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# The Relationship Between Creativity and Teamwork: The Effect of Improved Teamwork on the Creative Output of Gifted Students

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**Abstract**

The purpose of this study was twofold. First, it sought to determine how to improve students' cooperative learning skills and the ability to work in teams among gifted students. Secondly, whether and to what effect improved cooperative learning skills had on creativity among gifted students. Teamwork was improved through a direct instruction unit on teamwork, where students participated in coding activities, role-plays, and other cooperative games. Destination Imagination challenges were used to determine teamwork and creativity scores and students participated in a survey of their own and their teammates performance on the challenges. The participants were 38 gifted students from a mid-Atlantic school district ranging in grades from 2-5. The results showed a statistically significant improvement in students' ability to work cooperatively as well as a promising link between teamwork and creativity scores.

*Keywords*: Gifted, Elementary, Creativity, Teamwork, Cooperation

The National Association of Gifted Children (NAGC) states the importance of creativity and working cooperatively among gifted learners (National Association of Gifted Children, 2010). While creativity can be notoriously difficult to quantify or qualify, several researchers have described it as the ability to produce unique ideas, new behaviors, and generating ideas based on one's own thinking and socio-cultural constructs (Kim, Il Soon Roh, 2016). It is the last part of this definition that is at the heart of this study.

Gifted students can struggle to work in groups. Gifted students can struggle in heterogeneous groupings because they are intellectually different than their peers (Rinn, Siegal, and Davis, 2018). They often feel that they are pulling more than their own weight or doing things that do not interest them (Huss, 2006), because of this gifted students often do not develop teamwork skills in their regular classroom. Even in homogenous groups, gifted students can struggle with cooperative learning and teamwork skills (Patrick, Bangel, Jeon, and Townsend, 2005). In addition to the National Association of Gifted Students standards, Donald Treffinger noted that gifted educators need to provide opportunities for gifted students to apply teamwork skills along with creativity and problem solving (Rinn et al., 2018).

The importance of improving teamwork has been noted by several studies and educational programs (Destination Imagination, 2018; Rinn et al, 2018). The program that will be used in this study is Destination Imagination (DI). Two of the five principles of DI are creative problem solving and teamwork; allowing students to take agency over their decisions and challenges (Destination Imagination, 2018). While DI provides the basis for examining teamwork and creativity scores, the question remains of how to improve teamwork among gifted learners. Fortunately, there are a plethora of ways to accomplish this.

One way to accomplish this is through direct instruction on teamwork and leadership skills. Activities such as role-playing scenarios and discussions can help students build their ability to listen and learn from each other (Berkowitz and Hoppe, 2009). Teacher lead discussion groups and modeling are also ways to improve teamwork skills among students (Heacox and Cash, 2014). Developing good leadership skills such as the ability to delineate tasks and recognize skills of peers is also a valuable exercise (Rimm et. al., 2018). Developing interpersonal skills through games and activities and can develop problem solving skills in other areas of education as well (Kashani-Vahid, Afrooz, Shokoohi-Yekta, Kharrazi, and Ghobari, 2017).

With the increased availability of technology in the classroom, websites like Scratch, a coding website for students, opens up a world of possibilities. Students can create role playing games (RPGs) collaboratively, create stories together, and build on each other's ideas online (Hagge, 2017). RPGs, as well as traditional role-plays, can help students overcome struggles with interpersonal skills and find acceptance in the classroom (Rosselet and Stauffer, 2013).

Based on this information, the goal of this study is to determine two primary pieces of information. First, how can teachers improve teamwork skills among gifted students; secondly, what effect, if any, do improved teamwork skills have on creative output?

Students were given DI Instant Challenges, one STEM based and one performance based. After each challenge was completed once, students participated in a 4-week long unit on teamwork skills, then performed the same challenges again. Teamwork and creativity scores were taken as well as the total score based on score cards provided by DI. The teamwork unit consisted of role-plays, teamwork games, reflections and two days of creating stories on Scratch.

## Theoretical Framework

The idea of Communities of Practice was first put forth in 1991 by Lave and Wenger and furthered by Wenger in 1998. The theory of Communities of Practice is built on the idea that learning does not rest with the individual, but rather is a social process that occurs within a group (Farnsworth, Kleanthous, and Wenger, 2016). The theory of Communities of Practice states that people learn in communities who have similar interests and work together over a period of time (Wenger, 1998). Wenger breaks down learning into four main sections: identity, meaning, practice, and community (Paul, 2002). The identity of the learner is important because as the student becomes part of the learning community and by extension realizes their individuality as a learner (Paul, 2002). Communities of Practice allow learners to learn from themselves and from each other, rather than a typical top down method of education (Wenger, 1998). While Communities of Practice can arise in any social situation where humans interact (Farnsworth, Kleanthous, and Wenger, 2016), the focus of the theory in this context is in the classroom.

In the study of gifted students cooperative learning and creativity, the Communities of Practice theory will help inform the study. Students participating in the study will be participating in Communities of Practice as they build their skills. One of the things being studied is the students' ability to improve their creativity by learning from others. This fits nicely with the ideas behind Communities of Practice theory. The heart of Wenger's theory is the idea that learning is not just a simple acquisition of skills and knowledge, but is a process of learning as a community (Farnsworth, Kleanthous, and Wenger, 2016). In the study, students will be working in small groups to improve their problem-solving skills and creativity. The students should learn from each other and improve creativity as a whole. As they build their interpersonal skills and improve the community their creative outputs and skills will be measured.

