Learning Theories: Constructivism, Self-Regulation, and Social Learning Theory

Aislinn Breslin, Dana Hritz, Andrew Leman

Marist College

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**Introduction**

**Constructivism**

Constructivism is a theory about how learners attain knowledge. It “is a psychological and philosophical perspective contending that individuals form or construct much of what they learn and understand” (Schunk, 2016, p. 296). Constructivism, which emphasizes the relationship between persons, behaviors, and environments, has become an influential theory that is now used in many classrooms. The key ideas behind this theory involve a student-centered approach to teaching and a focus on interactive learning opportunities. Another key idea that is a part of constructivism is that students are able to become a part of making the rules that they must follow in the classroom (DeVries & Zan, 2003). Overall, students are the center of the constructivist classroom, constructing their own knowledge and expectations with the support of the teacher and peers.

Constructivism in general focuses on existing schema and beliefs about learning and how these factors influence students’ construction of knowledge. The interaction between existing knowledge, or schema, and newly encountered ideas or situations that students encounter is the fundamental principal behind constructivism (Airasian & Walsh, 1997). Each student learns best in his or her own way, so the idea of constructivism allows the students to interact with one another by sharing different strategies for performing a common task. This allows students to further develop their own ideas while constructing new ones that have resulted from the interaction they experience with their peers (Fischer & Rose, 2001). The interaction between
existing knowledge and different strategies of solving problems allows students to construct new knowledge effectively.

In a constructivist classroom, integration is key because it allows students to explore a topic from several perspectives. The teacher acts as the facilitator, encouraging students to ask questions and to work toward finding a solution collaboratively. Classroom materials should be used in such a way that the students are able to explore a topic through active engagement and inquiry (Schunk, 2016). This active learning allows students to connect new topics with those they have already explored. As a result, students are more likely to construct knowledge that is based on authentic experiences and exploration of a particular topic.

**Social Cognitive Theory**

Social cognitive theory attempts to explain students’ learning through the lens of their social experiences. “Social cognitive principles have been applied to the learning of cognitive, social, motor, and self regulation skills” (Shunk, 2016, p. 118). According to social cognitive theory students learn primarily by observing the people around them, these influences are referred to as models. Models can be the students’ families, teachers, and even their peers. Social cognitive theory can be used to help students learn content knowledge, but really is best utilized to model proper behavior and cognitive skills for students (Bandura, 1986).

Using the social cognitive theory, students learn not only by copying their models, but also by observing the rewards and or punishments given to their models when they behave a certain way. When a student sees a reward given to their model that they would like to receive they are more likely to imitate their model. If they see their model receive a punishment they are more likely to avoid that behavior (Schunk, 2016). This can often lead to unintended and
negative consequences in terms of how the media affects students. Researchers have recently noted and supported the connection between violent media and aggressive behavior in children (Martins & Wilson, 2011). These findings also support that fact that in today’s society children are not only influenced by those immediately around them such as their friends and families, who are likely to live in similar social situations to theirs, but they are also likely to imitate people they see on television and in the movies who live according to completely different social rules and will probably face different consequences for similar actions. While Martins and Wilson (2012) warn of the potential dangers offered by negative media influences, Banks and Mhunpiew encourage teachers and schools to use the social cognitive theory to provide their students with character development and leadership skills in focused classes (2012). They state that through proper teacher and administrator training, teachers can show and inherently teach character development through modeling, while simultaneously teaching their content.

It is also important that teachers model and show students proper metacognitive abilities and motivation. The influence of social cognitive theory can have unintended and often negative results, students who fail, or believe they are not likely to succeed are less likely to try again because of the negative results they had suffered or seen another suffer. One way we can counter this as teachers is to model resiliency, and a strong sense of autonomous learning, so that when students face a roadblock or setback, they will not be defeated but rather encouraged to try even harder for the sake of their own success (Ponton & Rhea, 2006).

**Self-Regulation**

Self-regulation, or “the process of monitoring one’s current state and subsequently adjusting towards optimal levels, is essential to our existence more broadly as well as our
learning” (Ben- Eliyahu & Linnenbrink- Garcia, 2013, p. 15). Self-regulated learning is something that has been addressed by several different theories and is something that is constantly changing (Schunk, 2015). Self-regulation is a skill that is used across multiple aspects of education. Having the ability to self-regulate is something that improves student performance. An abundance of research has been done on self-regulation and the different facets of this topic. Research has been done in the areas of goal setting, homework, reflection, and time management. With self-regulation practices being implemented in the classroom, all of these areas will show improvement. There will be improvement in the classroom as well as in the students’ lives outside of the classroom.

