Auditing Higher Order and Creative Thinking Skills in Teacher Created Instructional Units for Elementary Gifted and Talented Students: An Action Research Study

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Auditing Higher Order and Creative Thinking Skills in Teacher Created Instructional Units for Elementary Gifted and Talented Students: An Action Research Study

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Plan B Project

Submitted in partial fulfillment of the requirements for the degree of Master’s in Science in Natural Science/Mathematics in the Science and Mathematics Teaching Center of the University of Wyoming, 2017

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Master’s Committee:

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Abstract

The action research project focused on formative assessment in the context of an elementary education gifted and talented program. The project took place over the course of ten months in a mid-sized district in northeastern Wyoming and included a review of literature as well as the development and field test of an original teacher self-assessment tool. The review of literature identified and confirmed features of higher order thinking and creativity that reflected best practices in the field. Higher order thinking and creativity features were then displayed in an original auditing matrix, the assessment tool. The matrix guides a curriculum reviewer to look for elements of higher order thinking skills, creative thinking skills, and assessment in elementary gifted and talented curriculum. Using the matrix, three units of study representing the third, fourth, and fifth grades, were examined. Strengths and weaknesses of the units were discerned, even as the matrix was field-tested and refined. The matrix provides a formative assessment tool for a teacher, a team of teachers, or an external observer to examine evidence of best practices in elementary gifted and talented curricular materials.
How Do We Know Gifted and Talented Education Works?

I looked blankly at my curriculum director. I had no answer for his very simple question. “How do we know gifted and talented education works?” It was more than a question. It was a challenge. His challenge was to state and evaluate the purpose of the district’s gifted and talented program and to explain measures the district program used to determine if the purpose was being achieved. His question encouraged me to examine my practices and find ways to strengthen the assessments I use to understand how my teaching affects students. As an elementary teacher licensed in Wyoming and certified to teach gifted and talented students, I realized to improve my teaching practice, I must strengthen my understanding of ways to evaluate student learning.

Implementation of quality instruction across the district is another concern I had as a teacher of gifted and talented learners and as the current district gifted and talented Education (GATE) facilitator. The curriculum director had suggested that we, the GATE teachers, design an evaluation process to sort through ideas for units and activities that individual teachers wanted to submit as resources for other GATE teachers. Two facets of the GATE curriculum I wanted to better understand included higher order thinking skills and creative thinking skills. These concerns and questions led me on a journey, through this master’s study, to improve the instruction elementary GATE students receive.

Background

I earned my bachelor of science in education degree and taught in a seventh grade classroom for a partial year. That position included the responsibility to teach gifted and talented students as an extra duty position after school hours. After the school year ended, I moved to
another district where I substitute taught for classroom teachers at the elementary level. One of these substitute jobs was for a GATE teacher on maternity leave, which led to fifteen years in my current position. During this time, I joined a cohort of gifted and talented educators to complete a gifted and talented endorsement program that consisted of twelve graduate-level credit hours. The program included coursework in foundational theories of gifted education. Additional requirements included book studies, conference attendance, curriculum development, and practicum hours.

I have served as the gifted and talented education facilitator for the district for the past five years. One responsibility of the GATE facilitator is to act as a liaison between district administrators and the GATE teachers. Other duties include requesting professional development opportunities and purchasing and organizing resources for the GATE program. My work to date, including more and more district and building level leadership for the GATE program, underscores the importance of this master’s study. I believe it will benefit my district colleagues as well.

**Statement of Purpose**

The purpose of this project was to create an auditing matrix to examine three thematic units developed for the district’s third, fourth, and fifth grade GATE students. The matrix allows teachers to identify evidence of higher order thinking skills and creative thinking skills within units and to consider the types of assessment used.

The format of the pullout gifted and talented classes lends itself to the use of integrated thematic units as an instruction method. To complete these rigorous academic project units, students apply many basic skills across multiple subjects from the classroom. Based on the literature, I created an auditing matrix to examine three units. The elements in the matrix are
thinking skills that the gifted and talented literature identifies as essential to best practice, including higher order thinking skills and creative thinking skills. The matrix was used to audit several types of assessment including specific opportunities for students to self-reflect in oral and written formats. Two categories on the matrix distinguish between the roles of students and teachers. The project will be of interest to other gifted and talented educators as a tool to audit units they are using or plan to use in their classrooms.

**Significance**

Based on the work described above, the project included an examination of teacher created units to identify opportunities designed in the unit for students to use higher order thinking skills, think creatively, and to participate in the assessment process. The results will be suitable for sharing with the district’s curriculum director. This work may also be of interest to other practitioners, certainly my district colleagues. Venues in which I hope to share the auditing process are Wyoming’s bi-annual AdvancED school improvement conference and with the regional gifted and talented education association to which I belong.

**Summary**

The purpose of the project was to examine three units of study, designed by teachers, for third, fourth, and fifth grade students in the district GATE program. I conducted an audit of three units, anticipating that I would uncover strengths and weaknesses impacting student learning for each unit and examine the usefulness of the matrix. A focused literature review helped me better understand the concepts of higher order thinking, creativity, and assessment. The project enabled me to improve my practice. In addition, I learned more about assessing student learning in a gifted and talented context.
Chapter 2

Literature Review

Selected literature included theories and studies pertaining to developing higher order thinking skills and creative thinking skills. Articles focused on best practice in assessment of elementary gifted and talented students were included as well. The review of literature begins with an overview of the definition of gifted and talented as it relates to elementary education. The next section uses the literature to define the terms, higher order thinking and creative thinking skills. Higher order thinking theory includes the terms application, evaluation, elaboration, and synthesis. Creativity theory terms include the thinking skills of fluency, flexibility, originality, and elaboration. The final section of the review of literature concerns assessment of student learning. This section includes definitions of peer assessment, student self-assessment, and formative assessment.

Source Inclusion Criteria

Sources for this study were gathered through searches in the University of Wyoming virtual library. Keyword searches included gifted assessment, higher order thinking, creativity, author searches, and other specific topics. The university library database search parameters included academic journal articles, peer reviewed material, and articles published since 2007 with an emphasis on articles pertaining to empirical studies. Since the terms chosen as a focus for this project currently in use had their origins in literature from the 1950s, some of the sources were published prior to 2007. Overall, the goal was to examine current, high quality, research-based sources.

One challenge encountered when using the term assessment in connection with the term gifted is that assessment and identification are often used synonymously. Titles and abstracts
were reviewed to limit articles to those pertaining to assessing the learning of gifted students rather than assessment for the purpose of identification and eligibility to receive specialized services.

**Defining Gifted and Talented**

Gifted is a provocative term. It seems to have different meanings for different people. It has many definitions as some definitions pertain to school districts and, in some cases, even individual school buildings. In addition, there are also varied definitions across states. Often these definitions are tied to legislation and funding for gifted programs. The National Association for Gifted Children produced a position statement entitled Redefining Giftedness for a New Century: Shifting the Paradigm that the board of directors approved in 2010 that includes this definition of giftedness.

Gifted individuals are those who demonstrate outstanding levels of aptitude (defined as an exceptional ability to reason and learn) or competence (documented performance or achievement in top 10% or rarer) in one or more domains. Domains include any structured area of activity with its own symbol system (e.g. mathematics, music, language) and/or set of sensorimotor skills (e.g., painting, dance, sports). (p. 1)

This was the most recent authoritative definition available. Although this definition may appear to be broad and fail to account for varied traits of gifted individuals, I adopted it for the purpose of the work here. References to gifted and talented students include individual learners who have demonstrated above average ability in specific academic areas and who qualify for services beyond the regular classroom environment in a particular state, district, or school building. In some districts students receive services even if the abilities they demonstrate are not limited to the top ten percent. In other districts, students only receive services if they demonstrate
abilities in the top two percent. The difference in the services provided is largely due to the resources allocated to gifted and talented education in a particular school district as determined by state law or funding levels. Moreover, services may be rendered in various locales on different conceptions of giftedness.

**Higher Order Thinking**

A group of skills emphasized in current and foundational literature is labeled higher order thinking. Though many theorists examine this concept, Bloom and Krathwohl’s (1956) taxonomy and terminology is most widely used by educators at all levels. Bloom developed a taxonomy of learning domains. More recently, Krathwohl (2002) revised it to be more in line with current cognitive psychology.

According to Krathwohl (2002), referring to the original taxonomy, “The categories were ordered from simple to complex and from concrete to abstract. Further, it was assumed that the original taxonomy represented a cumulative hierarchy; that is, mastery of each simpler category was prerequisite to mastery of the next more complex one” (pp. 212-213). Five distinct areas of higher order thinking are create, analyze, evaluate, synthesize, and apply.

Application is to carry out or use a procedure in a given situation. The cognitive processes that fall under the application category are executing and implementing. Analysis is breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose. Cognitive processes associated with analysis are differentiating, organizing, and attributing. Evaluation is making judgments based on criteria and standards. Students who check or critique can be evaluating. Krathwohl (2002) changed the term synthesize on Bloom and Krathwohl’s (1956) original taxonomy to the term create on the revised
taxonomy. To synthesize means to put elements together to form a novel, coherent whole or make an original product.

Bloom and Krathwohl (1956) and Krathwohl (2002) contributed an organizational structure to understand the theory behind higher order thinking. A recent longitudinal study of Finnish students conducted by Grieff, Wüstenberg, Goetz, Vainikainen, Hautamäki, and Bornstein (2015) revealed that the working memory and fluid reasoning abilities of upper elementary students were strong predictors of whether an individual would be successful in solving complex problems three years later. The authors noted that there is a huge body of literature pertaining to higher order thinking, but very few studies include how higher order thinking skills relate to the development of the mind. Their findings support the idea that early opportunities to exercise higher order thinking skills lay the foundation for complex problem solving as an individual matures. “This result clearly supports the view that cognitive development evolves from basic processes in childhood into an increasingly complex structure of higher-order thinking skills in adolescence that enable the human mind to perform highly complex cognitive operations” (p. 8).