## Review of Literature

The discussion of gifted students and cooperative or group learning first came about in the 1990s with a comprehensive study done by Johnson, Johnson, and Smith that showed a positive correlation between higher-level thinking and cooperative learning environments (Huss, 2006). Parents pushed back against this finding because they felt that their student's potential was not being reached (Huss, 2006). This is a particular issue that arose when gifted students were working with non-gifted students, but even in homogenous groups of other gifted students (Patrick, Bangel, Jeon, and Townsend, 2005). In addition to recognizing the importance of building teamwork and cooperation, the gifted education standards put forth by the National Association of Gifted Children recognized the importance of fostering creativity in students (2010). One of the advantages of cooperative learning is that it can foster creativity in students and allow them to compete with other groups and build off other students' ideas (Chen and Chui, 2016; Baykoç, Aydemir, and Uyaroglu, 2013). There are several programs designed for gifted students such as Destination Imagination, Future Problem Solving, and Odyssey of the Mind that seek to foster creativity through the use of teamwork and cooperation (Rinn et al., 2018).

One of the most influential people in the education of gifted students is Joseph Renzulli (Rinn et al., 2018). His Three Ring Conception of Giftedness is one of the most prevalent theories in the world of gifted education. One of the rings in Renzulli's model is creativity (Schindler and Rott, 2017). Renzulli argues that creative output is among the most critical skills a gifted learner can possess as we are expecting our gifted students to become leaders and creators in our society (2012). Renzulli is also a proponent of the enrichment triad model of gifted education (2012). This model is designed to work with individuals as well as small groups of gifted students. Renzulli’s triad model allows students to discover passions and work with

other like-minded students on real world problems and solutions (Renzulli, 2012). While many gifted classrooms are homogenous, even within a class of all gifted students, there is a significant variation in the characteristics of the students (Castejón, Gilar, Miñano, and González, 2016). This fits nicely with Renzulli's third triad, which, when done with groups of gifted learners, promotes cooperation and a feeling of creative accomplishment (Renzulli, 2012). Indeed, one of the ideals of cooperative learning is that it increases creativity among gifted students (Gunawan, Harjono, Sahido, and Nisrina, 2018).

Technological advances in the classroom and STEM activities have also led to an advancement in creativity among gifted learners (Rinn et al., 2018). Keiler (2010) examined the use of digital storytelling with gifted students. She noted that gifted and talented students could struggle to interact with peers on a social level and used digital storytelling to allow her students to brainstorm and cooperate (2010). Housand and Housand (2012) also examined the role of technology in gifted education. They found that creating a video game in cooperative groups improved teamwork skills and creativity (Housand and Housand, 2012). They went on to state that working with other gifted students is vital to the development of gifted students' motivation and feelings of belonging (Housand and Housand, 2012). The use of technology, and collaboration through technology among gifted students, allow them to grow in creativity and the ability to work with others (Ariyani, Maulina, and Nurulsari, 2019).

Studies have also shown positive results when gifted students work with teams in Problem Based Learning (PBL) and engineering methods (Mann et al., 2011; Baykoç, Aydemir, Uyaroglu, 2013). Integrating PBL and engineering activities into the gifted classroom allows students to collaborate and work with each other on solutions to real-world problems. When examining gifted students at a STEM school, Kim, Roh, and Cho (2016) found that gifted

students working in teams to complete various engineering challenges showed improvement in creativity test scores as measured by the Tolerance Test of Creativity. These findings are promising and show the importance of gifted students working in groups and developing teamwork skills.

While much of the scholarship related to gifted education and collaborative learning shows a positive relationship between collaboration and the development of student creativity, some contend that gifted students work better as individuals. Gifted students often struggle in groups, even in homogenous ones, as they feel they are able to accomplish more work as individuals (Rinn et al., 2018). While this problem exists in homogenous groupings of gifted students, it is more pronounced in groups of mixed ability as the gifted students often feel they have to work as tutors (Patrick et al., 2005). Gifted students can struggle in groups and sometimes feel that they are doing more than their fair share (Colangelo and Davis, 2003). Patrick, Bangel, Jeon, and Townsend (2005) also noted the concern that gifted students struggle to reach their potential when grouped with non-gifted peers. According to French, Walker, and Shore (2011), there is a widely held belief that gifted students work better, and even prefer to work alone, than with a group of students. However, as a society, we are becoming more and more connected, and as collaborative technology increases in our society, students must be comfortable working in teams. Indeed, French et al.'s work showed that there are several variables to consider before the claim can be made with certainty (2011).

While several studies indicate the importance of developing cooperation and teamwork to help develop creative skills; a few studies have raised interesting discussions about competitiveness as a part of collaborative programs. Having students compete in a Rube Goldberg machine design challenge allowed them to work in teams competing against other

teams completing the same challenge (Kim et al., 2016). Results of this study were mixed as some groups enjoyed the challenge of competition, while others did not. Some gifted students enjoyed competition against other gifted individuals and see it as a way to test themselves against their peers (Baykoç et al., 2011). Indeed, Chen and Chui found that students who competed in groups against other groups showed more motivation and creativity when solving tasks and challenges (2016).

There are several ways that have been explored to foster teamwork and creativity. Keiler (2010) studied gifted students and how they worked with digital storytelling. Digital storytelling is a fantastic way to develop creativity because it allows for students to build on each other's stories and examine viewpoints that are not their own (Keiler, 2010; Hagge, 2017). Indeed, digital activities in general can be very useful in growing creativity. Coding activities such as Scratch can develop creative problem-solving skills and also allow students to explore their own interests (Hagge, 2017). Importantly, students can work with one another to develop programs and learn by playing with one another (Hagge, 2017). One teacher studied by Hagge (2017) combined coding through Scratch and digital stories. Students discussed and brainstormed with classmates and developed digital stories based on a reading they had done in class. Students were able to build on each other's ideas and present their stories to the class.