Goal setting is one of the components of successful self-regulation practice. Students learning how to set goals for themselves will lead them to higher achievement. Cheung (2004) examines how self-regulation practices can be used to showcase goal setting skills in students. Cheung (2004) also looks into how goal setting can be a motivational tool that improves their self-regulation learning processes, which in turn improves their academic performance. Research demonstrates that learners who practice goal setting showcased higher achievement than those that did not practice goal setting, these students are also learning oriented students (Cheung, 2004). Students are also more likely to work towards a goal they set for themselves rather than a goal that was set for them by someone else. Most students agree that setting goals is good for motivation because it gives them something to work for.

One of the stages of self-regulation that goes hand-in-hand with goal setting is reflection. It is very important that students reflect on their work and realize the improvements they have made or where they need to grow. Schunk (2015), as well as Siebert and Walsh (2013) talk
about reflection and how important it is in the process of self-regulation. If students begin practicing reflection early on in their education, it is a practice that will be replicated (Siebert & Walsh, 2013, p. 176). Reflection can only improve a student’s work. Reflection allows students to judge how they met or maintained the goals that they set for themselves. From there, students can judge whether their work reached the goal or was not quite there.

Ramdass and Zimmerman (2011) look at the role of homework and how it could be a productive factor in improving self-regulation. Also, time management is a tool that collaborates with homework. Time management teaches students how to control and utilize their time while in the classroom and outside of the classroom. Good time management can be described “as a combination of time assessment, goal setting, planning, and monitoring activities” (Hafner, Stock & Oberst, 2014, p. 83). Proper time management would have a positive effect on homework. Homework is assigned to students by teachers meant for students to complete during non-instructional time. One of the biggest ideas that Ramdass and Zimmerman (2011) look at is how homework teaches students to manage distractions and improve self-efficacy. It also manages responsibility for learning, setting goals, reflection, and time management. When students are completing their homework, they need to have the skills to motivate themselves when their teacher is not there to provide extrinsic motivation (Ramdass & Zimmerman, 2011). Self-regulation is a practice that will improve performance across a wide variety of skills in any student.

**Rationale**

We chose these three theories for our tower building lesson plan because of the fact that the activity is student-driven in nature. Our students must try and recall past problems we have
solved as a class in an attempt to try and solve this unique problem as a smaller group. This fits perfectly with the constructivist theory because students must draw on what they have learned in the past in order to complete the task in front of them. Students must use the webs of knowledge they have formed in order to create a new web of knowledge while they work and learn through a new problem (Fischer & Rose, 2001). When they are attempting to build their towers students will quickly face challenges such as how to support the weight of the top while maximizing the height of the structure. Students will have to recall information they have learned in the past such as the strength offered in different shapes, as well as the best way to connect different shapes. Students will have to decide what is best in each instance and will have to defend it by using it in their towers (Schunk, 2016).

At first glance it seems as if this constructivist theory goes against the social cognitive theory, which focuses more readily on the copying of models such as teachers and peers. However with closer inspection we can see that these two theories actually match up quite nicely. By combining these two theories we see that the web of ideas necessary for constructivism is provided by the modeling done by teachers, peers, and other professionals in the social cognitive theory. In our lesson plan we include a video for our students to watch in which engineers are building a tower and facing difficulties. While this does not fit perfectly with the constructivist ideal of students creating all of their own learning, it does fit well with the social cognitive theory of students learning from those who they see as experts in what they are trying to accomplish. While this activity is not perfectly in line with constructivist theory, it does not completely take away from that aspect of our lesson because students are learning more about how the builders face and solve problems, which can help them create metacognitive skills.
to help them when they face their own problems (Airasian & Walsh, 1997). Since the students will be faced with a unique set of problems, materials, and guidelines, their creativity should not be hampered by what they see on the video.

In terms of the social cognitive theory, students will primarily be learning in this fashion before the activity itself. Students will learn different metacognitive and cooperation skills by observing the teacher and classroom environment throughout the school year. However there are two ways in which students will be using the social cognitive theory during the activity itself. The first is that students will have to learn from the peers around them, each will bring their own ideas and experiences with them and in order to succeed the groups will have to work together in order to learn from each other and get the best idea possible in action. When students are able to successfully work together and encourage one another rather than tear each other down, their self-efficacy will increase and they will become a team more capable of completing their task (Phan & Ngu, 2015). This is part of the second way in which this activity uses components of the social cognitive theory. A classroom in which rules are made together with all parties in agreement is much more likely to follow those rules especially when they are in respect to how students treat one another. Copich notes that students who work together to base their rules off what they believe to be positive ideals are more likely to abide by those rules (2012). It is then important for teachers to model positive behaviors all year for the students to use as a model in their behaviors with one another.