**Critical thinking or higher order thinking.** The terms higher order thinking and critical thinking seem to overlap in many areas. The summary of common definitions given by Angelo (1995) mentions that critical thinking is applying higher order thinking skills. “…such as analysis, synthesis, problem recognition and problem solving, inference, and evaluation” (p. 1).

The 1987 definition of critical thinking formulated by the American Philosophical Association as recorded by Facione (1990) is “a purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which
that judgment is based” (p. 3). Because critical thinking requires analysis and evaluation, distinguishing between critical thinking skills and higher order thinking skills is a challenge. Miri, David, and Uri (2007) state that their operational definition of higher order thinking includes critical thinking in addition to systemic and creative thinking as types of higher order thinking.

According to Kettler (2014), “within the literature of critical thinking, very few studies examine the critical thinking skills of preadolescent students in upper elementary grades” (p. 128). The scarcity of studies in the specific area of critical thinking skills in the upper elementary grades makes this research project valuable as a way to possibly identify the number of opportunities instructional units offer students to practice higher order thinking skills.

Quality practice maximizes the benefit of including higher order thinking skills in instruction. As stated here, where CT means critical thinking, by Abrami, Bernard, Borokhovski, Wade, Surkes, Tamim, and Zhang (2008, p. 1121), “…improvements in students’ CT skills and dispositions cannot be a matter of implicit expectation. … educators must take steps to make CT objectives explicit in course and to integrate them into both preservice and in-service training and faculty development.”

Based on the literature summarized above, the higher order thinking terms application, analysis, evaluation, and synthesis were used to examine the units in this project. For the purpose of this project, I used the term higher order thinking skills. Some of the references that help to define the term and advocate for its inclusion in education use the term critical thinking skills. For this project, creativity was examined apart from higher order thinking skills.
Creativity

According to Guilford (1950), intelligence was judged by an individual’s ability to exhibit the skills needed to excel in math and reading that do not require significant levels of creative ability. This indicates that students need planned opportunities to think creatively. First, this section will overview the development of creative thinking skills as a theoretical construct. Next, will follow examples of what researchers mean by creative thinking skills. This project did not delve into the difference between the potential to be creative and actually producing creatively. The working definition is limited to creative evidence that could be required of students and assessed during the course of a unit of study.

Multiple models and theories of creative thinking skills have been developed to explain exceptional behaviors. Some of the literature is devoted to promoting the inclusion of creative thinking skills in instruction for students.

Craft (2003) advocates for the inclusion of creative thinking skills in curriculum for all students; especially young children, not only those identified as gifted. This researcher maintains that all students need to develop the type of creativity helpful for solving everyday life problems. Other proponents of fostering creativity as a part of primary education are Newton and Newton (2014) who assert that giving students freedom to choose and to work their way through challenges without providing answers can foster individual creativity. One of the teacher’s roles is to create a safe environment that promotes creative thinking skills. In addition, students should be encouraged to take risks, explore ideas, investigate, and use their imagination.

In the selected research for this project, creative thinking skills are tied to giftedness. The perceptions of the relationship of giftedness to creative thinking skills vary. Crowl, Kaminsky, and Podell (1997) state that creativity overlaps with other characteristics. Some of these
characteristics are intellectual ability, reliability, flexibility and skill in school subjects, which are found in all seven of the intelligences identified by Gardner (1983). Renzulli (2014) used the term “creative-productive giftedness” (p. 543) to emphasize the trait of productive creativity in the recognition of gifted individuals. He embraced the essence of Stein’s (1953) definition of creativity. “The creative work is a novel work that is accepted as tenable or useful or satisfying by a group in some point in time” (p. 311). Versions of this definition recurred throughout the literature examined for this project. Renzulli argues that unless an individual exhibits high levels of creativity in addition to above average ability and task commitment, he or she cannot be considered to be demonstrating truly gifted behaviors.

Sriraman (2005) maintains, based on Usiskin’s (2000) hierarchy of mathematical talent, that in the field of mathematics, one can be a gifted mathematician, but not be considered creative. Creativity, in mathematics, according to Sriraman, is far more rare than is giftedness. This suggests that the definitions of creativity and giftedness and their relationships to each other may differ when considered in the context of different fields.

More recently, according to Newton and Newton (2014), the concept of creativity is being re-evaluated by some to include multi-cultural views of important facets of creativity. Also, there is a renewal of the idea to value creative ideas, and not only tangible manifestations of the ideas.

The literature detailed above is a small sample of the many theories and models on the concept of creativity. They are included to give the reader an idea of the scope of the work that has been done to identify, measure, foster, and promote creativity, especially in the educational field.
Specific creative thinking skills. Guilford (1950) proposed four aspects of creativity: fluency, flexibility, originality, and elaboration. He proposed ideas about how people could test these properties in addition to others. Torrance (1966) used Guilford’s ideas concerning creativity to develop the Torrance Tests of Creative Thinking. A description taken from the Torrance Tests of Creative Thinking figural section written by Ball and Torrance (1984) is stated here:

- Fluency: The number of relevant ideas; shows an ability to produce a number of figural images.
- Originality: The number of statistically infrequent ideas; shows an ability to produce uncommon or unique responses. The scoring procedure counts the most common responses as 0 and all other legitimate responses as 1. The originality lists have been prepared for each item on the basis of normative data which are readily memorized by scorers
- Elaboration: The number of added ideas; demonstrates the subject’s ability to develop and elaborate on ideas. (p. 5)

Notably missing from this list is the term flexibility. Versions of the Torrance Test of Creative Thinking published prior to 1984 contained flexibility exercises. Kim (2006) explains that the element of fluency is so closely related to flexibility, that the test developers eliminated flexibility from the test.

The terms: fluency, flexibility, originality, and elaboration, were chosen to define the elements of creativity in the educational units audited for the project. These terms were chosen because they are well known and recognizable in the field of education. Also, the division of
creative thinking skills into these categories makes the identification and assessment of creative behavior possible for a classroom teacher, like myself.

**Assessment of Gifted Learners**

The topic of assessment is broad. To narrow the focus for the scope of this project, I completed a brief overview of self, peer, and teacher developed formative assessments using current literature. First, there is a brief examination of issues unique to assessing the learning of gifted learners. The next section includes student self-assessment, peer assessment, and teacher developed formative assessment. Each type of assessment includes a definition and examples of studies focused on that assessment.

According to VanTassel-Baska, (2013) assessing the learning of students with gifts and talents poses unique challenges. Students with gifts and talents need tests with high psychometric ceilings. They also need opportunities to demonstrate growth over time. Off level testing and the use of portfolios are two examples of ways to meet these unique assessment challenges. Off level testing refers to giving students a test that is designed for older students or students in a higher grade. Off level testing allows students to go beyond getting a high or perfect score on an on level test, one designed for their age or grade, to complete test items that show the limits of their abilities. Portfolios are collections of student work, gathered over an extended amount of time, to show growth in student skills and abilities.

Kettler (2014) states that researchers identify several characteristics representing advanced skill development typical of gifted students that require higher order thinking skills and creative thinking skills. These include thorough problem solving using a variety of strategies, more metacognitive strategies, accurate self-assessment of readiness for a learning task, and the ability to abstract and generalize.
One way to help students take on responsibility for their own learning is to incorporate student self-assessment. Barnes and Urbankowski (2014) observed that students who participated in self-assessment had the opportunity to reflect about learning, the requirements of an assignment, and ways to improve their work. This assessment strategy also promoted a culture of excellence as the focus was on learning from mistakes to improve.

**Self-Assessment**

Miedijensky and Tal (2016, p. 2) assert that (self-assessment) allows learners to address the level, value, or quality of their own products or performances. The students assess their performances according to criteria suggested through discussions with the teacher and these criteria are usually related to the content and the skills taught and practiced in class.

Fostering independent learning in students means that teachers must instruct students to realistically evaluate their own and peers’ work. Gifted and talented students may find regular class work unchallenging. According to Callahan, Moon, Oh, Azano, and Hailey (2015), up to 50% of the content and skill instruction gifted and talented learners encounter in the regular classroom has been found to be redundant. Students need to be instructed in and given the opportunity to critically look at their work and compare it to a standard. Another way students can assess themselves is to learn to recognize how new knowledge and skills contribute to growth in their thinking.

The idea of self-assessment is supported by a number of studies. In one recent study by Mideijensky and Tal (2016) interviews with students aged 12-15 confirmed that self-assessment helped students to examine their own abilities and to be metacognitive. Students were able to think critically about their ideas. They also recognized a learning sequence of examining, analyzing, and evaluating knowledge.
According to Black and William (1998), one of a learner’s routes to realizing that there is a learning target that he/she has not yet reached, is to engage in self-assessment. Based on the information gathered from self-assessment, the learner may formulate a plan to move toward the learning target by developing a plan of action. The learner may also receive instruction from a teacher that will provide guidance in reaching the learning target. Another way for a learner to become aware of a learning gap, is to participate in peer assessment.

Peer Assessment

One value of peer assessment is that it may help students deal with the affective component of learning and interaction with peers. Leading students to critique each others’ work benefits the student receiving the feedback and the student giving it. According to Mideijensky and Tal (2016):

Affective responses that addressed challenges, emotions and social relationships were evident in all the stages with some increase in the more advanced stages (of the project). This indicates that inquiry that incorporates reflection and feedback from peers can address challenges, emotions and social variables that are associated with the task. (p. 11)

According to Topping (2009), assessment of presentations, portfolios, tests, and especially writing, can be evaluated by academic peers. This practice provides authentic, timely feedback to students. It has the added benefit of helping students to better understand the criteria and standards used to assess the work they do themselves. The feedback peers give each other can confirm good practices, give suggestions for improvement, or point out mistakes to address.

