imagine math

FOUNDATIONS PAPER

Imagine Math®
Grade 3–High School

Innovative Approaches for Supporting Self-Efficacy and Motivation for Succeeding at Mathematics

Introduction

Educational technologies that incorporate research-based principles in the design of instruction and practice can increase students' self-efficacy and motivation for learning mathematics (Kadiyala & Crynes, 2000; Hung et al., 2014). Imagine Math is a supplemental mathematics learning solution that incorporates research-based principles that promote self-efficacy in mathematics. To support students in succeeding in mathematics, Imagine Math also integrates unique motivational elements that foster active engagement, collaboration, and perseverance in learning mathematics.

Research-Based Recommendations

Positive self-efficacy (Bandura, 2012) and motivation (Skaalvik et al., 2015) are strong predictors of mathematics achievement (Lewis et al., 2012; Parker et al., 2014). When students have positive beliefs about their capabilities (e.g., mathematics self-efficacy), they have greater confidence and are more likely to succeed in a task (Bandura, 2012). When students struggle in mathematics, their self-efficacy and motivation diminish. As proficiency and interest in learning mathematics decrease, anxiety and fear of failure will likely increase (Gersten et al., 2009). Students who are motivated and demonstrate positive self-efficacy for mathematics success tend to be more enthusiastic about doing mathematics and taking mathematics courses than their counterparts who don't exhibit those attributes.

To help students develop positive self-efficacy for mathematics, research has shown that motivational attributes such as multimedia presentation, adaptability to learners' styles and pace, and high degrees of interactivity embedded in digital games can be powerful vehicles for transforming learning (Connolly et al., 2012; Hwa, 2018). In addition to these aspects of game-based environments, providing engaging content promotes self-efficacy and motivation to learn that not only influence students' achievement, but also foster confidence and engagement in learning mathematics.

Student motivation and engagement correlate with students' overall success or failure in mathematics (Daly et al., 2019). Two types of motivation that influence student engagement with learning mathematics are intrinsic and extrinsic motivation. Intrinsic motivation refers to the act of doing something based on internal curiosity, interest, or inherent satisfaction (Filsecker & Hickey, 2014; Ryan & Deci, 2000). Research has found that students who are intrinsically motivated perform at higher levels (Lemos & Verissimo, 2014), are more inclined to persevere when faced with challenges (Huang, 2011), and develop a deeper understanding of content (Zainuddin et al., 2020). Students with intrinsic motivation also tend to set meaningful goals, monitor their progress toward achieving those goals (Bandura, 2012; Liao et al., 2019), and experience satisfaction in mastering new mathematics concepts (Elliot & Harackiewicz, 1996).

Extrinsic motivation reflects one's desire to engage in a behavior that is incentivized or produces an external reward (Moos & Marroquin, 2010). External motivations can promote students' willingness to learn (Cameron, 2001; Theodotou, 2014), and verbal rewards can positively influence task completion (Marinak & Gambrell, 2008).

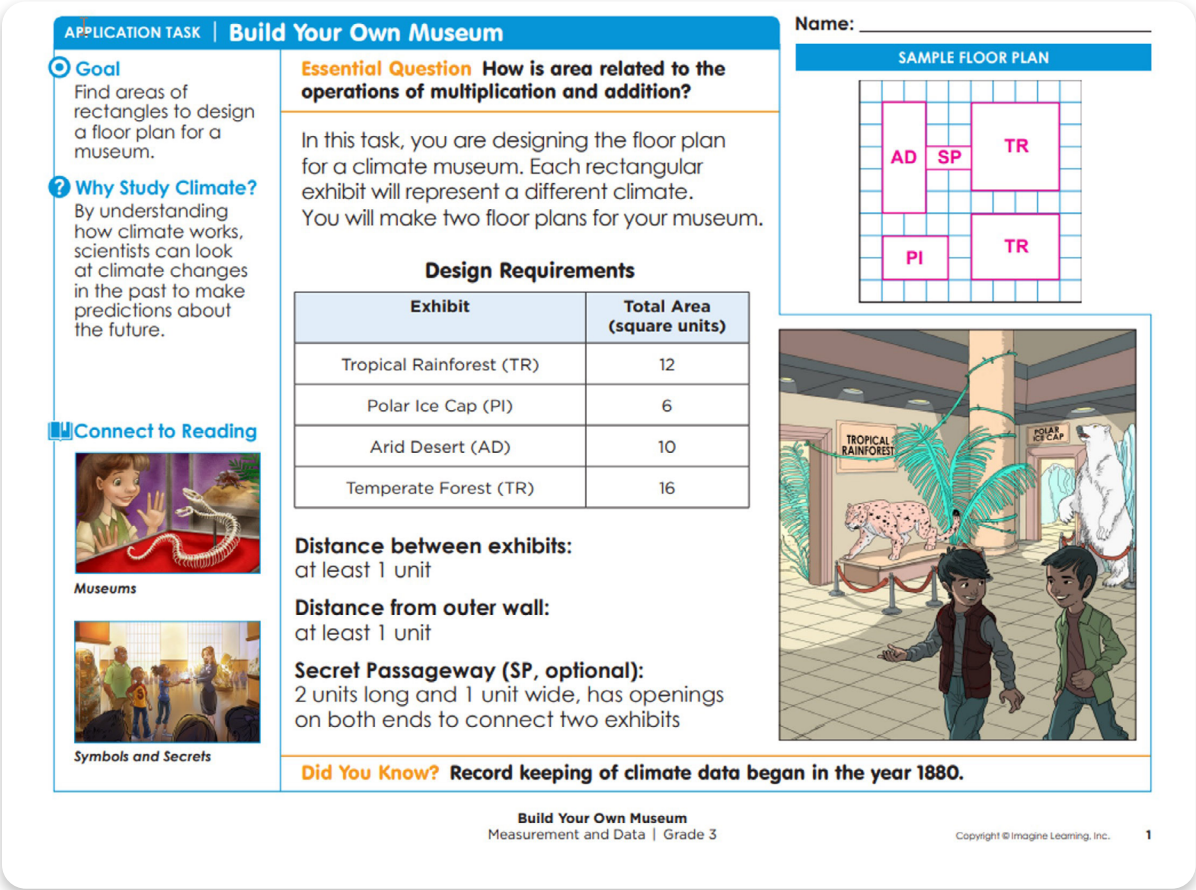
Imagine Math's Implementation of the Research