Another use of Scratch, examined by Hagge (2017), that had an even greater element of collaborative learning, was the use of RPGs. A seventh-grade class was studied by Hagge (2017), where students completed a RPG based on the novel *The Glass Sentence*. Students worked collaboratively in a Scratch studio. They worked together to find the essential characters and elements of the story and created their own characters and took turns being the narrator of the story, essentially making sure that the story moved along (Hagge, 2017). RPG activities, in

addition to helping develop cooperation and creativity, can also help gifted students overcome interpersonal skills that they can struggle with (Rosselet and Stauffer, 2013). In studying various interventions using RPGs, gifted students developed creative solutions to unique problems and increased social skills (Rosselet and Stauffer, 2013). One particular student examined, who struggled finding acceptance and working with peers, developed a sense of teamwork and social acceptance with other gifted students (Rosselet and Stauffer, 2013).

Creativity and teamwork are also built through creative problem-solving activities. Greg Laufer, of Adventures in Learning, discussed the importance of building teamwork as a means to improve creativity (Conrad, 2018). He stated that one of the best ways to build teamwork is to teach it through direct instruction. This desire to improve teamwork through direct education can be accomplished through character education (Berkowitz and Hoppe, 2009). One strategy discussed by Heacox and Cash (2014), is to have students discuss and reflect with peers on their learning: what was difficult and easy for each of them. This helped them recognize strengths among themselves and their classmates. Teacher modeling is also an important part of building a production cooperative learning environment for students. Teachers should demonstrate proper language and social skills in the group setting (Heacox and Cash, 2014).

Interpersonal relationships and character were also examined by Kashani-Vahid, Afrooz, Shokoohi-Yekta, Kharrazi, and Ghobari (2017). They found, when studying 4th grade girls, that when applying creative problem-solving techniques to interpersonal problem solving, students showed greater fluency, originality and creativity. These findings are promising and show that when social and character education is taught directly, students' creativity has the potential to improve in other areas of school as well. This development of interpersonal and cooperation skills has been developed into the Thinking Actively in a Social Context (TASC) model. Using

the TASC model allows the teacher to become a facilitator of learning, once cooperative skills are taught to the students (Alhusaini, 2018). TASC as a form of problem solving or Project Based Learning can help develop cooperative learning skills in students and allow them to come up with creative solutions to authentic problems (Alhusaini, 2018). Combining the TASC model with direct character instruction could be a very effective intervention. Interventions and strategies that aim to improve interpersonal skills and emotional intelligence can improve gifted students' ability to work cooperatively with each other and improve teamwork skills (Zeider and Matthews, 2017).

One thing that becomes clear when reading the literature surrounding gifted students and cooperative learning is the interconnectedness between teamwork, creativity, and leadership. The National Gifted Standards have several standards related to the development of leadership skills, collaboration skills, and creativity (National Association of Gifted Students, 2010). These traits are crucially essential to develop in gifted students (Rinn et al., 2018). If implemented correctly, the literature points to positive correlations between collaborative environments and challenges and building creative thinking in gifted youth.

## Methodology

The goal of the study was to discover whether, and if so, to what effect improving cooperative learning skills in gifted students had on their creative output. While creativity can be difficult to quantify, through the use of various collection tools, this study attempts to put a quantifiable measure on the creativity of gifted students. Students participated in three main activities to measure creative output over the 6-week study. First, students participated in DI Instant Challenges and were scored by their teacher. The building challenge consisted of

constructing a structure out of everyday materials that fit into four taped squares 12 inches apart and as tall as possible. Students also participated in a challenge that required them to create an imaginary antique from the year 2011, discovered in the future. Students were required to present a skit on the item they created and explain why it has value in the year 2511. Students participated in each DI challenge two times throughout the course of the study with discussions held after each time. The challenges used were provided for free from the DI website and can be found in Appendix A. For all group work during this study, a random number generator was used so students had the opportunity to work with different people each activity.

Between the first and second challenges, students also participated in direct instruction on cooperative learning skills and teamwork. During the direct instruction period, students role-played various scenarios and participated in group activities with assigned tasks. After the direct instruction lessons, the students and teacher again debriefed and discussed how they might improve teamwork and cooperative learning skills. Role-plays included scenarios that students often find themselves in during teamwork challenges. One activity asked students to create a story only saying one word at a time. This helped them learn to react and listen to what other students said and still create a story that made sense. Students also practiced refraining from saying comments to each other. In this role-play, students broke into groups and were given scenarios that could happen in group work. For example, a teammate accidentally broke a material for a building challenge, or a student disagreed with an idea another student had. They then practiced not making negative comments toward the other students in their group and came up with more productive ways to disagree.

Students also played team building games during this unit. The first game played was called “Yes And.” In this game students form a group and start a sentence, the next student says

another sentence. The only rule is no student can say "no." The second game that was played was the Human Knot where students had to work together to untangle themselves from each other. During the third game, students had to line up in order of birthdays without talking. The fourth game activity focused on practicing giving direct instructions to teammates. Students were given a common household object, for example a broom. Students then had to write directions on how to use the object while other students had to guess what it was.

The final aspect of the unit was story creation using Scratch. Students first built stories using Scratch in groups of two, then joined another group of two and "remixed" each other's stories (see Appendix B). This activity was done twice; once halfway through the unit on teamwork skills and once at the end of the unit before completing the DI challenges again.

## Data Collection

Data was collected in several ways throughout the study. The teacher kept a running log of activities during the unit on teamwork. After each instant challenge, students responded to a survey on how they and their teammates did during the challenge (Appendix C). During the instant challenges and Scratch activities, the researcher also tallied negative comments heard by the groups as well as times he had to step in and redirect students to stay on task. Finally, data was collected from the DI score sheets themselves. Each team received not only a composite score, but also had space for teamwork and creativity scores. These scores were compared at the end of the study to determine results of the study.