Black and Harrison (2001) state that to be effective, students require training in providing and receiving feedback and in the use of assessment criteria for peer and self-assessment.
Students should be able to accurately assess their peers' work, identify meaningful areas for improvement and provide high quality feedback. It is important for teachers to guide the selection of criteria on which evaluations are based.

With affective, academic, and cognitive benefits to students, peer assessment is a strong method to involve students in the assessment process. Black and Harrison (2001) documented teacher reactions to the project. One salient point is that preparing for peer assessment takes more time than when the teacher grades student work alone. Teachers needed support to implement change at an acceptable pace. Without proper training, students tend to assess surface level items instead of the thinking involved. A surface review would not justify the required time to prepare and train students to assess one another’s work.

**Formative Assessment**

In 1998, Black and William stated that formative assessments provide data so teachers can decide how quickly to move through material, whether or not students are ready for the next step, and to see how much support students may require. The purpose of formative assessment is to measure student progress through a learning cycle and to provide the teacher with information useful for making instructional adjustments as needed. Also, according to Black and William, the purpose of formative assessment is to alert the student to a gap between a standard or learning target and the student’s current level of achievement. The student can respond by formulating a plan to move toward the target. The teacher may choose the steps the student needs to take to advance their learning.

Misset, Brunner, Callahan, Moon, and Azano (2014) studied the use of acceleration, ability grouping, and formative assessment with third grade, gifted students. They found benefits of formative assessment included teachers’ ability to modify teaching methods and preparation,
an improvement in student grouping strategies, and improved learning. (Information gathered from formative assessment) informs teachers’ decisions “regarding pace, readiness, and scaffolding needs of students” (p. 247).

Summary

There is extensive research literature and many theories surrounding higher order thinking, creativity, and the assessment of both constructs. The literature has helped narrow the focus to include information relevant to my teaching practice. Students need to exercise the higher order thinking skills of analysis, application, evaluation, and synthesis. From the literature, it became apparent that the use of these skills must not only be embedded in instruction, they must also be explicit with opportunities to assess students’ use of the skills. In addition, the need for students to be able to think creatively using fluency, flexibility, originality, and elaboration was evident in the literature. By creating the matrix, my goal was to create a tool that could be used to document the presence or absence of these important skills that should be both embedded and explicit in gifted and talented curriculum. Another curriculum development area I hoped to improve was assessment. Self and peer assessment are ways to support cognitive, affective, and social and emotional needs of gifted students. The higher order thinking skill of evaluation can be applied through peer and self-assessments. Teachers can involve students by providing criteria for judging student work and allowing students to evaluate their own or peers’ progress or performance. Teachers may also involve students by allowing them to help develop the criteria by which progress and performance will be judged.

The next chapter includes a description of the process to develop the matrix and how it was used to audit three units that district colleagues and I developed.
Chapter 3

Methods

As stated in the introduction, the purpose of this action research project was to examine my practice as a teacher of elementary gifted and talented students. To do that, I wanted to determine the frequency of opportunities I provided in instructional units for students to exercise higher order thinking and creative thinking skills, I created an auditing matrix. The matrix is a tool to examine teaching materials, in this project, three units, one each for grades three, four, and five. To conceptualize and complete the work, I approached the task from an action research design perspective.

Research Design

Action research is a methodical way to examine professional practice for the purpose of improving it. Reason and Bradbury’s (2001) description of action research guided my planning.

Action research is a participatory, democratic process concerned with developing practical knowing in the pursuit of worthwhile human purposes, grounded in a participatory worldview. It seeks to bring together action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern to people, and more generally the flourishing of individual persons and their communities. (p.1)

Zuber-Skerrit and Fletcher (2007) confirm the approach emphasizing the improvement of practice and the emphasis on teacher reflection.

Mills (2003) makes a distinction between critical action research and practical action research. He outlines this process. First the teacher researcher chooses a focus area, then he/she
decides how to collect and process the data. Finally, the teacher researcher decides the actions to take to improve teaching and or learning. These steps are very similar to the process I followed to complete this project. So, it qualifies as practical action research. Also noted by Mills is that teacher researchers choose to examine their practice with the goal of improving it. Finally, Mills reminds readers that both students and professionals benefit from action research.

**Research Purpose**

The purpose of the research project was to examine curriculum and assessment to document how often students are asked to use higher order thinking and creative thinking skills, as defined in the literature review, within the span of an instructional unit. To examine units that were written in district, I developed an auditing matrix. To audit a unit, I identified which parts of the unit provided students opportunities to use either higher order thinking or creative thinking skills. For this project, I chose to focus on three different units: one for third grade, one for fourth grade, and one for fifth grade. See Appendix A for the three units. I consulted Wiggins and McTighe (2005) to guide the formatting.

The third grade unit is based on the *Next Generation Science Standards* (2013) and focuses on short-term and long-term changes in species of animals. In the fourth grade unit students explore the process of inventing and create and share a prototype of an original invention. The fifth grade unit is also designed from the *Next Generation Science Standards* and focuses on impacts, both positive and negative, that humans have on their environment.

**Research Setting, Pull Out Program, Teacher Qualifications**

I teach in a district located in northeastern Wyoming. The school district is comprised of 22 schools. According to 2016 enrollment figures, there are 299 students in the third through fifth grades identified as gifted and receiving gifted and talented services. That equates to almost
11% of all third, fourth, and fifth grade students. Time allotted to gifted and talented instruction in our district is as follows. Third grade students work with a gifted and talented teacher for one to two hours each week. Fourth and fifth grade students have one to three hours a week to complete the gifted and talented curriculum.

Licensed teachers, holding an endorsement, deliver gifted and talented services on site in each elementary school building. Students attend gifted and talented classes during the school day. As is typical of the pull out program format according to Rash and Miller (2000), gifted education teachers provide supplementary curriculum, however are not responsible for core subject instruction. Most instructional units were developed locally by teams of elementary gifted and talented teachers. Methods for the creation of units vary. I will outline each unit in full, in the creation of the units and selection for the research project section. There are three units developed by teams of gifted and talented teachers based on the National Association for Gifted Children Programming Standards (2010) integrating core district content that all third graders complete across the district. The GATE teacher in each building chooses and designs other projects and activities based on the needs of the particular students in that building in addition to the three units that are common across the district. For grades four and five, there are also three district-wide units based on standards with other projects and activities assigned by each GATE teacher.

**Creation of the Units and Selection for the Action Research Project**

The instructional units used in the district GATE program were developed locally by elementary gifted and talented teachers. I chose three units that are designed to extend student learning beyond the classroom offerings, one from each of the grades three through five as noted earlier, the complete unit plans are in Appendix A, Unit Plans.
Grade three unit: Life!. The unit for third graders was developed over the span of two calendar years as a part of a Science Technology Engineering and Mathematics (STEM) grant program with the University of Wyoming and our school district. District leaders, in collaboration with university professors, formulated a plan that would lead teachers through the process of developing science lessons based on the Next Generation Science Standards (2013), which were adopted by Wyoming in 2016. Three teachers of elementary gifted and talented students designed a third grade life science unit using the standards. The three of us developed the unit to supplement content in a life science unit that was created by classroom teachers for third graders in the regular classroom.

The unit included the following learning activities. Students keep a science journal in which they record their learning and respond to teacher prompts. The students explore changes that take place during an organism’s life span. Students analyze fossils to find clues about how the world used to be. Students observe similarities within their family to decide which are inherited traits and which are learned behaviors. Students engage in fact finding to see if there are variations of traits within animal species. The students report their findings about variant traits within species to their classmates and discuss how some of the variations benefit the species or sub-species. Students find information about different animal groups. They discuss how the grouping of certain animals is beneficial to individuals and to the species. Finally, students create a three-dimensional display to depict the life cycle of an animal of their choice. Students describe and defend changes the organism must undergo to survive a sudden change of habitat without becoming extinct. There are formative assessments throughout the unit. A summative assessment in the form of a teacher created rubric that assesses the process and the final project concludes the unit.
I chose to audit the third grade life science unit to discover whether the time and effort devoted to its development were worthwhile. Also, this unit is not currently used across the district. I am hoping to make it a more credible choice for gifted educators to use with students, in the future. As the unit is designed as an overview of these two full Next Generation Science Standards, Heredity: Inheritance and Variation of Traits and Biological Evolution: Unity and Diversity (NGSS, 2013), it should require a variety of types of student responses. The unit takes approximately eighteen hours of class time to complete. This unit is based on content standards with extended and deeper content to meet the needs of gifted students. I have used the third grade life science unit with one class since its development, so it is relatively new.

Grade four unit: Invention. This unit, which has been used by all gifted and talented teachers in the district and has been active for ten or more years, was developed by a team of elementary gifted and talented teachers. We based the idea on published units that focused on the invention process. A local committee of gifted and talented teachers recently revised the requirements and the assessment rubric for completion of this unit in its current form.

The first thing students must do is brainstorm various important inventions, for example, the car, the engine, the telescope, and penicillin. They may know who the inventor is, or they may need to research the information. Then, the student can begin finding facts about the inventor of their choice. Students report the information to their classmates. Next, students identify a personal or shared human challenge that can be improved through technology. Each student individually develops a gadget to address the need. The student researches the required elements to create a sculpture that represents a prototype of their invention. Students also design a single page of information to display with the prototype of their invention at the showcase or
invention convention that is attended by the fourth grade gifted and talented students and their families. Principals and classroom teachers are welcome to attend the event.

