective 7: Students Reflect on and Evaluate Their Performance

“Students who have the opportunity to discuss, analyze, and reflect on their learning experiences are more likely to retain and use their knowledge and skills” (Markham, 2003, p. 101); as such, students should spend time evaluating their own performance and the performance of their teams. Thirty minutes of instructional time is enough for the teacher to provide instructions on self-evaluation and allow students to complete the evaluation forms (see Appendix).
Chapter 4

DISCUSSION, RECOMMENDATIONS AND CONCLUSION

Discussion

Three classes of students in the author’s school participated in a pilot version of this project. All completed four of the five goals of the project; student teams conducted research about California’s natural resources, economy and education, physical geography, and social diversity, they synthesized information from their research; they worked together to develop a common solution to the challenge; and they communicated the team consensus to an audience. As for the final goal of the project, to create artifacts in the form of a written report and map of California, all teams created a map of California depicting their answer to the driving question of how to equally divide California into smaller states. The missing goal was the individual written report, with only an 80% completion rate.

The majority of students performed well throughout the project and were able to accomplish all of the learning outcomes; the reason for this success is attributed to students’ previous experiences with collaborative work, writing reports, and citing references. However, some objectives were difficult for this particular group of students to satisfy. The first challenge was the creation of the team contracts. Nearly all of the students had no experience with creating contracts that listed the norms of the group, the expectations for each team member, and the disciplinary measures for team members who failed to abide by the contract. Each team had to create several draft copies of their contract until they were deemed appropriate by the instructor.
However the greatest challenge for the students who participated in the project was satisfactorily completing the research objective. When beginning the research segment many students had misconceptions of their particular role in spite of focus questions provided by the instructor. This challenge was mitigated by encouraging students who had similar roles to work together. Students who worked with those who had similar roles were better able to define their responsibilities and reduce the stress associated with the work load by sharing reference sources and ideas. Still, because the overarching concept of academic research was conducted through a distracting medium (the internet) this proved difficult for approximately half of the students. Many of the students who had difficulty focusing on the research had little to no experience using the internet as anything more than a media and social networking source; therefore, many of them were frequently off-task during while they had access to the internet. The instructor for this project used this opportunity as a teachable moment and worked continuously with distracted students, showing them proper research methods.

At the conclusion of the unit, students were asked to reflect on the experience in evaluation forms. A majority of students felt the structure of the project teams provided support for individual students and led to a greater number of them completing the project validating claims that PBL helps struggling learners. For example, an English Language Learner whose CELDT score listed her as early intermediate wrote that, “Being in a group with kids that spoke Ukrainian helped a lot.” Likewise, a student with learning disabilities was asked why he performed so
much better on this project than other assignments, he wrote, “My friends explained a lot of what I was supposed to do. I learned what I had to do so I didn’t mess up so much.” These two students were not isolated examples. For many students creating a concrete product, with the support of their peers, was the assistance they needed to achieve academic success.

**Recommendations**

Upon completion of the project, the author became aware of several problems that were not identified or accounted for during the development of the curriculum. First, while most of the teams collaborated well with one another, the majority of the teams did not foster a democratic structure in which each team member contributed equally to the creation of the project. The author recommends that before undertaking this project again or another similar PBL curriculum, students spend time developing norms for team behavior and fostering trust between team members.

Second, approximately one-third of the teams who had an unsatisfactory performance on the team assessment did so because of misconceptions about how they were to separate California and what their map of the new state was supposed to look like. The author does not recommend teachers showing examples of finished products, as that may limit creativity. Instead the teacher should review the individual goals with each team to assess any misconceptions. Teachers may also wish to request a rough draft of each team’s product to evaluate whether each group has a clear understanding of the purpose of the project.
As this curriculum is continued to be implemented in the classroom, more issues may be identified and worked out. Each teacher will need to implement this curriculum individually to find out what works for them and their students and to make adjustments accordingly. The lesson plans provided in the Appendix reflect modifications the author felt were necessary to improve the curriculum after the project was complete.

Conclusions

Based on the completion of the projects’ goals and objectives by nearly all of the students who participated in the curriculum, and the number of students who scored proficient or better on the summative assessments, this project was successful. While some aspects of the curriculum can and will continually improve, the use of the PBL method not only ensured that students gained academic knowledge, but also ensured they learned and applied skills such as cooperative team work, evaluation, reflection, time management, problem-solving, and public speaking.

Student evaluations of the project support this conclusion, as 92% of those who participated in the project reported a favorable experience in which they learned more about the state of California and its resources from participating in the project.

The author of this project would like to add that he believes that PBL is an extremely effective way for students to learn. It provides teachers an opportunity to be transformed from instructors to managers of learning. However the author is also aware that the students’ learning styles are diverse, and many teachers struggle with the pressure to instruct students on all of the state-mandated standards before testing
near the end of the school year. Therefore, PBL should not be seen as a one-size-fits-all solution to the troubles of American education. Instead it is the author’s hope that PBL will be integrated into education on a broad basis and serve as a cornerstone method of instruction which can be used to create active, involved learning.
APPENDIX