## Participants

Participants in this study were 38 gifted elementary students across eight different schools. These students were designated as gifted as per state policy. The policy identifies students as gifted if they have a full-scale IQ in the 97$^{th}$ percentile range and/or the 90$^{th}$

percentile range in a specific subject in standardized testing and classroom performance (West Virginia Department of Education, 2017). Gifted class was held once a week for each student; two second through third grade classes and two fourth and fifth grade classes. The total number of students was broken down as such:

| *Class* | *Boys* | *Girls* |
|---|---|---|
| 2nd-3rd #1 | 2 | 6 |
| 4th–5th #1 | 9 | 3 |
| 2nd-3rd #2 | 7 | 4 |
| 4th–5th #2 | 7 | 2 |

The gifted students in the district studied are bused to central schools once a week for gifted instruction, which is why such a large number of individual schools were studied.

## Findings

The purpose of this study was to determine how to improve cooperative learning skills in gifted elementary students as well as to examine if the improved teamwork skills lead to a more creative output for the students. The research used both qualitative and quantitative data. Destination Imagination instant challenges were utilized, as well as coding activities via scratch.edu. Data was collected from instant challenge scores, negative comment counter and student reflections via survey.

### Improving cooperative skills/teamwork

The first research question deals with how to improve teamwork skills among elementary gifted students. After completing the instant challenges students took the survey (Appendix C)

for the first time. The survey asked them to identify things that they did and that their teammates did, as well as give themselves and their team a rating. After the first round of testing, five students gave their team a perfect rating. The second round of questions produced 20 students who gave their teammates a rating of 10/10. The average teammate rating for the first round of tests was 7.8 after the team building activities the average teammate rating rose to 9.0. These findings were statistically significant at a p-value of <.03. The individual average individual rating went from 7.3 to 7.8. This data was not statistically significant at the p-value of <.03. The short answer questions did become more positive at the second survey. The first round of survey had students struggling to find strengths in their teammates. One student mentioned he gave his teammates a higher grade than he gave himself because of a lack of "self-confidence." Another mentioned that some of their teammates gave up, when others did not. Not all of the surveys were negative however. One student gave both themselves and their teammates 10/10 because they "had great cooperation and teamwork."

The second round of surveys was generally more positive, though one student did give a 1/10 to both themselves and their teammates, but did not give a reason why. This was generally not the norm. Most students responded more positively the second time. One student gave both themselves and their teammates 9/10 and said cooperation was much better this time. One student mentioned how they were able to each work on a different part of the challenge and put it together as a team, "Well it [sic] think we did good because I made some[thing], 'Kasey' had ideas and 'Gretchen' wrote the script."

In addition to these qualitative answers, students were scored on their instant challenges both before and after the unit on teambuilding skills. Table 1 displays the mean scores for both the building and performance challenges among the two grade levels. The first two columns

display the means for building challenges before and after the teambuilding unit, the second two columns display the scores for the performance challenge before and after the unit. Each instant challenge had a maximum score of 100. Table 2 displays the teamwork part of the instant challenge scores. The teamwork scores had a maximum score of 40.

Table 1

*Instant Challenge Scores*

| Grade | Mean Building Score I | Mean Performance Score I | Mean Building Score II | Mean Performance Score II |
|---|---|---|---|---|
| 2/3 | 30.9 | 72.6 | 42.6 | 80.4 |
| 4/5 | 38.6 | 71.0 | 60.8 | 89.5 |

*Findings were statistically significant at p<.03

Table 2

*Teamwork Scores*

| Grade | Mean Teamwork Score Pre-Unit | Mean Teamwork Score Post-Unit |
|---|---|---|
| 2/3 | 22.7 | 32.4 |
| 4/5 | 25.4 | 35.9 |

*Findings were statistically significant at p<.03

The other qualitative data collection tool was the redirection/negative comment counter used during each instant challenge as well as during the teambuilding unit during the Scratch activities. Table 3 displays the average number of redirections for all three times the counter was used. The first two columns display the change between the two building challenges, the second

two columns display the change between the two performance challenges, and the third two columns display the change between the first day of Scratch and the second day of Scratch.

Table 3

*Redirection Counter*

| Grade | Building I | Building II | Performance I | Performance II | Scratch I | Scratch II |
|---|---|---|---|---|---|---|
| 2/3 | 3.7 | 1.2 | 2.7 | 0.6 | 3.4 | 0.9 |
| 4/5 | 4.7 | 1.1 | 3.3 | 0.6 | 3.0 | 1.1 |

*These findings were statistically significant at p<.03

## Improving Creativity Through Teamwork

A second area of research in this study was what, if any, effect the improved cooperative learning skills had on students' creative output. This was measured by the instant challenge scores in table 1 above. Each instant challenge score also had a creativity aspect to the score. The averages for before and after the unit are listed in table 4. The scores had a maximum of 50 points.

Table 4

*Creativity Scores*

| Grade | Creativity I | Creativity II |
|---|---|---|
| 2/3 | 35.3 | 41.4 |
| 4/5 | 33.8 | 44.2 |

*Statistically Significant at p<.03

## Findings/Conclusion

Based on the data collected during this study, both qualitative and quantitative, it is clear that creativity and teamwork can be improved among gifted learners. The final day of

Destination Imagination challenges showed this. Two students got into an argument over how to create an artifact. Instead of getting angry they talked it out and came to a new solution and both still participated in the challenge. At the beginning of the study, it would not have been surprising to see those students get angry, stop working, and receive lower teamwork scores; however, their ability to work through their problems, as well as the third member of their team stepping in to remind them of the challenge at hand, showed the growth in the students across the 6-week study. In addition to this anecdotal observation, students were better able to identify ways that their teammates helped during the instant challenges and gave their groups better scores in their post-challenge surveys. The average teammate scores went from 7.8 to 9.0 and was statistically significant at $p<.03$. Interestingly, however, students' perception of their own ability did not change much. It increased from 7.3 to 7.8. This was the only quantitative data point that did not show statistical significance at a p-value of $p<.03$. There could be a myriad of reasons for this. Students could have recognized the contributions of others in their group more or underestimated their own abilities. Gifted students can struggle with self-image and internalize self-doubt (Rinn et. al., 2018).