The fourth grade invention unit was included in the audit to find ways to improve on the structure and to strengthen the formative assessments. Also, I had just finished helping to revise the unit and the summative assessment rubric and wanted to know how useful it was for students to use higher order and creative thinking skills. I have used this unit with at least five of my fourth grade classes. This unit takes students approximately twelve hours to complete.

Grade five unit: Impact. The last unit, Impact, is also based on the Next Generation Science Standards (2013). Two elementary gifted and talented teachers developed it as a part of the project with the University of Wyoming noted in the section describing the third grade life science unit. The Impact unit took close to one calendar year to develop. The fifth grade science standard it addresses is Earth and Human Activity (NGSS, 2013). The unit guides students through an exploration of the effects of a human impact on earth systems. Students choose a particular human impact to examine. Students individually look for human impacts that affect two or more of earth’s systems. He/she creates a slideshow that addresses questions provided by his/her fellow gifted and talented students. To help peers understand concepts they encountered as they gathered information on their topic, each student develops demonstrations and or labs. Each learner conceives ideas to address the issue he/she studies. Next, individuals look for and share information on current measures that are being taken to address the issue in the real world. Finally, students compare their own solution ideas to the experts’ ideas. Impact is a unit that is available to all teachers of gifted and talented students in the district, but is currently considered optional curriculum.
I wanted to examine *Impact* to determine if it should be used in every fifth grade GATE classroom across the district. I recently finished revising the format of the unit with a colleague. I wanted to know what depth it reached in terms of the skill development in higher order and creative thinking skills. I have yet to have any of my fifth graders complete this unit, which would take students an estimated twelve to eighteen hours to complete.

**Developing and Using the Auditing Matrix**

To examine the units for the purpose of finding elements of and higher order thinking and creativity, I developed a tool called the auditing matrix. The purpose of the matrix is to document the presence and number of opportunities available to students within an instructional unit to exercise higher order thinking skills and creative thinking skills. As I drafted versions of the matrix, I focused on clarity, completeness, and ease of use. As a teacher, I wanted to be able to use it easily and knew that teaching colleagues would value these features as well. The auditing matrix enabled me to document if the units described above were actually engaging students in higher order and creative thinking skills. In essence, the tool is a kind of teacher self-assessment. Results of an audit would help me and others identify possible adjustments to make in developing or using instructional units to increase the frequency of occurrence of higher order thinking and creative thinking skills.

The first decision that needed to be made was the specific elements to include on the matrix. To identify and better understand these elements, I examined the higher order thinking, creativity, and assessment research literature. When the elements were defined, I first looked for them in an established unit that local elementary gifted and talented teachers developed and have used for the past ten years, with both fifth and sixth grade students, titled *Eminent Person*. Students choose an individual, whom the student considers to be a world changer, to study. The
choice to model the matrix after an existing unit was a good one, but I discovered that the

*Eminent Person* unit was not the right unit to use as a model. The unit focuses on fact finding.

Although an objective of the unit is to help students to identify the traits of creative individuals, the unit yielded few opportunities for students to actually practice higher order thinking or creativity. As my goal was to find opportunities for students to encounter higher order and creative thinking skills, I realized that a unit with more examples of student responsibilities would be a better model unit.

Next, a different unit was examined for elements. This unit on third grade life science provided a better starting point as there are a variety of types of student responsibilities expected in the unit. An early version of the auditing matrix is included as Appendix B. Examining these two units helped to develop, edit, and finalize the matrix. See Appendix C for the final version of the auditing matrix. Through the development and field tests of the matrix, an auditing procedure became apparent. The following list delineates steps in the process.

1. Select a unit to audit. When choosing a unit to audit, read the unit plan to decide if the student responsibilities are outlined clearly enough to be able to understand, as the auditor, what kind of thinking the unit is asking students to do.

2. Print a paper copy or open a new digital copy of the matrix.

3. Document the auditor’s name. Log the date and start time.

4. Read and re-read the unit instructions until you feel you are familiar with the layout. If you have any questions, jot them onto the matrix form and get answers if you can.

5. Based on the unit plan, complete the matrix. If an element is evident, mark it with an X. If an element is not evident, mark it with a 0. If the element does not apply in that situation, mark it with NA (not applicable).
6. Write examples in the far right column on the matrix in the appropriate row. Write comments concerning the matrix as a tool or the unit as a whole in the comment section at the bottom of the matrix.

7. Log end time.

Timeline

The project began with an action research graduate course completed during the Fall semester of 2016. The class was designed to help students choose a topic, formulate a researchable question, and evaluate and cite resources. After the class ended, the project continued with guidance from the master’s degree committee. The table below shows the phases of the project completed and in which month or months different parts of the project were completed.

Table 1

*Action Research Project Timeline*

<table>
<thead>
<tr>
<th>Phase 1: Background Research</th>
<th>Phase 2: Auditing Matrix Design</th>
<th>Phase 3: Testing the Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building knowledge on assessment, creativity, and higher order thinking.</td>
<td>Determining elements to include on the matrix.</td>
<td>Choosing the number of units to audit.</td>
</tr>
<tr>
<td></td>
<td>Rearranging the order of the elements.</td>
<td>Choosing the instructional units to audit.</td>
</tr>
<tr>
<td></td>
<td>Merging teacher responsibilities with assessments on the matrix.</td>
<td>Using the matrix to audit units.</td>
</tr>
<tr>
<td></td>
<td>Choosing the initial unit to use as a guideline for developing the matrix.</td>
<td></td>
</tr>
</tbody>
</table>

...
The primary investment required to complete this action research project was time. No purchases were necessary. As the subjects of the research were curricular units, no special permission was required.

**Summary**

The year-long action research project involved finding the answer to the question, What are the higher order thinking skills and creative thinking skills included in teacher developed curricular units? To answer the question, research literature on higher order and creative thinking skills, self assessment, peer assessment, and formative assessment was reviewed. A matrix was developed to document opportunities for students to exercise higher order and creative thinking skills. The matrix was field tested by auditing three curricular units.
Chapter 4

Results

Use of the auditing matrix revealed strengths of each unit and ways to improve each. By completing an audit of each unit, it was clear some areas of higher order thinking and creative thinking skills were emphasized. Skills that occur more frequently than others within a unit are strengths. Higher order and creative thinking skills that occur infrequently are considered weak areas. On the matrix are a total of nineteen opportunities for students to experience higher order or creative thinking skills either through instruction or assessment.

Although audit results indicated relative strengths when comparing the numbers of opportunities to encounter one higher order or creative thinking skill to another, the highest number of opportunities for students to either use a particular skill or complete an assessment focused on any one higher order or creative thinking skill was eleven. Eleven of nineteen opportunities leaves room to question whether the chances to teach and assess these skills are maximized in the unit. The next section outlines unit strengths and areas for improvement.

Results of the Third Grade Life! Unit Audit

Strengths. The audit of the third grade unit Life! indicates strength in the area of the higher order thinking skills of application and evaluation. Elaboration was the strongest of the four creative thinking skills.

The skill of application was evident in five assessments and two student responsibilities. Evaluation was assessed four times and students used evaluation two times in the unit learning activities. The total number of encounters is reported because for any assessment, there is a student expression.
Areas for improvement. The higher order thinking skills of analysis, and synthesis were weak areas. Fluency, flexibility and originality were the weakest creative thinking skills in this unit. The content of this unit does not lend itself to analysis as much as evaluation. Synthesis is an expression of learning that includes sharing new knowledge and existing knowledge in a way that is novel to the learner. It follows then, that there would be fewer student expressions of synthesis in a unit. So, maybe a unit weak on the synthesis side would not contain a single opportunity for students to synthesize.

In a product based unit, the most natural expression of synthesis comes near the end when the student creates a product a speech, presentation, model, or solution using the information gathered through the use of other higher order and creative thinking skills. In the third grade the model required is a concrete three-dimensional model to coincide with developmentally appropriate practices for younger learners who may not yet be ready to conceptualize more abstractly.

Skills students are being asked to use need to be made explicit in instruction and assessment. There is potential within the unit to require students to analyze more. Students could also think more in fluent, flexible and original ways. Opportunities for students to use higher order and creative thinking skills need to be maximized. If some skills are not suitable to include in this unit, teachers need to choose supplemental curricular material to address the skills that are missing or are not emphasized.

Results of the Grade Four Invention Unit Audit

Strengths. In the fourth grade unit Invention evaluation and synthesis were the strongest higher order thinking skills. Elaboration was the strongest creative thinking skill indicated on the auditing matrix form. Evaluation may be the strongest higher order thinking skill because
students make many decisions in the process of developing their invention to decide if each idea is satisfactorily addressing the current part of the project. Synthesis is essential to combine the information with the idea to demonstrate it in the form of a prototype model. There is opportunity for students to elaborate, but it is possible to create a prototype with a small amount of elaboration.

**Areas for improvement.** The higher order thinking skills of application, and analysis were the weakest. Fluency, flexibility, and originality were weakest creative thinking skills in this unit. There were three elements marked NA for not applicable. These were pre-test, diagnostic activity, and notebook entries. These missing elements stand out on the audit. See Appendix E. It seems that either a pre-test or a diagnostic activity would strengthen this unit. Students could easily track their progress through short, periodic notebook entries.

Skills students are being asked to use need to be made explicit in instruction and assessment. There is potential in the *Invention* unit to require students to use more application and analysis. Students could also utilize more fluent, flexible, and original thinking. Opportunities for students to use higher order and creative thinking skills need to be maximized. If some skills are not suitable to include in this unit, teachers need to choose supplemental curricular material to address the skills that are missing or are not as emphasized.