The States of California Unit
# Project Planning Form

<table>
<thead>
<tr>
<th>Name of Project:</th>
<th>The States of California</th>
<th>Duration: 650 Instructional Minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class(es):</td>
<td>Earth Science</td>
<td>Semester: Spring</td>
</tr>
<tr>
<td>Content/Curriculum areas to partner with</td>
<td>Geography and English</td>
<td></td>
</tr>
<tr>
<td><strong>Project Idea</strong> (investigation, scenario, problem, challenge, issue, etc.)</td>
<td>Due to the growing fiscal issues of California, the state is unable to support itself and therefore must be broken up into smaller, more fiscally solvent states. Students are to investigate and propose creation of smaller states with equal resources.</td>
<td></td>
</tr>
<tr>
<td><strong>Entry Event (grabber)</strong> to launch inquiry and spark curiosity</td>
<td>Letter from Governor Jerry Brown requesting assistance</td>
<td></td>
</tr>
<tr>
<td><strong>The Driving Question, Problem or Challenge Statement or Issue</strong></td>
<td>Is the concept of the state of California greater than the sum of its parts?</td>
<td></td>
</tr>
<tr>
<td><strong>Content and Skills Standards addressed:</strong></td>
<td>9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept: a. Students know the resources of major economic importance in California and their relation to California's geology. b. Students know the principal natural hazards in different California regions and the geologic basis of those hazards. c. Students know the importance of water to society, the origins of California's fresh water, and the relationship between supply and need. * Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.</td>
<td></td>
</tr>
<tr>
<td>Partnership for P21 Skills to be taught (T) and practiced (P): Check all that apply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical Thinking/Problem Solving</td>
<td>T</td>
<td>P</td>
</tr>
<tr>
<td>Communication (oral and written)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>ICT Literacy</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Collaboration</td>
<td>X</td>
<td>X</td>
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<tr>
<td>Information Literacy</td>
<td>X</td>
<td>X</td>
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<td>Flexibility and Adaptability</td>
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<td>Initiative and Self-Direction</td>
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<tr>
<td>Social Literacy and Cross/Multi-Cultural Literacy</td>
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<td>X</td>
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<tr>
<td>Productivity and Accountability</td>
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<td>X</td>
</tr>
<tr>
<td>Leadership and Responsibility</td>
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<td>X</td>
</tr>
<tr>
<td>Financial, Economic and Entrepreneurial literacy</td>
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<tr>
<td>Civic Literacy</td>
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</tr>
<tr>
<td>Health Literacy</td>
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<tr>
<th>Presentation Audience</th>
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<tbody>
<tr>
<td>Class Experts Other</td>
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<table>
<thead>
<tr>
<th>Student work</th>
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<table>
<thead>
<tr>
<th>Major group product(s):</th>
<th>Map of California split into smaller equitable states and a written summary of the map.</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Major individual product(s):</th>
<th>Individual report on findings and recommendation for the division of California from the perspective of one of the four project roles (physical geography, natural resources, economy &amp; education, and social diversity)</th>
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<table>
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<tr>
<th>Assessment &amp; Reflection</th>
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<table>
<thead>
<tr>
<th>Rubric(s) I’ll use (check all that apply)</th>
<th>Collaboration</th>
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<th>Content Knowledge</th>
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<tr>
<td>Critical Thinking</td>
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<td>CTE Competencies</td>
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<tr>
<td>Oral Communication</td>
<td>X</td>
<td></td>
<td>Physical Education skills</td>
<td></td>
</tr>
<tr>
<td>Written Communication</td>
<td>X</td>
<td></td>
<td>Physical Education skills</td>
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<tr>
<td>Visual/Performing Arts</td>
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<tr>
<th>Other assessments, benchmarks &amp; checkpoints (check all that apply)</th>
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<table>
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<tr>
<th>Quizzes/tests</th>
<th>X</th>
<th>Practice presentations</th>
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<tr>
<td>Self-evaluations</td>
<td>X</td>
<td>Notes</td>
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<tr>
<td>Peer evaluations</td>
<td>X</td>
<td>Checklists</td>
<td>X</td>
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<tr>
<td>On-line tests/exams</td>
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<td>Concept Maps</td>
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<table>
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<tr>
<th>Reflections</th>
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| Survey | X | Focus group | X |
| Discussion | X | Learning plan | X |
| Journal write/learning log | X |        | X |

<table>
<thead>
<tr>
<th>Resources</th>
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<table>
<thead>
<tr>
<th>On-site personnel:</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical (equipment)</td>
<td>Computers w/ internet access and overhead projector</td>
</tr>
<tr>
<td>Material resources</td>
<td>Included forms (reflection questions, California map, example websites, rubrics, etc.), butcher paper, and California map transparency</td>
</tr>
<tr>
<td>Start Date:</td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
<td>MONDAY</td>
<td></td>
</tr>
<tr>
<td>REVIEW PROJ. &amp; PREP.</td>
<td>PROJECT WEEK ONE</td>
</tr>
<tr>
<td>Reference citation lesson</td>
<td>Reference citation Quiz</td>
</tr>
<tr>
<td>MANDATE</td>
<td>PROJECT WEEK TWO</td>
</tr>
<tr>
<td>Develop individual report</td>
<td>Draw outline of California on butcher paper</td>
</tr>
<tr>
<td>Complete individual report</td>
<td>Complete team map of new California states</td>
</tr>
<tr>
<td>Complete written summary of map</td>
<td>Complete written summary of map</td>
</tr>
<tr>
<td>LAYOFF DAY</td>
<td>PROJECT WEEK THREE</td>
</tr>
<tr>
<td>Complete team reports</td>
<td>Student project evaluations</td>
</tr>
<tr>
<td>Team reports</td>
<td></td>
</tr>
</tbody>
</table>

**Project:** The States of California – California Geology
Lesson 1:  
Project Introduction & Team Development

Basic Information

Subject: Earth Science – California Geology
Grade Level: 9 – 12

Resources:
- Entry event (letter from the Governor)
- Suggested Project Timeline form
- New California Research Paper rubric (see page 4-5 & 4-6)
- New California Team Presentation rubric (see day 5-5 & 5-6)
- Project Focus Questions form
- Team Contract forms

Standards and Key Concepts

Standard:

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards.

Objectives:

1. Students will understand the expectations of the project and their part in it.
2. Students will develop small teams of four students, each taking on a different role of expertise (natural resources, economy & education, physical geography, and social diversity).
3. Students will create a team contract to denote the group expectations for each team member.

Performance Task and Assessment

Key Questions:
- What are the role and responsibilities of each individual student?
- What are the expectations each team has for its members?
- What happens to a team member if he or she does not meet the team’s expectations?
**Procedures:**

- Pass out the entry event (letter from the Governor), along with the Suggested Project Timeline form, rubrics for the final products and Project Focus Questions for each role of expertise. Review the letter and have a class discussion on the purpose and expectations of the project. (15 min.)
- Separate the students into small teams. Have students determine the role each member will assume for the project. Allow time for students to begin discussion on expectations for their team. (10 min.)
- Pass out team contracts. Have teams develop their contracts and complete at least a rough draft before the end of class. (25 min.)
- Teams can create a final draft of the contract as homework

**Assessment (Evaluation):**

Formative assessment of lesson objectives will be completed by teacher during class discussion and while she or he talks with students throughout the class time.

Summative assessment of objectives 1 – 3 will be done when the team contracts are evaluated by the teacher.

**Lesson Adaptations**

**Curriculum Extension:**

The teacher will want to keep a copy of the team contracts for when there are possible disputes later in the project; use such events as teachable moments for how to improve upon the development of team contracts and group dynamics.

Integrating the development of the team contracts into students’ English courses may be an opportunity for cross-curricular learning.

**Differentiated Instruction:**

The teacher is encouraged to ensure teams are made up of students of mixed abilities to provide peer support for struggling students.