Self-regulation synergizes perfectly with social cognitive theory, and to a lesser degree with constructivism. The modeling provided in the social cognitive theory is one of the best ways for students to learn proper self-regulation skills, such as time management and goal
setting. Hafner, Stock, and Oberst note that even perceived time management skills are known to relieve stress and increase productivity in students (2014). One of the best ways to teach skills like that is through modelling the desired behavior and having them see it throughout the year. One way self-regulation works well with both constructivism and social cognitive theory is through goal setting. Effective goal setting is known to increase student motivation in the future (Cheung, 2004). This is likely due to the constructivist thought process that if a student had successfully attained a desired goal once, that student will likely be able to do so again. This drives students to work harder until they reach that goal. If teachers are able to show students how to set reasonable yet challenging goals through modeling, students will be able to do this effectively which increases their motivation in the future.

**Implementation of Theories**

Constructivism, social cognitive theory, and self-regulation can all be applied in the typical classroom. The lesson we have included is designed for use in a fifth grade classroom to teach students about problem solving, particularly in the subjects of science (specifically engineering) and mathematics. The purpose of this lesson is to give students an opportunity to construct their own knowledge by working collaboratively toward a common goal. The focus of the lesson is on problem-solving techniques and reflecting on the process of working through a challenging problem. The three theories presented in this paper are all integral to this implementation of this particular lesson.

**Lesson Instructions:**

1. This lesson is based on the constructivist theory so for the building itself, teacher involvement will be minimal.
2. Throughout the year teachers should have been using social learning theory practices such as modeling to portray the importance of a positive classroom atmosphere, teamwork, and self-regulation techniques such as time management and goal setting.

3. Start the class by introducing the challenge and having the class break into pre-planned groups. For specifics on the challenge see appendix A.

4. Show images of towers and the video so that students can see the challenges engineers face when they are building real towers and how they combat those problems.

5. Hand out the worksheet in appendix B and allow students to work together to form their first design.

6. Hand out the materials and allow students to start working on their design.

7. While students work, circulate and ask questions while encouraging students to use their design sheet to make changes depending on what they have learned from each attempt.

8. When time is up, hold a discussion asking students what they learned, where they succeeded, and where they may have done something differently. Encourage self-regulation by telling students to ask these questions on their own during their next activity.

9. After the discussion hand out the worksheet in appendix D and allow them to complete it.

10. Once they have completed it correct the answers together or collect the worksheet to be graded.

11. Before the students leave or move on to the next lesson, give them the exit ticket to be completed and handed in. This is the reflective piece of the lesson that will help the teacher evaluate individual students.
Students who participate in this lesson will become more skilled in the area of self-regulation and self-management because they will need to manage their time and reflect on their performance. Students participating in this lesson are going to be working in groups to reach a final goal. Their goal will be set for them and they will need to come up with a plan to reach their goal, as seen in the Student Learning Goals/Outcomes section of the lesson plan. The lesson is going to be introduced by the teacher as seen in the Direct Instructions of the lesson plan, but the students are going to be taking charge of the outcome of the lesson.

A large part of self-regulation during this lesson is going to be for students to control their emotions and their frustrations. This lesson can be high pressure and frustrating for a lot of students. Students need to maintain composure and respect for their group members when completing this assignment. The teacher is going to be walking around guiding students, but the students are going to be the ones completing the tower and working through any difficulties. Students will have the teacher as well as their team members to help keep them on track, but they will need to keep their eyes on the final goal and not let distractions get in the way, as outlined in the Student Learning Goals/Outcomes section of the lesson plan. Part of self-regulation is not allowing distractions take away from achievement. There is going to be a lot going on in the classroom during this activity and students are going to have to remain focused on the task in front of them. At the end of the lesson, as seen in the Independent Practice section of the lesson, students are going to be reflecting on what they learned and what they would do differently if they were to complete the assignment again.

Because this lesson is designed to follow the constructivist approach to teaching, students will be able to work collaboratively to explore the topic by manipulating materials and thinking
critically. The teacher acts as the facilitator, asking questions as students work in order to encourage critical thinking about the topic. The teacher interacts with students as they are actively engaged in the learning process. Through completion of the attached assessments (see appendices B, C, and D), students are able to form their own conclusions, construct their own knowledge, and solve the problem by working through trial and error. Since constructivism can be described as the interaction between experiences, individuals, and behaviors, it is evident that this lesson is an implication of this theory.