**Results of the Grade Five *Impact* Unit Audit**

**Strengths.** In the audit of the grade five unit *Impact*, the higher order thinking skills of application and evaluation were strong areas. This unit has the creative thinking skill of originality as a strength. The requirement for students to apply what they learn about a human impact to create a solution makes application and evaluation logical higher order thinking skills
to emphasize. Originality is a good creative thinking skill on which to focus in this unit. Fluency is also necessary and is marked only two fewer times than originality.

**Areas for improvement.** The higher order thinking skills of analysis, and synthesis were weak areas. Fluency, flexibility, and elaboration were relatively weak creative thinking skills. The areas of diagnostic activity and notebook entries received NA marks.

The skills students are being asked to use need to be made explicit in the instruction and assessment in this unit. There is potential for students to do more analysis. Opportunities for students to use higher order and creative thinking skills need to be maximized. If some skills are not suitable to include in this unit, teachers need to choose supplemental curricular material to address the skills that are missing or are not as emphasized.

See Table 2 below for a numerical depiction of the number of higher order thinking and creative thinking skills identified in each unit.

Table 2

*Summary of the Audit Results*

<table>
<thead>
<tr>
<th>Number of Opportunities for Students to Encounter Higher Order Thinking Skills</th>
<th>Apply</th>
<th>Analyze</th>
<th>Evaluate</th>
<th>Synthesize</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd grade unit</td>
<td>n = 7</td>
<td>n = 2</td>
<td>n = 6</td>
<td>n = 3</td>
</tr>
<tr>
<td>4th grade unit</td>
<td>n = 2</td>
<td>n = 3</td>
<td>n = 10</td>
<td>n = 7</td>
</tr>
<tr>
<td>5th grade unit</td>
<td>n = 11</td>
<td>n = 3</td>
<td>n = 11</td>
<td>n = 4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of Opportunities for Students to Encounter Creative Thinking Skills</th>
<th>Fluency</th>
<th>Flexibility</th>
<th>Originality</th>
<th>Elaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd grade unit</td>
<td>n = 0</td>
<td>n = 2</td>
<td>n = 3</td>
<td>n = 5</td>
</tr>
<tr>
<td>4th grade unit</td>
<td>n = 5</td>
<td>n = 3</td>
<td>n = 3</td>
<td>n = 9</td>
</tr>
<tr>
<td>5th grade unit</td>
<td>n = 8</td>
<td>n = 8</td>
<td>n = 10</td>
<td>n = 7</td>
</tr>
</tbody>
</table>
The Auditing Matrix as an Assessment Tool

Data gathered during the field test of the matrix are promising. There were elements of targeted skills that were more evident than others. Information on the matrix showed a difference in emphasis of individual higher order and creative thinking skills across the three units. As one of my advisors stated, documentation through the matrix will encourage meaningful conversations concerning the strength and usability of curriculum designed for students identified as gifted and talented.

There are some additional issues I noted when using the matrix. On all three audits, I noted several examples to show what the auditor identified in the unit as thinking skills in the far right column of the matrix, but they are difficult to read as the space for recording examples as evidence is very limited. More space could be added on the matrix for auditors to note examples. See Appendices D, E, and F.

Some descriptions of student responsibilities in the unit plans were not detailed enough to make it clear to the auditor whether a particular higher order or creative thinking skill aspect was needed to complete it. For example, several discussions were listed in the unit plans, but the structure and topic of the discussion dictate what cognitive demand is being placed on students. When there was not enough information, I left the space blank on the matrix indicating that a particular skill or aspect of creativity was not exercised to complete that student responsibility.

One mistake I made in completing the first audit is not marking any 0s or non applicable (NAs) on the matrix. It would be good to know that the audit is complete and that the auditor did not simply quit in the middle of the audit. Also, as stated by one of my advisors, there is a big difference between omitting an item and having one that is not applicable. The second and third audits include 0 and NA.
As a tool, the auditing matrix should encourage and inform strong conversations among stakeholders about the kind of thinking required of students to complete curriculum. Decisions about what kind of thinking is required should be based on definitions of thinking skills outlined in the literature. Although there is no rating system as a part of the matrix, the presence or absence of a thinking skill is valuable information. If there are several different tasks requiring a particular thinking skill, they will be evident on the completed matrix. If particular skills are consistently missing, the teacher, or a team of curriculum developers, can be aware of the absence and supplement the curriculum or adjust the unit to include the less frequently used skills.

The matrix was designed to examine written curriculum. However, it could also be used as a checklist when conducting a peer observation. Peer observation has been found by Barnard, Croft, Irons, Cuffe, Bandara, and Rowntree (2011) to be beneficial to teachers. Peer observation participants increased levels of “knowledge, skills, and effectiveness.” Using a tool like the auditing matrix to guide observations, an observer should be able to recognize when higher order and creative thinking skills are part of explicit instruction and or assessment.

**Summary**

The idea for this study was inspired by concerns raised about developing and implementing quality material that includes higher order and creative thinking skills for gifted and talented learners. A desire to improve my assessment practices also figured into the plan for this study. To carry out the study, I conducted a focused literature review on both topics, developed and field tested an auditing matrix, and reported the findings here.

Three observations I made during the process are these:
• A unit must be carefully examined to determine the actual learning goal or goals. The auditing matrix is an effective formative assessment tool to use as units are being developed, implemented, and even reframed.

• Some higher order and creative thinking skills are taught as a matter of course, but others may be left out or taught less frequently.

• Higher order thinking and creative thinking skills must be taught intentionally and assessed well.

• It is helpful to standardize instructional unit formats for internal and external use.

One of the primary insights I gained was to understand how to examine curriculum to see what the learning outcomes really are. When a unit is touted as suitable for gifted and talented learners, what are the criteria on which the claim is based? In the unit, are students applying knowledge, analyzing structure, evaluating their own or peers’ thinking, or synthesizing to create something new and meaningful to them? Does the unit give students occasion to develop many ideas, stretch their thinking to vary the ideas so the thoughts are dissimilar? Do students get to create thoughts and ideas and then elaborate on them? If the answer is yes, how often do these occasions occur in the course of the unit? Are thinking skills evaluated with planned assessments?

I also learned to look at the intentionality of instruction in higher order and creative thinking skills. If students are offered opportunities to use higher order and creative thinking skills, are some higher order or creative thinking skills used more frequently than others? Do teachers make the use of these skills a focus of instruction? Do students know when they are thinking fluently or analyzing?
Another point I learned to consider through this process is the wisdom of standardized formats for teacher created units. Use of standardized formats for units ensures that teachers using the unit can find the information they need for effective instruction. Also, if a teacher has an external auditor review units, the auditor will begin to know exactly where certain information should be.

Overall, the matrix yielded information useful for making decisions concerning curriculum use. In the next chapter a synopsis of my reflections and recommendations concerning the units, the matrix and its possible uses, and the action research project as a whole is provided.
Chapter 5

Conclusion

I conclude by reminding the reader about the question that started my inquiry. How do I know GATE works? This one question, posed by my district curriculum director, influenced me to begin the journey of improving the GATE curriculum provided in the district. One important outcome of the work completed in this project is that I now have a partial answer to his question. I can tell him that there is a tool to audit curricular materials for use of higher order and creative thinking skills and share with him some of the insights I gathered through this project. I will also share the intentions I have to use the matrix to take a critical look at the curriculum and plans to improve it. Using the matrix as a formative assessment tool is one way our district can ensure gifted and talented students experience quality instruction.

Analysis of All Three Unit Audits

Detailed results of the audits for each unit are outlined in chapter four. This section will describe observations concerning all three units and some recommendations for use of the information uncovered in the audits.

The matrix findings rely on the quality of the material it is being used to evaluate. The stronger a unit is in terms of being anchored in robust standards and being written in sufficient detail, the better the chances are of the audit results providing confirming information that the unit is GATE worthy. The more planning and design care that goes into a unit and its assessments, the better it will stand up to scrutiny of any kind. It seems that for higher order and creative thinking skills to be learning targets, the curriculum has to have elements promoting student centered learning. In the case of the three audits I completed, the plan of action following
the unit audits is to look closely at the results to determine whether a unit is still considered to be a valuable component of the district-wide gifted and talented education or GATE curriculum. I will work with a committee of gifted and talented teachers to see how each unit can be improved to include more opportunities to have students practice higher order thinking and creative thinking skills. If a unit provides insufficient opportunities for students to encounter higher order and creative thinking skills, it will need to be improved or replaced. Also, in all three units, more emphasis on higher order and creative thinking skills is needed. This can be accomplished by making these skills the focus of direct instruction and assessment.

Reflecting on the audit results, I realized that not every higher order thinking skill or creative thinking skill will be used as often as any other. For example, in all three units, fluent and flexible thinking were weak areas. I need to broaden my understanding of these skills to incorporate them more. I need to be aware, when developing and implementing curriculum, to emphasize less frequently used skills to make sure they are not forgotten. There is also a progression of complexity in higher order and creative thinking skills. So, different skills may need to be introduced, practiced, or assessed in different grade levels. Careful consideration must be given to deciding what skills are appropriate to emphasize in specific grade levels. It makes sense to introduce specific higher order and creative thinking skills and then continue to revisit and increase complexity as students’ understanding matures.

The Auditing Matrix

One concern that drove the development of the auditing matrix is that the current gifted and talented education or GATE curriculum in my district is teacher developed. While this might support teacher ownership of curriculum, there is currently no procedure to examine units for quality and effectiveness. Any GATE teacher is encouraged to share anything that they found
worked well in their situation. There are high quality units shared this way, but there is also the possibility that units with no real instructional value are shared as well. Students and teachers could be victims of indiscriminate sharing practices. A tool, like this auditing matrix, could help to address this area of concern.