Extra time to develop the team contract may be needed depending on the dynamics of the teams or class.
California is currently facing a fiscal crisis that is too severe for the state to rectify. The leading option being discussed right now is to split California into smaller, more manageable states. However, it is the administration’s goal that any division of the state be done so in an equitable manner, where resources are split so that no single state has an advantage over another.

We are contacting you because we have been told that you are the most knowledgeable and published scientist in your field. It is our intent to commission you to put together a team of four scientific experts in the fields of Ecology & Land Management, Geology, Economy & Education, and Sociology. Once you compile your team members, we will need you to submit a copy of your legally binding contract. The contract will offer the state a level of protection if your team is unable to perform its duties.

When you team is assembled, each of you will conduct research into the various characteristics of California. It is highly encouraged that you record your findings during your research, including data patterns throughout the state and the sources of your information. When you are finished with your research, we ask that each individual create a three page (double spaced, 12 point font, Times New Roman) report with his or her recommendations for splitting California into smaller states. Finally, we want your team to present a map showing how to equitably split California into smaller states. This map should include the borders and names for the new states, as well as illustrations of some of the data gathered from each member of the team during his or her research. Accompanying the map should be a one page summary of how your team advises we go about splitting California into smaller states, with an emphasis on your reasoning for your recommendation.

If you have any questions, you can consult our Commissioner on State Separation, (insert name of teacher here); (s)he will be able to help advise you on the needs of the administration.

We expect you to supply us with daily updates to inform us of your projects. The Governor expects your analysis to be finished by (insert due date here), with your presentation to the governor on June (insert due date here). To aid you, included with this letter is a suggested time line for the project and a rubric on how the Commissioner and Governor will judge the merits of your report.
Thank you for your assistance in this matter. The Governor and his administration have every confidence that you will achieve your task and help the state work its way through its current crisis.

Sincerely,

Susan Kennedy
Chief of Staff
Suggested Project Timeline

Day 1
1. Assemble your team
2. Team members choose their role for the project
3. Create a team contract

Day 2
1. Review how to properly reference sources used in your research
2. Complete a quiz demonstrating knowledge of proper referencing procedure

Days 3 – 5
1. From the viewpoint of your role in the project (Ecology & Land Management, Geology, Economy & Education, or Sociology), conduct research and document characteristics of California.
2. Complete each day’s reflection log

Days 6 – 7
1. Write your individual 3 page report on your recommendations for smaller states with equal resources from what is now California.
2. Complete each day’s reflection log

Days 8 – 9
1. Create a team map of the new states, and illustrations of the resources found in California
2. Write a one page summary/explanation of the team map.
3. Complete each day’s reflection log

Day 10
1. Present your finding to the Commissioner and your peers

Day 11
1. Evaluate the performance of you or your team members
Project Focus Questions

There is a lot to what makes California unique. So where should you, in your role of expertise for the project, begin? Below are some questions for each member of your team to try to answer as you start your research.

Natural Resources

Which areas of California get the most precipitation? Which areas of California get the least precipitation? How is water moved to people living in dry regions (i.e. Southern California)?

What is the function of the California Aqueduct? Which areas of California does it run through?

How are natural resources spread throughout California? (Timber, farmland, pastures for livestock, etc.)

How are energy resources spread throughout California? (Wind, geothermal, solar, methane, oil, natural gas)

Geology

What are the various rock and sediment types in California? How does their layout determine the diverse geologic features in the state?

What are the major land forms in California (Mountains, lakes, rivers, valleys, etc.)? How might these contribute to the resources available to the local region?

How does the geology of California impact the size of cities and economic capabilities of the region?

Economy/Education

What are the five biggest industries in California and what regions are they located?

How is the average level of education of the state’s population spread?

Where are institutes of higher education located throughout the state?

How is the average income of the population spread amongst the state?
Sociology

Which parts of California lean Republican? Which parts of California lean Democratic?

What social characteristics define the various parts of California (environmentalists, beach-loving, down-to-earth people of the land, etc.)?

How are sources of entertainment spread throughout California?
Team Contract

We ________________________________ promise to live up to the following responsibilities of our respective positions in the team:

If anyone of us fail to live up to these responsibilities, we understand that discipline for the failure to meet these responsibilities may include:

_______________________________________
PRINT NAME

_______________________________________
SIGNATURE   DATE
Lesson 2: 
Referencing Source Information

Basic Information

Subject: Earth Science – California Geology

Grade Level: 9 – 12

Topic: APA-format reference citation

Resources:

- Referencing Resource Sources
  PowerPoint presentation
- Computer
- Projector
- Screen
- Source Referencing Quiz

Standards and Key Concepts

Standards:

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards.

Objectives:

1. Students will be able to reference a source of information according to APA format.

Performance Task and Assessment

Key Questions:

- What is the purpose of referencing one’s sources used in research?
- What kind of information should be communicated in a reference citation?

Procedures:

- Present the lecture Referencing Resource Sources. Ensure students write down the information given. (25 min.)
- Have students complete the Source Referencing Quiz. Allow students to use their notes that they took during the lecture. (10 min.)
- Have students pass their quiz to a neighboring student and grade them in class. (15 min.)
Assessment (Evaluation):

Formative assessment of the lesson objective will be completed by the teacher during the Referencing Resource Sources lecture through observation and answering student questions.

Summative assessment of the lesson objective will be accomplished through evaluation of the Source Referencing Quiz.

Lesson Adaptations

Curriculum Extension:

The content of this lesson is one that can be further addressed in other classes. The teacher should investigate possible cross-curricular use of reference citation in other classes such as English or social science courses.

Differentiated Instruction:

Allowing students to take notes should assist those with special needs and limited English abilities with performing well on the end-of-lesson quiz.

Students who have IEP or 504 plans may be given a printout of the lecture slides before the presentation.
REFERENCING RESEARCH SOURCES: APA-STYLE
Purpose

**WHY** it is necessary to cite the sources you use to support what you write in your papers?

- **Gives weight to your argument**
  - If other people, with more experience, say the same thing as you, it strengthens your argument.

- **Gives credit to those who put in the work**
  - Some people spend most of their lives coming up with answers to difficult questions. Referencing them honors their hard work.

- **Allows people to validate your information**
  - References allow people to check where you got your information, to make sure you aren’t making it up.
How To Reference

What questions are answered in an APA-style reference?

- **Who** wrote this document?
- **When** was it written?
- **What** was its title?
- **Where** was it published?
- **Who** published it?
Referencing Print Sources

Suppose you use information from a book titled *California: What It’s All About*, by Gerald R. Smith and Thomas T. Ferguson that was published by Worth Publishers of St. Paul, Minnesota in 2001

**General Format**

- Author, A. A. (Year of publication). *Title of work: Capital letter also for subtitle*. Location: Publisher.
Referencing Print Sources

Who wrote it?