Social cognitive theory focuses on modeling the behavior desired behavior so that students can imitate it. In our lesson plan seen in appendix A, our activity focuses primarily on a constructivist approach with students working together to accomplish a goal. The most effective way to use the social learning theory in this context is to model effective teamwork and the willingness to try new things throughout the year. Students who are stubborn and unwilling to work with the group will be a detriment during this activity. One of the most effective ways to avoid this is to establish an atmosphere where this behavior is discouraged and ultimately unacceptable. Social cognitive theory overlaps with constructivism in this instance because the students’ positive behavior is paramount to their success in a group. Students who know how to work with one another and build on each other’s ideas will be the most successful. Social cognitive theory overlaps with self-regulation because in most instances self-regulation is taught through modeling. These theories work well together because of the fact that the social cognitive theory adapts very well with other theories that have a more concrete goal. While there are times that constructivism and social cognitive theory clash due to the latent independent nature of the
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former, in this instance they work well together because of the fact that the social cognitive theory takes a backseat and takes a more passive approach during the lesson.

Assessment Plan

This lesson plan will be evaluated largely by student behavior during future activities. The primary goal of this lesson is for students to be able to work together and blend their ideas so that they can maximize the height of their towers. Students will be using skills they learned from teacher modeling in order to think through the problems offered by the assignment. Students will also have to construct their own ideas and remember what has worked and what has not as they try new and unique ways to increase the size of their tower. Successful students will be able to blend their successes and failures of each attempt, so that as time goes on their attempts at building the tower are more successful. Finally, students need to be able to use their time wisely so that they have enough time to create their best tower by the end of the 30 minute time limit.

While the most effective test of success in this assignment will be future assignments, teachers can evaluate their effectiveness more immediately by holding a question and answer segment after the building is over, or assigning a journal entry on what was learned from this activity. If students respond by stating they learned that teamwork and being flexible was one of the most important aspects of this lesson, then the activity was a success. Teachers can also reflect on what factors can be improved for future lessons. If certain students did not work well together, the teacher can make changes in future grouping. Also, students may pose questions during the process that the teacher should have accounted for during direct instruction or discussion. In this case it may be necessary to be more specific in the instructions if this lesson
would be used in the future. This would allow the learning outcomes of the lesson to take a more prominent role without the distraction of unanswered questions.

Student learning will be assessed by the three assessments attached in appendices B, C, and D. The primary use of the design sheet which is appendix B, is to see whether or not students are pre-planning, and whether or not they are planning in between each attempt. Groups that learn from each experiment and plan between each tower building attempt are more likely to succeed in their final build. The exit ticket found in appendix C will be used to see what individual students learned from the whole activity, including the discussion afterwards. This assessment asks questions such as what went wrong, what students would change, and how much their plans changed from start to finish. The final assessment attached in appendix D, is the most summative assessment. It first asks students to measure their tower in centimeters, then to convert all the teams’ centimeter measurements to meters, and finally to determine a “winner” who built the tallest tower that could hold the weight of the golf ball. These assessments along with informal class discussions and questioning will be the primary means by which students are assessed for this activity.

The teaching approach for this lesson is primarily a constructivist one. We allow students to develop their own plans and change them according to what they learn through trial and error. When used in conjunction with a broader social learning theory approach, this lesson allows teachers to help students develop their own ideas and strategies by modeling them rather than explicitly stating them and feeding them to the students. When done well, this type of modeling is one of the most effective ways to portray and teach self-regulation techniques such as time management and goal setting.
Pros and Cons of Implementing the Theories

Self-Regulation

Self-regulation can be very beneficial for most students, however there are students and certain situations that would not benefit from self-regulation. Self-regulation allows students to manage their own time and set their own goals. When implemented correctly, students who practice self-regulation are taking control of their own goals and their own achievements. In order for self-regulation to be effective, it would have to be implemented very early on in a student’s academic career. Self-monitoring, self-instruction and self-reinforcement are the varied levels of self-regulation and will take time to be taught and used effectively. Students who are struggling with goal setting and homework will benefit from practicing self-regulation. Self-regulation is also a skill that can be used by students throughout their lives. When students master self-regulation, a lot of behavior management time will be eliminated and less refocus time will be needed in the classroom. The teacher will be able to focus time on creating lessons and activities rather than guiding students on every aspect of their assignments. Teachers will also be able to assign more in depth assignments for homework because students will have the ability to plan their time and set their own goals. Students will also be more motivated to reach their goals because they are going to set them for themselves. Teachers will have more control over the content that they introduce to the students, and they will be able to go more in depth. Students will already know what is expected of them and will then focus on achieving their goals.