The process of choosing criteria to audit with the matrix taught me not to assume that units designed for the purpose of extending learning and encouraging students to exercise higher order thinking and creative thinking skills are actually accomplishing this purpose.

Developing this assessment tool required a focused literature review to narrow the focus of the matrix and to more fully understand the elements that should be present in curriculum designed for elementary students with gifts and talents. The matrix underwent several revisions before the format was finalized. See Appendices B and C. Information uncovered using the auditing matrix can be used as evidence to influence decisions regarding curriculum. This was the purpose of the matrix. So, the benefit of tangible evidence of the usefulness of curriculum would be worth the extra time and effort required to conduct a unit audit.

One possible use for the auditing matrix would be to reveal the progression of thinking skills from younger to older grades. I would expect, considering the literature that includes Bloom and Krathwohl (1956) and Krathwohl (2002) that the more complex thinking skills such as synthesis and analysis would be emphasized more in the upper grades than in the lower grades. I would also expect there to be a greater emphasis to be on less complex thinking skills like fluency and flexibility in the younger grades. More than three units would need to be examined to confirm this idea, but this may help to explain some of the differences in the thinking skills emphasized in the different units.
It would be valuable to use the auditing matrix to conduct an audit of published curriculum material. A published unit, designed for elementary gifted and talented students, could be audited by a team of gifted and talented teachers in my district. The findings could influence the decision of whether or not to purchase an entire set of published curriculum.

Even though the matrix was designed to evaluate written lesson plans, it could also be used as an observation tool in a lab classroom setting. It could help guide the observing teacher look for times in the lesson the teacher being observed explicitly teaches or assesses higher order and creative thinking skills. I would encourage the use of the matrix for this purpose as the practice of peer observation is a way to model and experience formative assessment.

There are many aspects of learning to consider when developing any curriculum, in particular GATE curriculum. Among these are state and district content requirements or standards, developmentally appropriate level of content, logical progression of knowledge, rigor level, measurement, relevance to students, sequencing, and as highlighted in this project, higher order and creative thinking skills. More and more in modern education models, teachers are being asked to develop or at least to modify curriculum to custom fit the needs of their students. It is comforting to know that some districts, like my own, provide professional development and opportunities to learn how to use standards to develop curriculum, but there is still a need for tools to assess how close the written lesson is to the identified learning target and whether delivery of the lesson includes the identified primary learning targets.

The auditing matrix contributes to this need for documenting the presence of skills that the literature identifies as foundational in gifted and talented education. I did a brief search, and if there are tools similar to the matrix, they are not at this time, readily available. Two tools with a similar focus have been developed by researchers. One of these tools is a guide for recognition
of levels of Bloom and Krathwohl (1956) thinking skills combined with methods of applying them. The other combines the thinking skills with depth of knowledge. Another difference is that the matrix only audits the presence of higher order and creative thinking skills. No lower thinking skills are included for the sake of focus, space, and simplicity.

The Action Research Project as a Whole

I would not have begun this journey were it not for the outreach nature of the Science and Math Teaching Center at the University of Wyoming. Because I was able to join a cohort of teachers developing science curriculum based on the soon to be adopted Next Generation Science Standards, I learned of a master’s program designed to accommodate in service teachers.

By offering classes during the summer on campus and the opportunity to complete a research methodology class and the required research project at a distance online, the program allowed me to continue working full time while fulfilling the requirements for a master’s degree.

Were I to continue my education to complete a doctorate, I think I would take sabbatical from teaching during the research portion. I would prefer to complete coursework at a distance or on campus during the summer if either was an option.

The process of action research was new to me. Through the process, I learned to be more methodical, reflective, and introspective in my thinking. There were strengths in the way the research was carried out, but there were also several things that should have been done differently.

The primary strength of this project is that I chose to critically examine my current practice for the purpose of improving it. Another strength of this project is that it focused on assessment in gifted and talented education on a local level.
One thing I would change about the study is that I did not have an external auditor either use or assess the matrix. To make the auditing matrix more useful and valuable to educators, the matrix should be reviewed and used by an external peer reviewer. An extension of this project would be to have the reviewer or colleague use the matrix to audit units and comment on the potential usefulness of the matrix as a tool.

I will seek feedback from at least two groups of educators. One group will be those who attend a session presented at an annual, statewide, education conference, this September. The other group will be the gifted and talented teachers in my district. I will share the matrix as a tool to help evaluate our current curriculum and any proposed for district-wide use.

Finally, a critical component to action research, a journal or log, is missing from this project. In the future, when I engage in reflective exercises, I plan to keep a dated journal of my observations and reflections.

Reflecting on the literature. The review of literature reinforced and introduced several important aspects of gifted and talented education, higher order thinking skills, creative thinking skills, and assessment. One important point of which I was reminded is that it is not enough to embed the information or to have students practice skills. I need to be explicit when teaching students higher order and creative thinking skills. I feel more prepared to make this change in my practice, having completed this project. The view of creativity being more rare than giftedness was new to me. I now have better language to help me explain the differences in some of the major views of giftedness and creativity. I can use my familiarity with these few topics in selecting articles to share with my colleagues that provide evidence for best practice in gifted education. One conversation we, as colleagues, can have is a discussion of the definition of higher order and creative thinking skills and whether our internal definitions align to those found
in the literature. I formulated a clearer understanding of terms through reading peer reviewed material. I expect my colleagues may benefit from clarified definitions as well.

There is also ample evidence in the literature that the development and use of quality formative assessments impacts all student learning and growth. This evidence will be useful as we GATE teachers continue our curriculum development, implementation, and review process by developing common formative assessments for the units used with grade levels three through five across the district.

Through reviewing literature on peer assessment and student self-assessment as methods of formative assessment and on assessing the learning of gifted and talented students, my perspective on assessment has shifted. Before reviewing the literature, I saw formative assessment as an aspect of teaching done to be compliant with the requirements of building and district administration. I also thought that formative assessment was not as beneficial to students in the context in which I teach. Now I understand formative assessment to be a necessary component of learning target-focused instruction. The teacher or the learner can use information from frequent, quality, low stakes assessments to orient progressive understanding, skills, or progress to a learning target. The teacher or the learner can make adjustments to align the current evidence of learning with the target. This makes more sense than aiming for the goal and having no way of knowing if the learning trajectory is in line with the intended learning target. If a summative assessment shows a mismatch in the learning that took place and the learning target, the teacher and learner must repeat parts of the process and try again. Learner success and efficient use of resources require ongoing monitoring of learning to make sure the learning taking place is leading toward the overall learning target.
Assessment of gifted learners may require adjustments in order to measure growth and change in learning and skills. High test ceilings, self assessment, peer assessment, use of portfolios, and involvement in developing evaluation criteria are methods that can address some unique assessment needs of gifted students.

It is empowering to know that I can impact my teaching by critically looking at my current methods and focusing on an area to improve. Formal evaluation of the way things are currently being done takes time and effort, but the outcome, if it is improvement, is definitely worth it. Assessment methods have a huge effect on the amount of learning students do, their ability to retain the knowledge, and their ability to transfer new knowledge to a novel situation. Peer and student self-assessment are methods that align with student centered learning. Knowing this, I will concentrate effort on improving assessments and how I use them in my classroom.

**Ways to Improve the Action Research**

The nature of action research and its emphasis on the value of authentic reflection require documentation of the teacher researcher’s thoughts through the process. Had I thought of this earlier in the project, I would have documented more of my thoughts along the journey. It would have been beneficial and helped strengthen the auditing matrix as a tool had I asked a peer to also conduct several audits and to give me feedback as to its usefulness.

**Extension Ideas**

A peer auditor can, in the future, use and suggest improvements for the audit. A connection can be made from the audit results to recommendations for curriculum development and the need to include learning goals focused on higher order and creative thinking skills as a way to fulfill increasing demand for rigor in the Common Core State Standards (2010).
Recommendations

Concerning the units or any curriculum audited with the matrix, I recommend that the audit results be used to discuss the qualities of the unit of study to discover the areas of strength and weakness. The ideas generated in the discussion should influence the curriculum users to improve or replace the curriculum with more suitable material. This process is what I intend to carry out with my colleagues as the GATE facilitator in my district. I also recommend that decisions be made about teaching and assessing skills that most closely tie into developmentally appropriate levels for students.

I promote using the auditing matrix to look at written curriculum. Audit results of written curriculum can be used to detect patterns in the types of skills most often emphasized and at which grades. I also think the matrix would be a useful observation guide for teachers observing other teachers. The audit would be of implementation of curriculum rather than the intended curriculum in written form.

Because of what I have learned through this project, I would recommend that educational professionals stop to evaluate the materials they want to or are currently using in their classrooms to document that they are truly aligned with student learning goals.

Summary

In conclusion, I will list some of the higher order and creative thinking skills and assessments I utilized to complete this action research project.

Analysis was used to discern the purposes for and the best sources of pertinent information. Evaluation was used to justify the information included and not included. Application was necessary to take information from literature sources and craft explanations and
arguments. The entire project is a synthesis of former understanding, new knowledge, and information that was magnified through the lenses of purpose and necessity.

Fluency was used to generate ideas for a topic, potential elements to include in the matrix, the list of possible units to audit, and the many changes in word choice used in the accompanying paper. Flexibility was required to consider perspectives of the author, readers, potential matrix users, and outside reviewers. I employed originality to try to conceptualize thinking skills in new ways and in the creation of the matrix, which does not to my knowledge, exist in that form anywhere else. I elaborated on the ideas of many thinkers to share information in unique and thought-provoking ways.