- Smith, G. R., & Ferguson, T. T.

When was it written?


What is the title?

  California: What it’s all about.
Referencing Print Material

Where was it published?

Who published it?
Referencing Print Sources

- How many of you plan to get most of your information from books?

- So, how do you reference online sources?
Referencing Online Sources

General Format


☐ Don’t be lazy!!!

☐ Include as much of the above information as possible

☐ Hunt around the web page for the above information
Referencing Online Sources

Stepping Outside the Box
A Short History of Water in Southern California
Speech by Martha Davis
UCLA Environment Symposium
March 3, 1998
Referencing Online Sources

Referencing Other Sources

- There are ways to reference many other types of sources.
- If you use a different source of information during your research, use online resources, such as Perdue OWL, to figure things out.
  - [http://owl.english.purdue.edu/owl/resource/560/01/](http://owl.english.purdue.edu/owl/resource/560/01/)
- Or ask me for help.
Quiz Time

- We’re going to see how much you learned by taking a quiz

- It’s open notes, so use the information you wrote down.
Source Referencing Quiz
(10 points)

Instructions

1. Look at the images below that were taken from a document on one website.
2. Circle the parts of the web page that you need to create a citation.
3. Then write the citation at the bottom of the page as it would appear in the reference section of your paper.

CALIFORNIA GEOLOGICAL SURVEY
GENERALIZED GEOLOGIC MAP OF CALIFORNIA

Geologic maps show the distribution of rocks exposed at the surface of the earth as well as other geologic information. Rocks are grouped according to age and origin on the map. Age of the rocks is considered to be the geologic time at which the rock formed (see Geologic Time Scale on back page). Rocks are classified according to their origin:

- Mesozoic sedimentary rocks. Sandstone and shale that were deposited mostly in the ocean. The rocks make up the bulk of the Coast Ranges. They also occur in coastal southern California.
- Mesozoic granite rocks. A wide variety of coarse-grained igneous rocks formed when magma that intruded the earth’s crust cooled and was later exposed by erosion. Granite rocks occur throughout the state, but are most common in the mountainous areas such as the Klamath Mountains, the Sierra Nevada, and the Cascades.

Source Referencing Quiz (Key)
(10 points)

Instructions
1. Look at the images below that were taken from a document on one website.
2. Circle the parts of the web page that you need to create a citation.
3. Then write the citation at the bottom of the page as it would appear in the reference section of your paper.


1 point for each correctly placed circle

- 6 points for a perfectly correct reference citation.
- 4 points for citations with minor errors
- 2 points for citations with major errors or are incomplete
Lesson 3:
Student Research

Basic Information

Subject: Earth Science – California Geology
Grade Level: 9 – 12

Resources:

- Computers with internet access
- Project Focus Questions form
- California Map handout, Online Resources form
- Day 3 Project Reflection Slip
- Day 4 Project Reflection Slip
- Day 5 Project Reflection Slip

Standards and Key Concepts

Standards:

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:
   a. Students know the resources of major economic importance in California and their relation to California's geology.
   b. Students know the principal natural hazards in different California regions and the geologic basis of those hazards.
   c. Students know the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.
   * Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.

Objectives:

1. Students will conduct research, centered on their project role of expertise, and collect data to assist them in answering the project’s driving question.
2. Students will develop research methods that will assist them throughout their academic careers.
3. Students will collaborate with others to improve their research methods and communication skills.
Performance Task and Assessment

Key Questions:

- What data about California is important enough to use in for your project paper?
- What is the best way to record the information that you find?
- How can you use the skills gained during this process in other classes and situations?

Procedures:

Day 1

- Pass out Project Focus Questions forms (see page 1-5), California Map handouts, and Online Resources forms to students.
- Working in a computer lab, or in class with mobile computer resources (such as a computer on wheels system), students begin conducting online research, looking for data that will assist them in determining how to equitably split California into smaller states based on their project role of expertise.
  - The teacher may consider having students with similar project roles pair up to conduct research in order to facilitate one-on-one peer assistance. This will allow students to learn different research methods from others as well as prevent misconceptions that may develop.
- Roam the classroom to ensure students remain on task and address problems or misconceptions students may have by asking leading questions.
- Approximately 10 minutes before class is over, pass out Day 3 Project Reflection Slip to students and collect them as students exit.

Day 2

- Have students continue with their online research as the day before.
- Pass out California Map handouts to students as needed.
- Roam the classroom to ensure students remain on task and address problems or misconceptions students may have by asking leading questions.
- Approximately 10 minutes before class is over, pass out Day 4 Project Reflection Slip to students and collect them as students exit.
Day 3

- Have students finalize their online research. Encourage students to compare data they collected with other students with the same project roles to facilitate peer collaboration and ensure individual students have the resources they need to create their individual project report.
- Pass out California Map handouts to students as needed.
- Roam the classroom to ensure students remain on task and address problems or misconceptions students may have by asking leading questions.
- Approximately 10 minutes before class is over, pass out Day 5 Project Reflection Slip to students and collect them as students exit.

Assessment (Evaluation):

Formative assessment of lesson objectives will be completed by the teacher as she or he talks with students while roaming the classroom. Assessment of objective 1 will be completed as the teacher evaluates the notes students take on the California Map handouts. Objectives 2 and 3 will be completed throughout the lesson as the teacher evaluates the responses on the Project Reflection Slips.

Summative assessment of objective 1 will be completed when the individual reports students create during the following lesson are evaluated.

Lesson Adaptations

Curriculum Extension:

Teachers responsible for computer and technology instruction can be consulted about the objectives for this project, and cross-curricular lessons can be developed to further promote success as students conduct their research.

Differentiated Instruction:

The teacher is encouraged to pair students of mixed abilities to provide peer support for struggling students.