Self-regulation, or the ability to manage thoughts, feelings, and actions in different ways across social or physical contexts, may not benefit all learners (Saarni, 1999). Teachers
experience a wide variety of levels of learners; all of these learners have different physical and emotional capabilities. Students with disabilities will struggle with implementing self-regulation, especially those that are affected by the wide varieties of disabilities. Some students are required to have redirection based on their special needs. Self-regulation does not support this redirection. Students with disabilities need support from the classroom teacher and sometimes multiple teachers or teachers assistants in the room. Also, these students often need homework support that is provided for them at school. Depending of the age of the student with the disability, self-regulation can be altered to them. Saarni (1994) discusses how learners that practice self-regulation need to have a high threshold for the tolerance of negative emotions. Not all students would have the capabilities to deal with negative emotions. Lastly, students who are ELLs (English Language Learners) will not greatly benefit from self-regulation. Students who are ELLs need guidance and direction when completing assignments. While they can create their own goals, they may have difficulty reaching their goals without guidance along the way. Both ELLs and students with disabilities will need great guidance. They will have the ability to set their own goals and reflect on their achievement, but they will need additional guidance and support in the process.

**Constructivism**

Constructivist teaching can be beneficial for both students and teachers if used correctly. The constructivist approach allows students to become active participants in the learning process, rather than passive listeners. They are able to construct their own knowledge by exploring a new topic through inquiry and collaboration. In the constructive learning environment, the student is the center of learning; he or she controls his or her own knowledge through active participation
and support from classmates and the teacher. Also, the constructivist classroom is a place where integration of knowledge is made possible (Schunk, 2016). The teacher can design lessons that integrate a multitude of skills as well as several subject areas. Overall, constructivism is beneficial for both students and teachers because of its use of collaboration through active learning and the opportunity to integrate many different skills and subjects.

Though constructivism is beneficial in many ways, there are some roadblocks that teachers may face during implementation of the theory. One of these is the lack of instruction and concrete research we have about the application of constructivism. We know that it can be beneficial for students and have suggestions for use in the classroom, but it is not clear that these suggestions will be applicable or equally successful in every subject area (Airasian & Walsh, 1997). We also cannot conclude that constructivist teaching is the only way that students construct knowledge. Sometimes, students need to learn mechanically, following the teacher’s lead in order to become proficient in a certain skill or subject. Not all subjects can be taught using a collaborative, hands-on method. Lastly, we must not ignore the time constraints that are a reality in every school and classroom. Realistically, it is not possible to include constructivist lessons in the daily schedule. These lessons take more time to plan, implement, and assess than typical lessons. Also, teachers will need to take additional time to teach the norms that are necessary in order for a constructivist lesson to be successful. Naturally, teachers and students learn as they experience these kinds of lessons, resulting in instances of unsuccessful constructivist lessons that were not worth the time. Like any learning theory, constructivism has its pros and cons, but it is becoming widely accepted and applied in many classrooms.
Social Cognitive Theory

In this assignment the social cognitive theory takes a more passive role than the constructivist and self-regulation theories. The primary role of the social cognitive theory is to provide students with a model way to act when approaching the problem they are faced with as well as having to work within a team (Schunk, 2016). This will primarily take part before the actual start of the assignment. One of the most difficult aspects of using the social cognitive theory is the fact that teachers must remember their behavior is always being viewed, judged, and sometimes emulated. While social learning does take place at home and in other areas outside of school, the only social learning a teacher can directly control is what happens in school where students learn from the behavior of the teacher and their peers. The social cognitive theory primarily focuses on behavior modification metacognitive growth, which in turn leads to learning (Banks & Mhunpiew, 2012).

This theory is lacking in terms of how to more directly teach students information. Students can be encouraged and influenced to act a certain way but this theory revolves around the fact that students will become a product of the atmosphere around them. What they consider important is generally tied to what others around them consider important and if education is not one of those things a teacher’s job becomes much more difficult. This makes knowing the background of different students critically important when trying to use this theory. Students who come from a culture where education is important will naturally consider it important as well, these students will not need the same level of positive modeling as other students who may not consider learning or education as inherently important.
However modeling learning strategies is not the aspect of the social learning theory. In recent years the primary goal of social learning theorists has been modifying the behavior of students. One of the biggest benefits to using this theory is the fact that it encourages positive behavior which leads to a better classroom experience and learning atmosphere for all students. Many theorists believe recent bullying trends are caused by social learning and students being influenced by violence they see on television (Martins & Wilson, 2011). If this is true then one of the effective ways to combat this trend would be by offering students a positive influence and model to follow.