Both self and peer assessment took place throughout the project. I gained perspective from two people outside of the master’s committee. Their comments helped me to see ways to improve the work I was doing and to clarify some of the ideas I shared. I benefited from ongoing assessment as well from members of the master’s committee who helped guide me in the direction of the research, focus, and proper communication. Without formative assessment, I would have appeared at the final review with a project I had put a lot of time and effort into only to be told that I needed to change most of it and hopefully be able to re-submit it for a more favorable outcome.

Through use of these skills and assessments as a learner, I can see how necessary they are to ensure successful student learning and growth.
References


10.3102/002831214549448

10.1080/09575140303105


STAGE 1 – DESIRED RESULTS

Unit Title: Life! – 3rd grade GATE Next Generation Science Standards Life Science Unit

Established Goals: Through completion of this unit, students will fulfill these Next Generation Science Standards. Students will also build organizational and presentation skills, but the focus will be these stated standards:

NGSS STANDARDS:
3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.
3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.
3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms.
3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.
3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.
3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.
3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.

Science and Engineering Practices (SEP):
Developing and Using Models -- Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.
Develop models to describe phenomena. (3-LS1-1)

Engaging in Argument from Evidence -- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-LS4-4)
Construct an argument with evidence, data, and/or a model. (3-LS2-1)
Construct an argument with evidence. (3-LS4-3)
Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. (3-LS4-4)

Analyzing and Interpreting Data -- Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.
Analyze and interpret data to make sense of phenomena using logical reasoning. (3-
LS3-1)

**Disciplinary Core Ideas (DCI):**

**LS1.B:** Growth and Development of Organisms -- Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)

**LS4.A:** Evidence of Common Ancestry and Diversity -- Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (Note: Moved from K–2)

Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1)

**LS3.A:** Inheritance of Traits -- Many characteristics of organisms are inherited from their parents. (3-LS3-1)

Other characteristics result from individuals’ interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2)

**LS3.B:** Variation of Traits -- Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1)

The environment also affects the traits that an organism develops. (3-LS3-2)

**LS4.B:** Natural Selection -- Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (3-LS4-2)

**LS4.C:** Adaptation -- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3)

**LS4.D:** Biodiversity and Humans -- Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (3-LS4-4)

**Cross-Cutting Concepts (CCC):**

Patterns -- Patterns of change can be used to make predictions. (3-LS1-1)

Cause and effect -- Cause and effect relationships are routinely identified and used to explain change. (3-LS3-2), (3-LS4-2)

Scientific Knowledge Assumes an Order and Consistency in Natural Systems -- Science assumes consistent patterns in natural systems. (3-LS4-1)

Systems and System Models -- A system can be described in terms of its components and their interactions. (3-LS4-4)

**NAGC STANDARDS:**
1.6. Cognitive and Affective Growth. Students with gifts and talents benefit from meaningful and challenging learning activities addressing their unique characteristics and needs.

3.4 Instructional Strategies. Students with gifts and talents become independent investigators.

4.5 Communication Competence. Students with gifts and talents develop competence in interpersonal and technical communication skills. They demonstrate advanced oral and written skills, balanced biliteracy or multiliteracy, and creative expression. They display fluency with technologies that support effective communication.

<table>
<thead>
<tr>
<th><strong>Understandings:</strong> Students will understand ...</th>
<th><strong>Essential Questions:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>* how to use the journal to record data, results, thoughts, ideas, and responses to teacher prompts.</td>
<td>• How do plants and animals change over time?</td>
</tr>
<tr>
<td>* how to develop a model from their personal knowledge of a life cycle of a plant and an animal.</td>
<td>• How do the changes help their species survive?</td>
</tr>
<tr>
<td>* that aging is a part of the life cycle and some of the changes that happen due to aging.</td>
<td></td>
</tr>
<tr>
<td>* fossils tell us about past organisms and environments.</td>
<td></td>
</tr>
<tr>
<td>* the difference between inherited traits and behaviors</td>
<td></td>
</tr>
<tr>
<td>* how to identify their own inherited traits.</td>
<td></td>
</tr>
<tr>
<td>* that there are different traits that occur within animal species</td>
<td></td>
</tr>
<tr>
<td>* reasons for the traits and how they think the traits came to be different</td>
<td></td>
</tr>
<tr>
<td>* the advantages animals have when living in certain groups</td>
<td></td>
</tr>
<tr>
<td>* that changes in an environment can cause changes in the traits of animals.</td>
<td></td>
</tr>
<tr>
<td>* some of the changes that would benefit animals</td>
<td></td>
</tr>
<tr>
<td>Students will know:</td>
<td>Students will be able to:</td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>* Personalize and organize a scientific notebook * record data, results, thoughts, ideas, and responses to teacher prompts. * Develop a model from their personal knowledge of a life cycle of a plant and an animal. * Use comparing and contrasting to process the life cycles they created in their pre assessment. * “Lose” their eyesight, hearing, and mobility * Explore the idea that students will eventually experience the aging process and how that may affect their lives at that time (driving, strength, …) * Record their reactions to the investigations in their journal * Examine and discuss fossil samples * Discuss and record their thoughts on what fossils tell us about past organisms and environments. * Complete a close read of an article and a website on the fossil record * Use the National Geographic maps on Maps 101 to make inferences about the differences in climate and environments in the past. * Explain the difference between inherited traits and learned behaviors. * Complete an activity at home that will help them to identify some of their inherited traits. * Research variances within an animal species. * Discuss the advantages of some of the grouping behaviors of animals * Complete the Baby Mice probe * Create a creature-self on <a href="http://www.buildyourwildself.com">http://www.buildyourwildself.com</a> * Use what they know to explain or show what types of changes their organism would undergo if the environment were to change.</td>
<td></td>
</tr>
</tbody>
</table>
### STAGE 3 – LEARNING PLAN

**Summary of Learning Activities:**

1. Students demonstrate their understanding of plants and animals’ life cycles by creating a model of the life cycles and comparing and contrasting them.
2. Students complete an investigation in which they experience some of the changes that happen to humans as they age.
3. Students examine fossils and look at maps of fossils to determine some of the changes that have happened to the planet.
4. Discover the difference between inherited traits and learned behaviors.
5. Discover some of their inherited traits.
6. Research variations of traits within a particular animal species.
7. Infer some reasons the variations have occurred.
8. Discuss the advantages of certain animal grouping behaviors.
9. Create a model of the life stages of a particular animal.
10. Explain changes that an animal may go through if there were a change in its environment in order for it to survive.

### Differentiation:

**Cross-curricular connections:**

RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect. (3-LS2-1), (3-LS4-1), (3-LS4-3), (3-LS4-4)

SL.3.4 Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace. (3-LS4-3), (3-LS4-4)
**STAGE 1 – DESIRED RESULTS**

**Unit Title: Invention -- 4th grade GATE Unit**

**NAGC STANDARDS:**

1.6. Cognitive and Affective Growth. Students with gifts and talents benefit from meaningful and challenging learning activities addressing their unique characteristics and needs.

3.4 Instructional Strategies. Students with gifts and talents become independent investigators.

4.5 Communication Competence. Students with gifts and talents develop competence in interpersonal and technical communication skills. They demonstrate advanced oral and written skills, balanced biliteracy or multiliteracy, and creative expression. They display fluency with technologies that support effective communication.

Established Goals: Through completion of this unit, students will identify a need, think of ways to address the need, and create a gadget that will address the need.

<table>
<thead>
<tr>
<th>Understandings: <em>Students will understand that...</em></th>
<th>Essential Questions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• inventors are creative individuals</td>
<td>• Who is an inventor of something of interest to the student?</td>
</tr>
<tr>
<td>• the process of inventing involves thinking of problems or challenges and ways to address those challenges.</td>
<td></td>
</tr>
<tr>
<td>• how to persist when challenges arise with the logistics of building a prototype of their idea</td>
<td>• What is the process of inventing?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Students will know:</th>
<th>Students will be able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Brainstorm some challenges of which they are aware.</td>
</tr>
<tr>
<td></td>
<td>• Brainstorm ways to address some of the most interesting challenges</td>
</tr>
<tr>
<td></td>
<td>• Choose a workable solution</td>
</tr>
<tr>
<td></td>
<td>• Build a prototype of their chosen solution</td>
</tr>
<tr>
<td></td>
<td>• Present their idea to a supportive audience</td>
</tr>
</tbody>
</table>
### STAGE 2 – ASSESSMENT EVIDENCE

<table>
<thead>
<tr>
<th>Formative:</th>
<th>Other Evidence:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor solution choice and design decisions.</td>
<td></td>
</tr>
<tr>
<td>Teacher provides feedback on the invention model.</td>
<td></td>
</tr>
<tr>
<td>Students’ peers provide feedback on the invention model.</td>
<td></td>
</tr>
<tr>
<td>Teachers and students evaluate the solution the student creates.</td>
<td></td>
</tr>
</tbody>
</table>

**Summative:**
Teacher evaluates the whole process and the finished prototype using a teacher created rubric.
Student evaluates the whole process and the finished prototype using a teacher created rubric.

### STAGE 3 – LEARNING PLAN

**Summary of Learning Activities:**

1. Students choose an inventor to complete a fact finding project about.
2. Each student shares the information they find about the inventor creatively.
3. Students work together to brainstorm specific challenges.
4. Each student chooses a challenge to solve with a gadget.
5. Each student searches out information on the technology necessary to create a gadget.
6. Each student creates a three-dimensional model of a prototype of the gadget.
7. Students present their gadget to a supportive audience.
Unit Title: Impact -- 5th grade GATE Next Generation Science Standards Earth Science Unit

Established Goals: Through completion of this unit, students will fulfill these Next Generation Science Standards. Students will also build organizational and presentation skills, but the focus will be these stated standards:

**NGSS STANDARDS:**

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.