The second part of the research question sought to answer if there was a connection between improved teamwork skills and creativity. While something like creativity can be a nebulous thing to study, Destination Imagination gives excellent score cards with measurable aspects of creativity. On the average, the creativity scores went up nearly 18% in second and third graders and 21% in fourth and fifth graders. This is significant because it shows a link between teamwork skills, which also went up by nearly 25% in second and third graders and slightly over 25% in fourth and fifth graders, and the creativity of the solutions. During debriefing sessions students were able to identify ways in which group members improved their

stories in Scratch activities. They were able to add details to each other's stories and enjoyed watching them as a class after. Students also expressed greater enjoyment with the activities we did on Scratch and to a lesser extent in the role-play and other games. Another interesting observation was that students started going to each other for help on Scratch instead of just asking the teacher. It was clear that students were learning from each other and combining ideas to create unique and exciting stories and games. Several 4th and 5th grade students even decided to continue working on their Scratch stories during recess instead of switching to another activity. While this study did not find the exact extent to which teamwork skills improved creativity, it does show a correlation between the two. This is similar to findings made by previous researchers (Chen and Chui, 2016; Baykoç, Aydemir, and Uyaroglu, 2013).

While the findings of this study were encouraging, that is not to say there were not hiccups along the way. When the students first started working in groups students were resistant to the idea, arguing that they do better work individually. This is common among gifted students who, even among other gifted students, often prefer to work alone (Patrick, Bangel, Jeon, and Townsend, 2005; Rinn et. al., 2018). While several students mastered the ability to share ideas and work together, not all students bought in to the same extent. When teams were made for instant challenges and coding work, several students complained, and other students never could work well with certain other students. The way groups were picked was always a random number generator; a possible idea for future study is to keep students in the same groups over the full length of the study.

## Limitations/Areas of Further Study

This study had several limitations and several areas for further studies to assess. The nature of the school district studied meant that the students were only seen once a week, so while

the study lasted for six weeks, in truth there were only six full days of activities. Something that could add to the discussion is to study students who have gifted classes more regularly than once a week. Another possibility for further study is to change up the instant challenges more. For this study, only two instant challenges were used, but Destination Imagination has hundreds of instant challenges to choose from all with a varying degree of difficulty. It is possible that students improved their creativity scores in the instant challenges simply because they had seen the challenge before. While this is unlikely to affect their teamwork scores, it is something to consider if replicating this study.

There was also a clear difference in the grades of students and the way they responded to the interventions. While all students enjoyed the activities and developed better teamwork skills, the older students improved to a greater extent both in terms of teamwork and creativity. It would be fascinating to continue this study into the middle school and even high school years for the students. Older students were also quicker to recognize the strengths and weaknesses of their teammates and delineate responsibility. It was surprising that younger students typically had lower average redirections at the beginning as well as higher creativity scores; however, by the end of the study, the older students were, on average, stronger across the board.

## Recommendations

The activities that students found the most enjoyable were the Scratch activities. While students needed a basic working knowledge of how to code, these activities allowed for greater freedom and creativity. The possibilities of what students create are infinite and when working together on Scratch, students developed the ability to share and listen to each other's ideas. When watching other students' stories and remixing them, they were able to add to something that was already created and learn from each other as well.

Direct instruction and a unit on teamwork also worked well, though the students did not enjoy it as much. By adding games and hands on activities to role-play and discussion students were able to move around the room and work on teamwork skills such as leadership, flexibility, and communication then bring their learning back into group discussions.

Finally, as students build their teamwork skills it is important to give them a way to express frustrations both with themselves and with their teammates in a safe and productive manner. By giving the students a survey where they not only discussed what they did well, but also, their teammates' strengths, they were able to identify ways that they can help their group succeed and ways that they can encourage their teammates to succeed as well. These surveys were private and allowed them to vent frustrations in a way that did not put them in an uncomfortable position with their fellow classmates.

Based on the findings, it is important to develop the ability of gifted students to work as a team. As the world becomes more and more connected more future jobs rely on the ability to work effectively as a group. This study shows several ways to improve teamwork skills among gifted that can be implemented in gifted classrooms.

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Appendix A

APPRAISER COPY
**Advanced Level / Focus: STEM / Task Oriented**

# A FOUR SQUARE DEAL

**Challenge**
Your **TASK** is to build a free-standing tower that touches 4 squares and that is as tall as possible. For the purpose of this Challenge, "free-standing" means the tower is not attached to anything.

**Time**
You will have up to 5 minutes to use your IMAGINATION to build your tower and then up to 2 minutes to place your tower in the squares.

**Setup**
In the center of the room are 4 taped squares. There also is a table with materials.

**Procedure:** There has been a disaster! Your civilization was rocked by an earthquake. Because of the earthquake, all the materials used by your civilization to build their towers have separated back into their original condition. In this Challenge, you must rebuild one of the towers.

- **Part One** (5 minutes): Use the materials to build a free-standing tower that will be able to touch all 4 squares and that will be as tall as possible. You should NOT place your tower in the squares during this part of the Challenge. At the end of Part One, the Appraisers will measure the height of the tower above the table.

- **Part Two** (2 minutes): Place your tower in the squares. To receive points, the tower must touch all 4 of the taped squares and may only touch the floor within the taped squares. You may adjust your tower during this part of the Challenge. At the end of Part Two, the Appraisers will again measure the height of the tower if all 4 squares are being touched by the tower and the tower is only touching the floor within the taped squares.