**Conclusion**

Self-regulation, constructivism and Social Cognitive Theory are very valuable to both teachers and students. Self-regulation is extremely beneficial for teachers, but more importantly students. Self-regulation teaches students to manage their own time and work. Students will perform better on work that is required outside of the classroom because they will have increased ability to manage their time. If students improve their self-regulation they will have the ability to set their own goals, work towards those goals and reflect on their performance working towards those goals.

Constructivism allows students to construct knowledge by connecting schema to new experiences. All of the knowledge that the student acquire is through experience, including interactive experiences. Constructivism also says that students benefit the most and learn the most when they are working collaboratively. The relationship between the student and teacher is interactive and the teacher acts as the facilitator in the collaborative work. This provides
students with active instead of passive learning experiences. Students asking questions and making observations is the key to the construction of knowledge.

The social cognitive theory was made popular by Albert Bandura and the Bobo doll experiment. The social cognitive theory says that students learn by observing and imitating models. Some potential models are family, teachers, peers, professional athletes, actors and musicians. Students are storing information as words or pictures before they rewrite it as their own actions. Social cognitive theory makes connections between self-regulation and constructivism. Since social cognitive theory encourages teachers to model certain behaviors for students that will encourage certain behaviors, vicarious learning can influence a student’s belief concerning what he can and cannot do. A teacher’s encouragement and modeling will give students the confidence they need to push themselves to achieve their goals. While constructivism works with students being their own model, it still can have connections with social cognitive theory. In constructivist learning, a student’s model will be the other students. Self-regulation, constructivism, and social cognitive theory are all important aspects of student learning and have many connections across a wide range of skills and subject areas.


Lesson Plan Title: Tall Tower Challenge

Grade level: 5th grade

Content area: Science (engineering) and mathematics

Concept / Topic to Teach (succinct overview of the lesson): During this lesson, students will be introduced to the world of engineering by constructing tall towers using limited materials and a time limit. Students will be required to apply their skills of measurement and conversion during this collaborative lesson. They will work through trial and error and reflect on the process of building the tower after completion.

General Goal(s)/Rationale: The goal of this lesson is for students to gain understanding about how to solve problems effectively by constructing their own knowledge through exploration. Students will benefit from working collaboratively towards a common goal. The ability to compare and contrast methods for problem solving is built into this lesson in order for students to form conclusions about how each team solved the problem. Self-regulation and reflection is key to this lesson because students must be able to effectively analyze their experiences and form conclusions about the strategies used and possible changes that could have been made. Overall, this lesson integrates many different skills and subject areas in order to provide students with an opportunity to construct their own learning in an authentic way.

Standards Addressed:

Next Generation Science Standards
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

CCSS Mathematics
5.NBT.2. Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.
5.NBT.1. Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.
4.MD.1. Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express
measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table.

1. Student Learning Goals/Outcomes
Students will:
- learn about structural engineering by building a tower.
- generate and discuss multiple solutions to a problem.
- convert measurements using powers of ten.
- work collaboratively to plan and carry out tests in order to solve a problem.
- collect data and present it neatly.

MATERIALS:
2. Required Materials and Equipment
- Powerpoint presentation
- Smart Board
- Youtube video: [https://www.youtube.com/watch?v=9W8qkf96Hp8](https://www.youtube.com/watch?v=9W8qkf96Hp8)
- Each group of 3-4 students will receive the following materials:
  - 30 straws
  - 30 pipe cleaners
  - 20 paper clips
  - scissors
  - rulers
  - golf ball

PROCEDURES:
3. Prior Academic Knowledge and Conceptions/Anticipatory Set
What knowledge, skills, and concepts must students know to be successful with this lesson?

The most important knowledge sets students will need in order to be successful in this lesson will be the strength provided by different shapes and materials, as well as the ability to effectively work together as a team and learn from your mistakes.

What prior knowledge and/or gaps in knowledge do these students have that are necessary to support the learning of the skills and concepts for this lesson?

This lesson is primarily set up to be a lesson in problem solving and learning from past experiences in a constructivist manner. While prior knowledge may be helpful students with no preconceived notions may actually be more effective since they may have a more open mind when trying to solve problems. The most important skill necessary for success in this lesson is the ability learn from previous experiences.

What are the common errors, developmental approximations, misconceptions, partial understandings, or misunderstandings of students related to the central focus of this lesson?
Common errors or misconceptions involved in this lesson are trying to imitate the types of buildings students see, specifically in the video shown, rather than try and adapt the solutions provided to the work with the materials available. Another major problem students can have with this assignment is being too rigid and set in your ideas. It is important to at least attempt different ideas of each person involved but when students try to stick to their ideas even after they have failed they usually end up wasting valuable time and ignoring their teammates.