Students may need extra time to conduct research depending on the dynamics of the teams or class.
Online Resources

Geologist
http://nbsp.sonoma.edu/resources/teachers_materials/earth_03/CAlandforms_files/v3_document.htm
http://vulcan.wr.usgs.gov/Volcanoes/WesternUSA/Maps/map_west_coast_volcanoes.html
http://www.humboldt.edu/cga/sites/cga/themes/cga/calatlas/atlas.html

Ecology & Land Management
http://ceres.ca.gov/natural_resources/
http://www.monolake.org/mlc/outsidebox
http://www.energyatlas.org/PDFs/LowRes/atlas_state_CA.pdf
http://www.water.ca.gov/swp/
http://www.humboldt.edu/cga/sites/cga/themes/cga/calatlas/atlas.html

Economy & Education
http://www.city-data.com/states/California.html
http://www.californiacolleges.edu/

Sociology
http://www.city-data.com/states/California.html
http://www.humboldt.edu/cga/california-student-atlas/
http://library.humboldt.edu/~rls/geospatial/calmaps.htm
http://www.humboldt.edu/cga/sites/cga/themes/cga/calatlas/atlas.html
Write down notes and record your research sources on the back of this map

3 – 5
Example Data

Annual Precipitation
Example Data

California Aqueduct
Project Reflection Slip – Day 3

What information were you able to research today?

What was the most challenging part of your research today? (List any problems you are facing)

Write one question you still have about your project
Name ___________________________________

Project Reflection Slip – Day 4

How did you improve your research technique?

What information are you going to focus on for your paper?

Write one concern you have about your team members.

Name ___________________________________

Project Reflection Slip – Day 4

How did you improve your research technique?

What information are you going to focus on for your paper?

Write one concern you have about your team members.
Name ___________________________________  

Project Reflection Slip – Day 5

From your research, what patterns have you noticed in California?

Relying on your research, where do you think California should be separated?

How did you improve your researching skills since you started 2 days ago?

Name ___________________________________  

Project Reflection Slip – Day 5

From your research, what patterns have you noticed in California?

Relying on your research, where do you think California should be separated?

How did you improve your researching skills since you started 2 days ago?

3 – 10
Lesson 4:
Individual Research Paper

Basic Information

Subject: Earth Science – California Geology
Grade Level: 9 – 12

Resources:
- Computer access
- Printer access
- New California Research Paper Outline form
- New California Research Paper rubric

Standards and Key Concepts

Standards:
9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:
   a. Students know the resources of major economic importance in California and their relation to California's geology.
   b. Students know the principal natural hazards in different California regions and the geologic basis of those hazards.
   c. Students know the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.
   * Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.

Objectives:
1. Students will write a paper that synthesizes their research and answers the question: “How should California be split into smaller states in a manner where resources are shared equally?”
Performance Task and Assessment

Key Questions:

• How can the data that was collected during research be used to determine how to divide California into small, equal states?

• After California is split into smaller states, do any of them retain the spirit of California? Or are the new states complete new entities in and of themselves?

Procedures:

Day 1

• Pass out the New California Research Paper Outline handout as well as the New California Research Paper rubric to students who need another copy. Read the outline as a class and explain the expectations of the paper. Conduct a class discussion on the paper and answer student questions. (25 min.)

• Have students start writing their paper. Roam the classroom checking on the progress of students individually and keep students on task by asking leading questions. (20 min.)

• Approximately 10 minutes before class is over, remind students to save their work, preferably on their personal flash drive. Also, pass out Day 6 Project Reflection Slip to students and collect them as students exit. (10 min.)

• Encourage students to work on their paper as homework to make sure they finish by the end of tomorrow.

Day 2

• Remind students they should be finished with their report by the end of today. If individuals are unable to finish in class, they should finish the paper outside of class – either at home or through afterschool resources. Have students start writing their paper. Roam the classroom, checking on the progress of students individually, and keep students on task by asking leading questions. (40 min.)

  o Students who finish early can start on the next lesson by drawing an outline of California on a piece of butcher paper for their team.

• Approximately 10 minutes before class is over, remind students to print out their finished product and save their work, preferably on their personal flash drive. Also, pass out Day 7 Project Reflection Slip to students and collect them as students exit. (10 min.)
Assessment (Evaluation):

Formative assessment of the lesson objective will be completed by the teacher as he or she walks the classroom, talks with students, reads what they’ve written, and answers questions students may have.

Summative assessment of the lesson objective will be completed when the teacher evaluates and grades each student’s final report.

Lesson Adaptations

Curriculum Extension:

Since the writing aspect of this particular lesson is extensive, the teacher should consider collaborating with the students’ English classes to integrate the lesson as part of the English instruction.

Some social science courses, such as Geography, may be interested in the project’s purpose and driving question. Social science teachers should be encouraged to integrate students’ work into class instruction.

Differentiated Instruction:

Depending on the individual challenges of students, using IEP and 504 plans as a reference, teachers may consider allowing struggling students to pair with one another and submit a joint report.

Students may need extra time to develop and write the report depending on the dynamics of the students or class.
New California Research Paper Outline

You’ve done your research and collected a bunch of data. But now you might be struggling with how you can transfer all that into a research paper. Below is a general outline that might help you get started.

Remember, when all is done, this is your paper and your opportunity to make your opinion known. From the viewpoint of your role in the project (Ecology & Land Management, Geology, Economy & Education, and Sociology) the outcome of your paper is to answer the question: “How should California be split into smaller states in a manner where resources are shared equally?” Use your research to help you make your decision and support your conclusion.

I. Introduction (¼ - ½ page)
   • This is where you introduce your paper. Explain the problem, your role, and why you are writing this paper.

II. Research (1 – 1 ½ pages)
   • Explain your research to the reader. What topics and information did you focus on? What where your findings? Why are they important? How do they pertain to the project’s driving question?

III. Your Solution (½ - 1 page)
   • Using the data from your research as your foundation, explain how you decided to split California into smaller states. Make sure you also explain how no one state is better off than another; explain how you ensured equality in your decision.

IV. Conclusion (¼ page)
   • Wrap up your paper. Restate the problem you faced, but focus on your solution and why you think it works. End your paper with a sentence or two about hopes or thoughts on the future.