**Materials**

| | | | |
|---|---|---|---|
| **Two 12 in (30 cm) Pieces of String** | **4 Index Cards** | **4 Rubber Bands** | **1 Coffee Filter** |
| **8 Chenille Sticks (Pipe Cleaners)** | **2 Mailing Labels** | **1 Piece of Foil** | **12 Pieces of Ziti** |
| **2 Paper Cups** | | | |

**Scoring:** You will receive

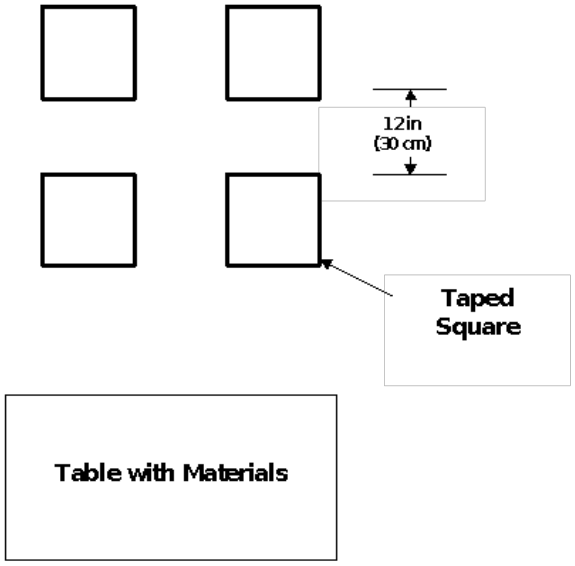
A. ½ point (20 points maximum) for each inch (2.5 cm) of height of your tower above the table at the end of Part One.
B. 20 points if you have a tower touching all 4 taped squares at the end of Part Two.
C. 1 point (40 points maximum) for each inch (2.5 cm) of height of your tower above the floor at the end of Part Two.
D. Up to 20 points for how well your team works together.

APPRAISER COPY
Advanced Level / Focus: STEM / Task Oriented

# A FOUR SQUARE DEAL

**For Appraisers Only:**

1. The set-up consists of 4 12 in X 12 in (30 cm X 30 cm) taped squares in the center of the room. The squares are 12 in (30 cm) from each other. There is also a table with materials.



TEAM COPY
**Advanced Level / Focus: STEM / Task Oriented**

# A FOUR SQUARE DEAL

**Challenge**
Your **TASK** is to build a free-standing tower that touches 4 squares and that is as tall as possible.

For the purpose of this Challenge, "free-standing" means the tower is not attached to anything.

**Time**
You will have up to 5 minutes to use your IMAGINATION to build your tower and then up to 2 minutes to place your tower in the squares.

**Set-up**
In the center of the room are 4 taped squares. There also is a table with materials.

**Procedure**
There has been a disaster! Your civilization was rocked by an earthquake. Because of the earthquake, all the materials used by your civilization to build their towers have separated back into their original condition. In this Challenge, you must rebuild one of the towers.

**Part One** (5 minutes):
- Use the materials to build a free-standing tower that will be able to touch all 4 squares and that will be as tall as possible.
- You should NOT place your tower in the squares during this part of the Challenge.
- At the end of Part One, the Appraisers will measure the height of the tower above the table.

**Part Two** (2 minutes):
- Place your tower in the squares.
- To receive points, the tower must touch all 4 of the taped squares and may only touch the floor within the taped squares.
- You may adjust your tower during this part of the Challenge.
- At the end of Part Two, the Appraisers will again measure the height of the tower if all 4 squares are being touched by the tower and the tower is only touching the floor within the taped squares.

**Scoring:** You will receive
A. ½ point (20 points maximum) for each inch (2.5 cm) of height of your tower above the table at the end of Part One.
B. 20 points if you have a tower touching all 4 taped squares at the end of Part Two.
C. 1 point (40 points maximum) for each inch (2.5 cm) of height of your tower above the floor at the end of Part Two.
D. Up to 20 points for how well your team works together.

TEAM COPY
Advanced Level / Focus: STEM / Task Oriented

# A FOUR SQUARE DEAL

**Materials**
(Tape to Table)

Two 12 in (30 cm) Pieces of String

4 Index Cards

4 Rubber Bands

1 Coffee Filter

8 Chenille Sticks (Pipe Cleaners)

2 Mailing Labels

1 Piece of Foil

12 Pieces of Ziti

2 Paper Cups

# A FOUR SQUARE DEAL

## APPRAISER RUBRICS

RUBRIC FOR APPRAISING TEAMWORK

| Points | 1 – 5 | 6 – 10 | 11 – 15 | 16 – 20 |
|---|---|---|---|---|
| Qualities | • Dominating individual who limits participation of others<br>• Cooperation is minimal<br>• Little sharing of ideas | • Some evidence of individual team member roles<br>• Some cooperation<br>• Some evidence of accepting ideas of others | • Acceptance of team roles above average<br>• Good cooperation<br>• Sharing and acceptance of ideas of others | • Leadership and team roles are easily identified<br>• Diversity of skills mutually respected and evident<br>• Team dynamics are exemplary |

# A FOUR SQUARE DEAL

Team Name:_____ Level: E M S U

Team Number:_____ Team Challenge:_____

Appraiser's Name:_____

## INSTANT CHALLENGE INDIVIDUAL SCORE SHEET

| Score Element | Range | Team Score |
|---|---|---|
| A. # of inches (2.5 cm) in height of structure above the table at the end of Part One. | ____ X ½ **(Number: 40 Maximum)** | |
| B. Tower touches all 4 taped squares at the end of Part Two. | 0 or 20 | |
| C. # of inches (2.5 cm) in height of structure above the floor at the end of Part Two if the tower only touches all 4 taped squares. | ___ **(Number: 40 Maximum)** | |
| D. Teamwork | 1 – 20 | |
| Total | | |

Note: Team score elements should be recorded in whole numbers. (No fractions or decimals.)