**What kind of triggers do you use to tap into your students’ previous knowledge and prepare them for the next lesson?**

Most of the triggers used are in the form of questions such as, what did your team do that helped, what may have you done better? By reflecting on these questions we prepare for future similar tasks while also building a community within the classroom that realizes it is better to work with one another and blend one another’s ideas than it is to try and do everything one way.

**4. Direct Instruction**

Tell students that today they will become engineers. They will be given a task which requires teamwork and some trial and error in order to be solved. First, show students pictures of tall towers around the world (see powerpoint presentation). Ask students to discuss what they know about towers and how structure affects the strength of the tower. Students will discuss what makes these towers stand so tall without falling over. Ideas from discussion will be written on chart paper to display for all students. After this discussion, show the following video about the construction of the Eiffel Tower: https://www.youtube.com/watch?v=9W8qkf96Hp8. This video will serve as a model for students as they begin their work in groups. Add anything students wish to add to the list created before the video. Display and read instructions to students.

**Instructions:** You are part of a team of engineers. You have been given the task of building a tall tower that can support the weight of a golf ball for at least two minutes. You have a limited supply of materials and can NOT use anything other than what is provided to you. Your goal is to design and build the **tallest tower possible** that can support the weight of the golf ball for the entire two minutes or longer. You must measure and record the width of your tower’s base as well as the height of the tower’s tallest point. The golf ball must sit at the tallest point of the tower. You will have 30 minutes to construct your tower. Here are your materials: 30 straws, 30 pipe cleaners, 20 paper clips, scissors, and a ruler. The team that builds the tallest tower that can support the golf ball for the full two minutes is the winner! Good luck, my exceptional engineers!

Students will be assessed formatively during work time based on the answers they provide for questions the teacher asks. They will also be assessed on their team-building strategies and the planning they put into their designs.

**5. Structured/Guided Practice**

Give students about 5 minutes to consult with their teams and draw a sketch of their designs. Remind them to include the ideas discussed during the beginning of the lesson. After
designs have been completed, allow students 30 minutes to complete the task. As the teams work, circulate the room to ask questions about strategies that are working and not working. Question students about their predictions. Be sure to watch for students who are not putting in enough effort and encourage them to take a more integral role in the process. After teams are finished with towers, test their tower with the golf ball. Each tower should hold the ball for at least two minutes. Require students to work through challenges as a team, making changes that will move them closer to achieving their goal. Make note of the conversations students have within their groups, and commend students on successful problem solving strategies.

6. Closure
After all teams have finished (approximately 30 minutes), view and discuss each tower as a class. Make a large chart on the board (or Smart Board) representing each team’s name and information about its tower (height, width at base, and golf ball results). This will be similar to the data table provided for students. Teams will discuss their tower’s success, what they did to create it, and what they could improve. Each student will record the results and measurements in his or her own chart. Students will then individually complete an exit ticket, or reflective response sheet, to assess understanding of the learning objectives. They will also be assessed on their completion of the data table.

7. Independent Practice
*What kind of methods (homework or other in class or out of class independent work) you will use to make sure that your students will demonstrate whether or not they can demonstrate the learning outcomes set forth.*

The best way to know whether or not students learned the problem solving skills they are meant to learn in this class would be to have other similar assignments in class. Students who learned the lesson will behave in a manner that encourages teamwork and uses the skills learned during this lesson. Students can also be asked to write in the journals lessons they may have learned and what they may do differently if they were able to attempt this activity again.

**ENRICHMENT:**

8. Adaptations/ Differentiation/Planned Support:

a. **Whole class:** Prior knowledge is activated through discussion and engagement in the form of images and a video. Students will discuss the topic with a partner and share ideas as a whole class. Those who have no prior knowledge will learn from this discussion and from the images and video presented. The prior knowledge that is needed for this lesson is not critical to the success of the students who complete the lesson.

b. **Groups of students with similar needs:** Students will be grouped heterogeneously so that strengths and weaknesses will compliment one another. Students with similar needs will be dispersed among different groups to help balance the teams to ensure success. The teacher will group students according to ability level, communication and social skills, and individual strengths.
c. **Individual students:** Individual students who show gaps in prior knowledge can be given additional resources to review in a small group. This may include additional images of towers, short descriptions of how towers are structured, and brief videos that relate to the concept. This group will be monitored and supported by the teacher and students will then be placed in heterogeneous groups for the remainder of the lesson (work time).

d. **Students with IEP or 504 plans:** Students who have IEP or 504 plans will not require additional support for the experimental (collaborative) portion of this lesson. They may need further support during the assessment that requires them to reflect on the activity and make changes that would ensure future success. In this case, these students would be provided with sentence starters to help them begin formulating their conclusions about the activity.