Paper Parameters: 12 point font, Time New Roman, double spaced
### New California Research Paper
(130 Points)

<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>ADVANCED</th>
<th>PROFICIENT</th>
<th>UNSATISFACTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
<td>• Problem is stated and elaborated on with clarifying detail</td>
<td>• Problem is stated and elaborated on with little detail</td>
<td>• Problem is stated but not elaborated on.</td>
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<td></td>
<td>• Purpose of paper (solution to problem) is written in a detailed manner</td>
<td>• Purpose of paper (solution to problem) is written somewhat awkwardly</td>
<td>• Purpose of paper (solution to problem) is written but with little else added.</td>
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<td>• Author’s role and/or reason in writing the paper is stated clearly.</td>
<td>• Author’s role and/or reason in writing the paper is stated.</td>
<td>• Author’s role and/or reason in writing the paper is not stated.</td>
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<tr>
<td>10 --------- 9 --------------- 8</td>
<td>7 -------------- 6 -------------- 5</td>
<td>4 ------------ 2 -------------- 0</td>
<td></td>
</tr>
<tr>
<td><strong>Research</strong></td>
<td>• Several topics are addressed in the research section.</td>
<td>• Several topics are addressed in the research section.</td>
<td>• One topic is addressed in the research section.</td>
</tr>
<tr>
<td></td>
<td>• Information/data for each topic is given and explained in detail (What does the data tell us? What does it mean?)</td>
<td>• Information/data for each topic is given and explained with little detail (What does the data tell us? What does it mean?)</td>
<td>• Information/data for each topic is given but not explained (What does the data tell us? What does it mean?)</td>
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<td>• The importance of each topic (why it is needed) as it pertains to splitting California is clearly stated and is reasonable.</td>
<td>The importance of each topic (why it is needed) as it pertains to splitting California is stated but reasoning is problematic.</td>
<td>The importance of each topic (why it is needed) as it pertains to splitting California is poorly stated or not included in the section.</td>
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<tr>
<td>20 --------- 18 --------------- 16</td>
<td>14 ------------ 12 --------------- 10</td>
<td>8 ------------ 4 --------------- 0</td>
<td></td>
</tr>
<tr>
<td><strong>Expert Opinion / Solution</strong></td>
<td>• Reasoning for the author’s division of California is clearly given and expanded. (How and why)</td>
<td>• Reasoning for the author’s division of California is stated but little information is given on why it was done. (How and why)</td>
<td>• Author states how California is divided, but does not explain their decision making.</td>
</tr>
<tr>
<td></td>
<td>• Author explains how he/she attempted to ensure equality amongst the new states.</td>
<td>• Author poorly explains how he/she attempted to ensure equality amongst the new states.</td>
<td>• Author fails to explain how he/she attempted to ensure equality amongst the new states.</td>
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<tr>
<td>20 --------- 18 --------------- 16</td>
<td>14 ------------ 12 --------------- 10</td>
<td>8 ------------ 4 --------------- 0</td>
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<tr>
<td>Criterial</td>
<td>Advanced (Demonstrates Superior Performance)</td>
<td>Proficient (Minimal Criteria)</td>
<td>Unsatisfactory (Below Performance Standards)</td>
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<tr>
<td>Conclusion</td>
<td>Problem and solution are restated in a detailed, yet succinct manner.</td>
<td>Problem and solution are restated in, yet in an awkward manner.</td>
<td>Problem and solution are restated poorly.</td>
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<td>Author's thoughts are summarized clearly.</td>
<td>Author's thoughts are summarized.</td>
<td>Author's thoughts are not summarized.</td>
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<td></td>
<td>Goals and/or hopes for the success of the problem and its solution are given.</td>
<td>Goals and/or hopes for the success of the problem and its solution are given.</td>
<td>Goals and/or hopes for the success of the problem and its solution are not given.</td>
</tr>
<tr>
<td>Written Communication</td>
<td>Paper is virtually free of grammar, punctuation, and spelling errors.</td>
<td>Occasional errors in grammar, punctuation, spelling, and word choice.</td>
<td>Many errors in grammar, punctuation, spelling, and word choice.</td>
</tr>
<tr>
<td></td>
<td>Correct word choice.</td>
<td>Vocabulary is varied and sophisticated.</td>
<td>Vocabulary is repetitive.</td>
</tr>
<tr>
<td></td>
<td>Vocabulary is varied and sophisticated.</td>
<td>Errors do not cause confusion.</td>
<td>Errors cause confusion for reader.</td>
</tr>
<tr>
<td>References</td>
<td>Paper includes a variety of sources (electronic &amp; print) for data.</td>
<td>Paper mainly references a single source (electronic &amp; print) for data.</td>
<td>Paper references a single source (electronic &amp; print) for data.</td>
</tr>
<tr>
<td></td>
<td>There are more than 4 referenced sources for the paper's research.</td>
<td>There are 3-4 referenced sources for the paper's research.</td>
<td>There are less than 3 referenced sources for the paper's research.</td>
</tr>
<tr>
<td></td>
<td>References are written, without error, in APA-format.</td>
<td>References are written, with minimal errors, in APA-format.</td>
<td>References are written, with many errors, in APA-format, or not recorded at all.</td>
</tr>
<tr>
<td>Mechanics</td>
<td>Report is approximately 3 or more pages long.</td>
<td>Report is approximately 2 pages long.</td>
<td>Report is approximately less than 2 pages long.</td>
</tr>
</tbody>
</table>
Name ___________________________________

Project Reflection Slip – Day 6

What specific topics (or data patterns) did you decide to address in your 3 page report?

How are you advising that California should be split up?

What is the most difficult part of writing your report?

Name ___________________________________

Project Reflection Slip – Day 6

What specific topics (patterns) did you decide to address in your 3 page report?

How are you advising that California should be split up?

What is the most difficult part of writing your report?
What do you think the new states that you created will be like? Are they places you would want to visit on vacation?

How well do you think your team will do integrating each member’s ideas into a final collaborative team solution? What do you think some of the challenges may be?
Lesson 5:
Team Map

Basic Information

Subject: Earth Science – California Geology
Grade Level: 9 – 12

Resources:
- New California Team Presentation rubric
- 24” x 36” butcher paper
- Overhead projector
- California Map transparency
- Assorted colored marker and pencils
- Computer access
- Printer access
- Day 8 Reflection Slip form
- Day 9 Reflection Slip form

Standards and Key Concepts

Standards:

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:
   a. Students know the resources of major economic importance in California and their relation to California's geology.
   b. Students know the principal natural hazards in different California regions and the geologic basis of those hazards.
   c. Students know the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.
   * Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.
Objectives:

1. Students will collaborate with team members to create a map depicting a compromise on how best to split California into smaller, equal states.
2. Students will illustrate data sets they discovered during the research process.
3. Teams will write a 1 page summary explaining the map they created.

Performance Task and Assessment

Key Questions:

• How do teams determine the importance of each member’s data to create a final product that integrates the work of each member, but also creates smaller equal states?
• Which data sets are important enough to include on the final team map?