**If computerized scoring is being utilized, fill-in only the outlined boxes.**

# A FOUR SQUARE DEAL

Team Name:_____ Level: E M S U

Team Number:_____ Team Challenge:_____

## INSTANT CHALLENGE MASTER SCORE SHEET

| Appraiser's Name | Total Score |
|---|---|
| 1.<br>2.<br>3.<br>4. | |
| Add 1 + 2 + 3 + 4 | E. |
| Divide E by # of Appraisers | F. |

NOTE: The division in the final step should be carried out to 3 decimal places.

| *INSTANT CHALLENGE* SCORE |
|---|
| G. |

NOTE: Rewrite the final score in the box above. The final score should be rounded to 2 decimal points. Round up if the third decimal is 5 or more.

APPRAISER COPY
**Entry Level / Focus: The Arts and STEM / Task and Performance Based**

# ANTIQUES 2511!

**Challenge:** Your **TASK** is to create an antique found in the year 2511 and then to present a **PERFORMANCE** in which you show what the antique is, and explain what it did and why it is valuable.

For the purpose of this Challenge, an "antique" is anything at least 500 years old.

**Time:** You will have up to 4 minutes to use your IMAGINATION to make your antique, as well as to plan and practice your skit, and then up to 2 minutes to present your **PERFORMANCE** to the Appraisers.

**The Scene:** It is the year 2511. You have found a valuable antique from the year 2011! You are to use the materials to make a replica of this antique and then present a **PERFORMANCE** in which you show what the antique is, and explain what it did and why it is valuable.

**Materials:**

| | | | |
|---|---|---|---|
| **Two 24in (60cm) Pieces of String** | **4 Straws** | **2 Cupcake Wrappers** | **2 Rubber Bands** |
| **3 Chenille Sticks (Pipe Cleaners)** | **2 Pencils** | **2 Mailing Labels** | **2 Sheets of Colored Paper** |

A piece of paper and a pencil will be available for your team to use as you plan and present your **PERFORMANCE**.

**Scoring:** You will receive
A. 10 points if you create an antique.
B. 20 points if you show what the antique is, and explain what it did and why it is valuable in your **PERFORMANCE**.
C. Up to 20 points for the creativity of the antique.
D. Up to 30 points for the creativity of your **PERFORMANCE**.
E. Up to 20 points for how well your team works together.

TEAM COPY
**Entry Level / Focus: The Arts and STEM / Task and Performance Based**

# ANTIQUES 2511!

**Challenge:** Your **TASK** is to create an antique found in the year 2511 and then to present a **PERFORMANCE** in which you show what the antique is, and explain what it did and why it is valuable.

For the purpose of this Challenge, an "antique" is anything at least 500 years old.

**Time:** You will have up to 4 minutes to use your IMAGINATION to make your antique, as well as to plan and practice your skit, and then up to 2 minutes to present your **PERFORMANCE** to the Appraisers.

**The Scene:**

- It is the year 2511.
- You have found a valuable antique from the year 2011!
- You are to use the materials to make a replica of this antique and then present a **PERFORMANCE** in which you show what the antique is, and explain what it did and why it is valuable.

**Scoring:** You will receive

A. 10 points if you create an antique.
B. 20 points if you show what the antique is, and explain what it did and why it is valuable in your **PERFORMANCE**.
C. Up to 20 points for the creativity of the antique.
D. Up to 30 points for the creativity of your **PERFORMANCE**.
E. Up to 20 points for how well your team works together.

# ANTIQUES 2511!

**Materials:**
(Tape to Table)

Two 24in (60cm) Pieces of String

4 Straws

2 Cupcake Wrappers

2 Rubber Bands

3 Chenille Sticks (Pipe Cleaners)

2 Pencils

2 Mailing Labels

2 Sheets of Colored Paper

A piece of paper and a pencil will be available for your team to use as you plan and present your **PERFORMANCE**.

# ANTIQUES 2511!

## APPRAISER RUBRICS

RUBRIC FOR APPRAISING THE CREATIVITY OF ANTIQUE

| Points | 1 – 5 | 6 – 10 | 11 – 15 | 16 – 20 |
|---|---|---|---|---|
| Qualities | • Creativity is present and it's somewhat enhanced<br>• The solution applies | • Creativity is present and it's relevant<br>• There is a theme<br>• The solution is complete<br>• Solved with related elements | • Creativity is present and it's integrated<br>• Chiefly original work | • Creativity is there and it's innovative<br>• AHA! WOW! |

RUBRIC FOR APPRAISING CREATIVITY OF PERFORMANCE

| Points | 1 – 8 | 7 – 15 | 16 – 22 | 23 – 30 |
|---|---|---|---|---|
| Qualities | • Creativity is present and it's somewhat enhanced<br>• The solution applies<br>• Attempt at application<br>• Solved with marginal addition | • Creativity is present and it's relevant<br>• There is a theme<br>• The solution is complete<br>• Solved with related elements | • Creativity is present and it's integrated<br>• There is synthesis<br>• Chiefly original work<br>• Solved with integration | • Creativity is there and it's innovative<br>• AHA! WOW!<br>• Unrelated elements synthesized to create a new idea<br>• Solved by innovation |