9. **Extensions and Student Interactions:**
   This activity is naturally a group assignment so it will not need to be altered to encourage collaboration. Groups will be heterogeneously arranged; the reason for this is so that students will be able to understand that the “smartest” group may not necessarily perform the best in this activity. Groups who are willing to work with one another and not waste time will be more successful than groups who all think they have the best idea and are unwilling to modify their plans.

10. **Possible Connections to Other Subjects/Courses:**
   This activity can connect well to both math and history courses. Depending on what you are studying in those subjects this activity can connect directly with history by focusing on the challenges and achievements of ancient civilizations such as the Greeks and Romans who were able to build great buildings without modern equipment. This activity can also be related to mathematics in a number of ways. Students can measure their towers and the towers of their peers and make a chart or graph depicting the difference heights. Students can record the measurements of each of their towers and make ratios or fractions comparing the heights of different towers.

**ASSESSMENT:**

11. **Assessment**
   The assessment must be aligned to learning outcomes and standards targeted with the lesson, and must measure the learning outcomes that you set for the lesson. Describe the tools/procedures that will be used in this lesson to monitor students’ learning of the lesson objectives. Attach a copy of the assessments and/or the evaluation criteria/rubric at the end of lesson plan (or separate)

<table>
<thead>
<tr>
<th>Type of assessment</th>
<th>Description of assessment</th>
<th>Modifications to the assessment</th>
<th>Evaluation Criteria</th>
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<tbody>
<tr>
<td>(Informal or)</td>
<td>(So that all students)</td>
<td>(What evidence of student learning)</td>
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<tr>
<td>Formal; Formative or Summative; etc.)</td>
<td>can demonstrate their learning)</td>
<td>outcomes set for does the assessment provide?)</td>
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<td>informal, formative</td>
<td>Each team will complete a design sheet, illustrating how they plan to build their tower.</td>
<td>Students will work in groups so that they will be able to assist one another.</td>
<td>How many designs did the students use? Did they change their designs to take new knowledge into account? How successful was their final design?</td>
</tr>
<tr>
<td>informal, formative</td>
<td>Teacher will question individual students during work time, focusing on the strategies used to solve the problem.</td>
<td>Teacher will tailor the questions to meet the needs of individual students</td>
<td>Student responses both verbal and physical will determine their learning.</td>
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<tr>
<td>formal, summative</td>
<td>Students will complete an exit ticket, which asks them to reflect on the strategies used during work time and the changes that could be made in order to improve performance.</td>
<td>Student who need extra time or the need to take the assessment home will be able to do so.</td>
<td>Answers on the exit ticket will reflect student understanding.</td>
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<tr>
<td>formal, summative</td>
<td>Students will complete a data table involving measurements from each team’s structure. Individual students will convert the measurements from centimeters to meters.</td>
<td>Students will be working in groups, students who are allowed to use calculators in their IEP will be allowed to do so.</td>
<td>Did students accurately measure each tower, and were they able to convert centimeters into meters?</td>
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</table>

(adapted from a lesson found on [http://tryengineering.org/lesson-plans/tall-tower-challenge](http://tryengineering.org/lesson-plans/tall-tower-challenge))
Appendix B

Team Name: __________________________________________

Date: __________________

Tall Tower Challenge

Design Sheet

Draw a sketch that shows what your team’s design will look like. This is just a plan. Your tower may not look exactly like the sketch when it is finished. Trial and error will occur during your construction.
Appendix C
Name:_____________________________________________
Date:__________________

**Tall Tower Challenge**

**Exit Ticket**

Did your team’s tower successfully hold the golf ball for two minutes? If so, why was it successful? If not, what went wrong?

How similar was your final tower to the sketch you drew before you began? What was different?

If you could complete this task again, what would you do differently? What would you do the same?
## Tall Tower Challenge

### Data Collection Sheet

<table>
<thead>
<tr>
<th>Team #</th>
<th><strong>Height of Tower</strong> (cm &amp; m)</th>
<th><strong>Greatest Width at Base</strong> (cm &amp; m)</th>
<th>Did it hold the golf ball for at least two minutes?</th>
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<tr>
<td></td>
<td>Write an equation with an exponent to convert cm to m.</td>
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**Winning Team** ___________________________________________________