**Science and Engineering Practices (SEP):**

Obtaining, Evaluating, and Communicating Information -- Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.

Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. (5-ESS3-1)

**Disciplinary Core Ideas (DCI):**

ESS3.C: Human Impacts on Earth Systems --

Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth’s resources and environments. (5-ESS3-1)

**Cross-Cutting Concepts (CCC):**

Systems and System Models --

A system can be described in terms of its components and their interactions. (5-ESS3-1)

**NAGC STANDARDS:**

1.6. Cognitive and Affective Growth. Students with gifts and talents benefit from meaningful and challenging learning activities addressing their unique characteristics and needs.

3.4 Instructional Strategies. Students with gifts and talents become independent investigators.

4.5 Communication Competence. Students with gifts and talents develop competence in interpersonal and technical communication skills. They demonstrate advanced oral and written skills, balanced biliteracy or multiliteracy, and creative expression. They display fluency with technologies that support effective communication.
### Understandings: *Students will understand that...*

- That human activity in everyday life, agriculture, and industry has had major effects on ecosystems and in outer space.
- That all of Earth’s systems are interconnected, so changes in one system can cause unforeseen changes in others.
- That individuals and communities can take action to help protect the Earth’s resources and environment.

### Essential Questions:

- How do humans change/alter their environment, planet, or the universe?
- What can be done to improve the situation?
- What is being done?

### Students will know:

- Research an ecosystem and create a presentation explaining human impact (everyday life, industry, agriculture, etc.) both beneficial and detrimental to the ecosystem. (CCSS - RI.5.7, RI.5.9, W.5.8, W.5.9)
- Construct a model to show the results of a human caused event (ex. global warming, oil spill, etc) that has altered two or more of Earth’s interconnected systems in obvious and unforeseen ways. (ex. demonstration, concept map/web, diorama, multimedia) (CCSS - RI.5.7, RI.5.9, W.5.8, W.5.9)
- Identify a problem caused by human impact and design a solution that would help reduce the human footprint associated with this problem. (CCSS - RI.5.7, RI.5.9, W.5.8, W.5.9)

### Students will be able to:

- Research an ecosystem and create a presentation explaining human impact (everyday life, industry, agriculture, etc.) both beneficial and detrimental to the ecosystem. (CCSS - RI.5.7, RI.5.9, W.5.8, W.5.9)
### STAGE 2 – ASSESSMENT EVIDENCE

#### Formative:
- **Pre-Test** - List ways humans alter their environment, the planet, and the universe.
- Monitor topic questions and advise students about refining them for successful fact finding.
- Teacher provides feedback on the impact model.
- Students’ peers provide feedback on the impact model.
- Teachers and students evaluate the solution the student creates.

#### Summative:
- Teacher evaluates the whole process and the finished slideshow using a teacher created rubric.
- Student evaluates the whole process and the finished slideshow using a teacher created rubric.

#### Other Evidence:

### STAGE 3 – LEARNING PLAN

**Summary of Learning Activities:**

1. Students select their own human impact event and research it. (ex. air pollution, reforestation, garbage, chemical waste, oil spills, etc.)
2. Students will create a slideshow that follows the same structure as the example.
3. To create a starting point, individual students will pose their own questions and gather ideas from classmates about questions to research. Each student must contribute at least 3 questions about others’ topics.
4. Students will explain what impact this human event has had two or more of Earth’s systems (ex. atmosphere, hydroosphere, cryosphere, geosphere, pedosphere, biosphere, and the magnetosphere or air, water, soil etc.) Including statistics, pictures, video, graphs, etc as evidence.
5. Students will create a model showing the impact. Here are some ideas for impact model depiction: Minecraft, 3D, concept map/web, diorama, lab, or interactive demonstration
6. Students will design their own solution to the human impact event.
7. Students will also include slides showing the current methods of solving the same human impact...
<table>
<thead>
<tr>
<th>Higher Order Thinking Skills</th>
<th>Creativity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply</td>
<td>Analyze</td>
</tr>
<tr>
<td></td>
<td></td>
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</tbody>
</table>

**Student responsibilities**

<table>
<thead>
<tr>
<th>Topic choice</th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose good sources</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Generate questions</td>
<td></td>
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<tr>
<td>Find information</td>
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<tr>
<td>Share information</td>
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</tr>
</tbody>
</table>

**Teacher responsibilities**

| Provide criteria for sources |          |          |          |          |             |            |             |
| Help students understand quality questions |          |          |          |          |             |            |             |
| Supervise information search |          |          |          |          |             |            |             |
| Help student edit the product |          |          |          |          |             |            |             |
| Assess the process |          |          |          |          |             |            |             |
| Assess the product |          |          |          |          |             |            |             |

**Assessment**

| Formative - observation |          |          |          |          |             |            |             |
| editing with student |          |          |          |          |             |            |             |
| Summative - rubric for product |          |          |          |          |             |            |             |
### Auditing Matrix for Thinking Skills and Creativity

**Unit Title:**

<table>
<thead>
<tr>
<th>Higher Order Thinking Skills</th>
<th>Creative Thinking Skills</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply</td>
<td>Analyze</td>
<td>Evaluate</td>
</tr>
<tr>
<td>Assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-test - student notebook entries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>results of diagnostic activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formative - observation - documented!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>evaluate notebook entries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>peer responses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>discussion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summative - teacher rubric</td>
<td></td>
<td></td>
</tr>
<tr>
<td>student self assessment rubric</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Student responsibilities**

| pre-test | notebook entries | diagnostic activity | investigation | peer evaluation | discussion | fact finding and sharing information | self assessment | final product | solution defense |

**Comments:**

**Name of Auditor:**

**Date of Audit:**

**Time begun:**

**Time completed:**

**revised 7/25/2017**
### Appendix D

**Audit Grade 3**

**Unit Title:** Life! 3rd Gr. GATE Auditing Matrix for Thinking Skills and Creativity

**Next Generation Science Standards**

**Life Science Unit**

<table>
<thead>
<tr>
<th>Higher Order Thinking Skills</th>
<th>Creativity</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apply</td>
<td>Analyze</td>
<td>Evaluate</td>
</tr>
<tr>
<td>I. Assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.a Pre-test - student notebook entries</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>I.b results of diagnostic activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.e Formative - observation - documented</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.d evaluate notebook entries</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>I.e peer responses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.f discussion</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>I.g Summative -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.h student self assessment rubric</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>I.i teacher rubric</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**II. Student responsibilities**

| II.a pre-test | what are students required to do? | | | | | | |
| II.b notebook entries | | | | | | | |
| II.c diagnostic activity | | | | | | | |
| II.d investigation | | | | | | | |
| II.e peer evaluation | | | | | | | |
| II.f discussion | | | | | | | |
| II.g fact finding and sharing information | x | | | | | | |
| II.h self assessment | | | | | | | |
| II.i final product | | | | | | | |
| II.j solution defense | | | | | | | |

**Name of Auditor:** Anna Kluver

**Date of Audit:** 10-17 began 9:18AM pause 9:15PM resume 9:18PM 10:06PM apparently fluency is not exercised in this unit. Apparently, fluency is not exercised in this unit. Apparently, fluency is not exercised in this unit. Apparently, fluency is not exercised in this unit. Apparently, fluency is not exercised in this unit. Apparently, fluency is not exercised in this unit. Apparently, fluency is not exercised in this unit. Apparently, fluency is not exercised in this unit.

**Comment:** Why have discussion + pre-test and peer evaluation under student responsibilities? x means it is possible that HOT or creativity could happen, but not everyone required.

**Xp = means it is possible that HOT or creativity could happen, but not everyone required.**

```
Discussion requires students to evaluate synthesize apply be flexible original to elaborate. How can I ensure the discussion continues some of these? These? Script the 35.
```
### Audit Grade 4

**Auditing Matrix for Thinking Skills and Creativity**

**Unit Title:** 4th Grade GATE, *Invention*

#### Higher Order Thinking Skills

<table>
<thead>
<tr>
<th></th>
<th>Apply</th>
<th>Analyze</th>
<th>Evaluate</th>
<th>Synthesize</th>
<th>Fluency</th>
<th>Flexibility</th>
<th>Originality</th>
<th>Elaboration</th>
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<tbody>
<tr>
<td>I.</td>
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</table>

#### Creativity

- Teacher monitors and assesses students on prototypes.
- Peers provide feedback on prototype.
- Brainstorming, designing a solution.
- Students use teacher created rubric.
- Students evaluate process and product.
- The creation of a prototype.
- Brainstorming.

#### Student Responsibilities

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**Name of Auditor:** Anna Kluger

**Date of Audit:** May 9, 2017 7:15 PM - 7:30 PM

**Comments:** The unit is very basic. It needs some form of pre-assessment. The auditor is unclear how to distinguish between analyze, evaluate, and apply to synthesize.

**revised 3/15/2017**
## Auditing Matrix for Thinking Skills and Creativity

### Higher Order Thinking Skills

<table>
<thead>
<tr>
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</table>

### Creativity

- List ways a problem could
- Brainstorm

### Examples

- Brainstorming
- Creating and defending
- Providing feedback
- Brainstorming

### Student Responsibilities

<table>
<thead>
<tr>
<th>Assessment</th>
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**Name of Auditor:** Anna Kluser  
**Date of Audit:** 5/19/17  
**Time:** 7:00PM  
**END:** 7:25

**Comments:** The two skills students seem to exercise least in this unit are analyze + synthesize. I understand synthesize being infrequent as a unit tends to build ideas separately and they have students combine them near the end. I am not sure why there are so few opps for students to analyze. There are three elements that are not apart of this unit. Every skill appears to be required at some point in this unit.

**revised 3/15/2017**