RUBRIC FOR APPRAISING TEAMWORK

| Points | 1 – 5 | 6 – 10 | 11 – 15 | 16 – 20 |
|---|---|---|---|---|
| Qualities | • Dominating individual who limits participation of others<br>• Cooperation is minimal<br>• Little sharing of ideas | • Some evidence of individual team member roles<br>• Some cooperation<br>• Some evidence of accepting ideas of others | • Acceptance of team roles above average<br>• Good cooperation<br>• Sharing and acceptance of ideas of others | • Leadership and team roles are easily identified<br>• Diversity of skills mutually respected and evident<br>• Team dynamics are exemplary |

# ANTIQUES 2511!

Team Name:_____ Level: E M S U

Team Number:_____ Team Challenge:_____

Appraiser's Name:_____

**ANTIQUES 2511!**

***INSTANT CHALLENGE* INDIVIDUAL SCORE SHEET**

| Score Element | Range | Team Score |
|---|---|---|
| A. Antique is created. | 0 or 10 | |
| B. **PERFORMANCE** includes what the antique is, what it did, and why it is valuable. | 0 or 20 | |
| C. Creativity of antique | 0 or 1 – 20 | |
| D. Creativity of **PERFORMANCE** | 1 – 30 | |
| E. Teamwork | 1 – 20 | |
| Total | | |

Note: Team score elements should be recorded in whole numbers. (No fractions or decimals.) In score element C, the team should receive 0 points if the team does not create an antique.

**If computerized scoring is being utilized, fill in only the outlined boxes.**

# ANTIQUES 2511!

Team Name:_____ Level: E M S U

Team Number:_____ Team Challenge:_____

**ANTIQUES 2511!**

***INSTANT CHALLENGE* MASTER SCORE SHEET**

| Appraiser's Name | Total Score |
|---|---|
| 1.<br>2.<br>3. | |
| 4. | |
| Add 1 + 2 + 3 + 4 | F. |
| Divide F by # of Appraisers | G. |

NOTE: The division in the final step should be carried out to 3 decimal places.

| *INSTANT CHALLENGE* SCORE |
|---|
| H. |

NOTE: Rewrite the final score in the box above. The final score should be rounded to 2 decimal points. Round up if the third decimal is 5 or more.

Appendix B

UNIT 3

# PASS IT ON

SUGGESTED TIME
45–60 MINUTES

**OBJECTIVES**

By completing this activity, students will:

+ be able to create a Scratch project that tells a story by reusing and remixing the work of others
+ experience pair programming by working in pairs to develop a collaborative storytelling project

## ACTIVITY DESCRIPTION

- ☐ Divide the group into pairs. Introduce students to the concept of a pass-it-on-story: a Scratch project that is started by a pair of people, and then passed on to two other pairs to extend and reimagine. Optionally, print out the Pass It On handout.
- ☐ Encourage students to start in whatever way they want – focusing on characters, scene, plot, or whatever element excites them. Give each pair 10 minutes to work on their collaborative story. Then, ask students to rotate and extend another story by remixing another group's project. Encourage students to give credit for reusing or remixing content.
- ☐ After two rotations, allow students to revisit story projects with their contributions. We suggest hosting a Scratch screening: with projector and screen, present the story projects with students gathered around to watch. Optionally, invite students to add their projects to the Pass It On studio or a class studio.
- ☐ Ask students to respond to the reflection prompts in their design journals or in a group discussion.

## RESOURCES

- ☐ Pass It On handout
- ☐ Pass It On studio http://scratch.mit.edu/studios/475543
- ☐ Projector and screen to present student work (optional)

## REFLECTION PROMPTS

+ How did it feel to remix and build on others' work? How did it feel to be remixed?
+ Where else in your life have you seen or experienced reusing and remixing? Share two examples.
+ How was working with someone else different from your prior experiences of designing your Scratch projects?

## REVIEWING STUDENT WORK

+ What parts of projects did students contribute to?
+ Do students seem comfortable with the concepts of events and parallelism and practices of reusing and remixing? If not, in what ways can these be further clarified?

## NOTES

+ Consider organizing your Scratch screening as an event! Invite students from other classes to the viewing, offer snacks and drinks, or host the event in an auditorium or room with a large wall or screen for displaying projects.
+ Introduce students to the backpack (located at the bottom of the Scratch project editor) as another way to remix projects. Learn more in this tutorial: https://youtu.be/r9xu_ysPUto?t=30

## NOTES TO SELF

- ☐ _____
- ☐ _____
- ☐ _____
- ☐ _____

# PASS IT ON

WHAT CAN WE CREATE BY BUILDING ON OTHERS' WORK?

In this project, you will start developing an animated story project, and then you will pass the story on to others to remix, extend, or reimagine!

## START HERE

- ☐ Work on a story project that focuses on characters, scene, plot, or whatever element excites you.
- ☐ After 10 minutes, save and share your project online.
- ☐ Rotate & extend another story project by remixing it.
- ☐ Repeat!

## THINGS TO TRY

- ☐ Brainstorm different possibilities for remixing, extending, or reimagining a story. Do you want to add a new scene to the end? Could you imagine what happens before the story begins? What if a new character was added? How about inserting a plot twist? What else?
- ☐ Adding comments in your code can help others understand different parts of your program. To attach a comment to a script, right click on a block and add a description.

## BLOCKS TO PLAY WITH

## FINISHED?

+ Add your project to the Pass It On studio: http://scratch.mit.edu/studios/475543
+ Help a neighbor!
+ Revisit the projects you contributed to and check out how the stories have evolved!

## Appendix C

## Teamwork Survey

1. Describe one thing your team did well.

2. Describe one thing your team could improve on.

3. On a scale of 1-5 how well did your team work together?

4. On a scale of 1-5, rate your team's creativity.

5. What is one thing you contributed to the group?

6. What is one thing someone else contributed to the group?

7. Give each teammate a rating based on teamwork.

8. Give yourself an overall grade out of 10.

9. Give your team an overall grade out of 10.

10. Why did you give the grades you did?