Procedures:

Day 1

• Pass out the New California Team Presentation rubric and review it as a class. Lead a class discussion regarding the expectations of the team map and summary as well as the team presentation following it. Answer student questions. (20 min.)
  o Spend time during class discussion emphasizing team work and the delegation of tasks to individual team members. All team members need to be included in the decision of separating California into smaller but equal states. However, once a consensus has been made, the role of drawing and coloring the map as well as the writing of the summary report can be divided among the team members.
• Have teams start on the following tasks: 1) develop a team compromise of how California should be split into smaller equal states, and come up with new state’s names, 2) determine which data sets should be illustrated on the team map, and 3) draw an outline of the state of California on butcher paper. (20 min.)
  o The team map is made by projecting a transparency of the California Map onto the butcher paper (which is taped to the wall) with an overhead projector. Students then trace the outline onto the butcher paper with pencil.
If teams complete the above tasks, they can begin with 4) illustrate the team map, and 5) write the team report.

- Approximately 10 minutes before class is over, pass out Day 8 Project Reflection Slip to students and collect them as students exit. (10 min.)
- Encourage students to work on their project as homework to make sure they finish by the end of tomorrow.

**Day 2**

- Have teams finish illustrating the team map and writing the team report. (40 min.)
- Approximately 10 minutes before class is over, remind students to print out their finished product and save their work, preferably on their personal flash drive. Also, pass out Day 9 Project Reflection Slip to students and collect them as students exit. (10 min.)

**Assessment (Evaluation):**

Formative assessment of the lesson objective will be completed by the teacher as he or she walks the classroom, talks with students, evaluates their progress, asks leading questions, and answers student questions.

Summative assessment of the lesson objective will be accomplished when the teacher evaluates and grades the team’s final product during the team presentation to the class.

**Lesson Adaptations**

**Curriculum Extension:**

Some social science courses, such as Geography, may be interested in the project’s purpose and driving question. Social science teachers should be encouraged to integrate students’ work into class instruction.

**Differentiated Instruction:**

The teacher is encouraged to ensure teams are made up of students of mixed abilities to provide peer support for struggling students.

Students may need extra time to develop and write the report depending on the dynamics of the students or class.
# New California Team Presentation
(55 Points)

| STUDENTS: ___________________________ |
| EVALUATOR: _______________ DATE: _____ |

<table>
<thead>
<tr>
<th>CriteriA</th>
<th>Advanced (Demonstrates Superior Performance)</th>
<th>Proficient (Minimal Criteria)</th>
<th>Unsatisfactory (Below Performance Standards)</th>
</tr>
</thead>
</table>
| Delivery                     | • Students use a clear voice and correct, precise pronunciation of terms.  
                                  • All students speak during presentation  
                                  • Student(s) speak from memory and make only passing reference to notes or cards.  
                                  • Class has difficulty hearing students speak  
                                  • Several of the team members speak during presentation  
                                  • Student(s) possess notes but do not read from them.  
                                  • Students mumble and incorrectly pronounce words.  
                                  • Class has difficulty hearing students speak  
                                  • Only 1 – 2 students speak during presentation  
                                  • Student(s) reads from notes.                |
| 10  -  9  -  8               | 7  -  6  -  5                              | 4  -  2  -  0                  |
| Content Knowledge            | • Students demonstrate full knowledge (more than is required)  
                                  • Students display willingness and ability to move away from their script/plan and modify presentation based on audience response  
                                  • Students answer questions with detailed explanations.  
                                  • Students are knowledgeable and at ease with content.  
                                  • Students make minor modifications to their presentation based on questions, concerns or comments from audience.  
                                  • Students answer questions but fail to elaborate.  
                                  • Students are uncomfortable with information and appear awkward.  
                                  • Students do not adapt their presentation based on questions, concerns or comments from audience.  
                                  • Students are able to only answer rudimentary questions. |
| 10  -  9  -  8               | 7  -  6  -  5                              | 4  -  2  -  0                  |
| Visual Aid                   | • Map contains detailed information from all four members of the team  
                                  • Borders are clearly defined and names for new states are given.  
                                  • Legend / Key that decodes all symbols used on the map is present  
                                  • Map contains detailed information from most of the members of the team  
                                  • Borders are clearly defined but lack names for new states.  
                                  • Legend / Key that decodes most symbols used on the map is present  
                                  • Map contains detailed information from only 1 – 2 members of the team  
                                  • Borders are not well defined and names for new states are not given.  
                                  • Legend / Key is absent from the map                  |
<p>| 20  -  18  -  16             | 14  -  12  -  10                           | 8  -  4  -  0                  |</p>
<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>ADVANCED (Demonstrates Superior Performance)</th>
<th>PROFICIENT (Minimal Criteria)</th>
<th>UNSATISFACTORY (Below Performance Standards)</th>
</tr>
</thead>
</table>
| Team Report | • Report includes a detailed summary of the finding of each team member  
• Team explains the reasoning of why they created the new borders that they did. | • Report includes a detailed summary of the finding of most of the team members.  
• Team explains how they separated California with little detail as to why they chose the borders as they did. | • Report includes summaries of the finding of only 1–2 team members.  
• Team explains how they separated California, with no detail as to why they chose to do so. |
|          | 15 - - - - - - - 14 - - - - - - 13 | 12 - - - - - - - 10 - - - - - - 8 | 6 - - - - - - 3 - - - - - - 0 |
Between the individual team members, what were the differences in the new, smaller states that were created?

Was there any one member of the group that whose research you relied on the most to develop your team map?

What data have you decided to illustrate on your team map?
Name ______________________________

**Project Reflection Slip – Day 9**

Describe the new states that your team came up with?

How did you determine that the states are on equal footing when it comes to access to resources?

Is there any one member of the team that you feel was more crucial to the success of the team?

Name ______________________________

**Project Reflection Slip – Day 9**

Describe the new states that your team came up with?

How did you determine that the states are on equal footing when it comes to access to resources?

Is there any one member of the team that you feel was more crucial to the success of the team?

5 – 8
Lesson 6: Team Presentations

Basic Information

Subject: Earth Science – California Geology

Grade Level: 9 – 12

Resources:
- New California Team Presentation rubric (see page 5-5 & 5-6)

Standards and Key Concepts

Standards:

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:

   a. Students know the resources of major economic importance in California and their relation to California's geology.

   b. Students know the principal natural hazards in different California regions and the geologic basis of those hazards.

   c. Students know the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.

   * Students know how to analyze published geologic hazard maps of California and know how to use the map's information to identify evidence of geologic events of the past and predict geologic changes in the future.

Objectives:

1. Students will present their team’s map and explain how their final solution addresses the project’s driving question.

2. Students will practice their public speaking abilities.

3. Students will critique the performance of other teams.

Performance Task and Assessment

Key Questions:

- Is there one right answer for the project’s driving question?

- How is the contribution of each student evident in the team’s presentation?
Procedures:

- Spend time discussing the expectations for the team presentations. Review with the class the New California Team Presentation rubric, focusing on what teams can do to get the best score possible. (10 min.)

- Have teams take turns presenting their findings to the class. As each team finishes, give the observing teams time to fill out the New California Team Presentation rubric to evaluate the presenting team’s performance.

Assessment (Evaluation):

Summative assessment of lesson objectives 1 and 2 will be accomplished when the teacher evaluates and grades the team’s performance using the New California Team Presentation rubric.

Assessment of objective 3 will be done as teams complete the New California Team Presentation rubric.

Lesson Adaptations

Curriculum Extension:

Teachers can invite the school’s media class to come and film the team presentations. The yearbook or photography class can also take part to record the presentations as well.

Differentiated Instruction:

The teacher is encouraged to ensure teams are made up of students of mixed abilities to provide peer support for struggling students.
Lesson 7:  
Student Evaluations

Basic Information

Subject: Earth Science – California Geology  
Grade Level: 9 – 12

Resources:
• Peer Collaboration and Teamwork rubric  
• Team Leadership Evaluation form  
• Project Debrief form

Standards and Key Concepts

Standards:
9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards.

Objectives:
1. Students will evaluate the contribution of themselves and those of their team members.  
2. Students will assess which student served as the main leader for the team.

Performance Task and Assessment

Key Questions:
• What dynamic within the team lead to its overall success or challenges?  
• What can students do next time to improve upon their teamwork?

Procedures:
• Spend time discussing the purpose and expectations of the evaluation forms. Answer questions as necessary. (10 min.)  
• Have individual students complete the Peer Collaboration and Teamwork rubric and Project Debrief form. (15 min.)
• Have teams deliberate and choose a member to receive the leadership bonus points. (15 min.)

Assessment (Evaluation):

Summative assessment of objective 1 will be completed when individual students complete the Peer Collaboration and Teamwork rubric and Project Debrief form.

Assessment of objective 2 will be completed when teams complete the Team Leadership Evaluation form.
<table>
<thead>
<tr>
<th>CRITERIA</th>
<th>ADVANCED</th>
<th>PROFICIENT</th>
<th>UNSATISFACTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEADERSHIP AND INITIATIVE</td>
<td>In addition to the “Acceptable” qualities, the team member provided leadership to the team by thoughtfully organizing and dividing the work, checking on progress, or providing focus and direction for the project.</td>
<td>Team member played an active role in generating new ideas, took initiative in getting tasks organized and completed and sought help when needed.</td>
<td>Team member played a passive role, generating few new ideas; tended to only do what they were told to do by others, or did not seek help when needed.</td>
</tr>
<tr>
<td></td>
<td>10 ----------------------- 9</td>
<td>8 ----------------------- 6 ----------------------- 4</td>
<td>3 ----------------------- 2 ----------------------- 1 ----------------------- 0</td>
</tr>
<tr>
<td>FACILITATION AND SUPPORT</td>
<td>In addition to the “Acceptable” qualities, the team member actively checked with others to understand how each member was progressing and how he or she may be of help.</td>
<td>Team member demonstrated willingness to help other team members when asked, actively listened to the ideas of others, and helped create a positive work environment.</td>
<td>Team member seemed unable or unwilling to help others, made non-constructive criticisms toward the project or other team members or was distracted by other members.</td>
</tr>
<tr>
<td></td>
<td>10 ----------------------- 9</td>
<td>8 ----------------------- 6 ----------------------- 4</td>
<td>3 ----------------------- 2 ----------------------- 1 ----------------------- 0</td>
</tr>
<tr>
<td>CONTRIBUTIONS AND WORK ETHIC</td>
<td>In addition to the “Acceptable” qualities, the team member made up for work left undone by other team members, and demonstrated willingness to spend significant time outside of class/school to complete the project.</td>
<td>Team member was prepared to work each day, met due dates by completing assignments/duties, and worked hard on the project most of the time. If absent, other team members knew the reason and progress was not significantly impeded.</td>
<td>Team member was often off task, did not complete assignments or duties, or had attendance problems that significantly impeded progress on project. May have worked hard, but on relatively unimportant parts of the project.</td>
</tr>
<tr>
<td></td>
<td>20 ----------------------- 18 ----------------------- 16</td>
<td>14 ----------------------- 12 ----------------------- 10 ----------------------- 8</td>
<td>6 ----------------------- 4 ----------------------- 2 ----------------------- 0</td>
</tr>
</tbody>
</table>

PROJECT INFORMATION

PROJECT NAME: The States of California

COURSE: Earth Science

EVALUATOR: __________________________

DATE: / / 

ADDITIONAL COMMENTS:
TEAM LEADERSHIP EVALUATION

Who among your team was instrumental to its success? Now is your team’s opportunity to recognize that individual.

The leadership bonus will go to the one person on your team who made sure everyone in your team was on task and contributing. Without the influence of this person, your team would not have been able to do as well as it did.

Only one person can be awarded the leadership bonus; the points cannot be split. Furthermore, your nomination has to be unanimous. If all of you cannot come to a consensus of who deserves the points, then no one will receive them.

Members of your team:

Name of project: The States of California

Leadership bonus (maximum of 20 points for 1 person) goes to:

Why?

Breaking a Tie

Note: If your team is at an impasse and can’t decide how to divvy up the points, use the following voting system. On a separate piece of paper, have each member of the team list the members of your team and each of you vote, giving your top candidate five points, your second choice four points, your third choice three points, and so on. The person with the most points wins.

Example:

Leadership bonus

<table>
<thead>
<tr>
<th>Person</th>
<th>Points (assign points from 5 to 1, with 5 being your top candidate)</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>
**Project Debrief**

Spend a few minutes to analyze your performance on team and individual tasks.

<table>
<thead>
<tr>
<th>Name:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Name:</strong></td>
<td>The States of California</td>
</tr>
<tr>
<td><strong>What is the most important thing you learned during this project?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>What do you wish the class had spent more time on?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>What do you wish the class had spent less time on?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Where there any assignments (or parts of assignments) you didn’t understand? Provide details.</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Was there a part of the project you didn’t enjoy? Why?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Which part of the project should be dropped? Why?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>What could be added to make this a better project?</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Was there any part of the project that was graded unfairly or worth too few or too many points? Explain.</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note: You will receive full points for completing this assignment in a thoughtful manner. Points will be given for both critical and positive comments ONLY when they are supported by details/specifies.
REFERENCES