Imagine Math influences students' **self-efficacy** and **motivation** by capitalizing on student choice and interest, providing the appropriate level of task difficulty, and incorporating frequent and focused feedback. By supporting self-efficacy, Imagine Math nurtures the belief that students can do mathematics and master challenging concepts. One way this occurs is through immediate feedback. Within Imagine Math, immediate feedback—both verbal and visual feedback, in the form of points for completed work and check marks for correct answers—reinforces a growth mindset, or the idea that talents and abilities can be developed through effort, effective teaching, and persistence (Mueller & Dweck, 1998; O'Rourke et al., 2014). For example, lessons help students develop confidence by providing immediate feedback that encourages effort, such as, *"Nice job. It can take a lot of work to find all of the right choices."*

A unique feature of Imagine Math for supporting self-efficacy is access to certified Live Teachers. When students are engaging in lessons and need real-time help, they can easily request support from Imagine Math's Live Teachers, who are certified educators. Live Teachers are trained to provide individualized instruction that reinforces mastery of grade-level content and supports self-efficacy for mathematics. When discussing student questions, teachers use phrases like, *"I like your thinking"* to help students develop confidence in thinking about and doing math. When students demonstrate errors or need encouragement, Live Teachers might say, *"Take some time to think about it and type your answer when you are ready!"* or *"See if you can use what we did to try this on your own. You can do this!"* To reinforce conceptual understanding, Live Teachers might also say, *"You are understanding how to solve word problems by representing the problem as an equation,"* or *"Good work writing the inverse operation."* This type of feedback attends to the student's mathematical thinking, as well as the accuracy of their response. It encourages them to take time to think through their answer, while promoting confidence in their ability to do so independently.

Imagine Math optimizes students' intrinsic and extrinsic motivation to engage with mathematics by integrating interactive gamified elements throughout the program (e.g., points, leaderboards, trophies, customized avatars, and narratives) and by linking mathematics to real-world contexts that encourage curiosity and exploration. Throughout the program, lessons incorporate word problems that require students to connect mathematic concepts and algorithms to applied contexts. The Imagine Math Application Tasks are particularly powerful for encouraging exploration and creativity in connecting mathematics to real life. For example, in a Grade 3 Application Task entitled "Build Your Own Museum," students are challenged to design a floorplan for a climate museum. They are given design requirements, such as the total area for specific exhibits, and provided with scaffolding to use their creativity in using mathematics to design their museum (Figure 1).

Figure 1. *Build Your Own Museum Application Task, Grade 3*



APPLICATION TASK | **Build Your Own Museum**

Name: _____

Goal
Find areas of rectangles to design a floor plan for a museum.

Why Study Climate?
By understanding how climate works, scientists can look at climate changes in the past to make predictions about the future.

Connect to Reading

Museums

Symbols and Secrets

Essential Question **How is area related to the operations of multiplication and addition?**

In this task, you are designing the floor plan for a climate museum. Each rectangular exhibit will represent a different climate. You will make two floor plans for your museum.

Design Requirements

Exhibit	Total Area (square units)
Tropical Rainforest (TR)	12
Polar Ice Cap (PI)	6
Arid Desert (AD)	10
Temperate Forest (TR)	16

Distance between exhibits:
at least 1 unit

Distance from outer wall:
at least 1 unit

Secret Passageway (SP, optional):
2 units long and 1 unit wide, has openings on both ends to connect two exhibits

SAMPLE FLOOR PLAN

Did You Know? **Record keeping of climate data began in the year 1880.**

Build Your Own Museum
Measurement and Data | Grade 3

 1

Imagine Math bolsters students' extrinsic motivation by embedding external reward systems that provide continuous feedback (e.g., earned points) and opportunities to improve. Specifically, Imagine Math allows students to earn Think! Points for themselves and others. These points can be used to customize students' own avatars (Figure 2), personalize their dashboards (Figure 3), contribute to classroom goals, or donate to charities.

Figure 2. *A student avatar*

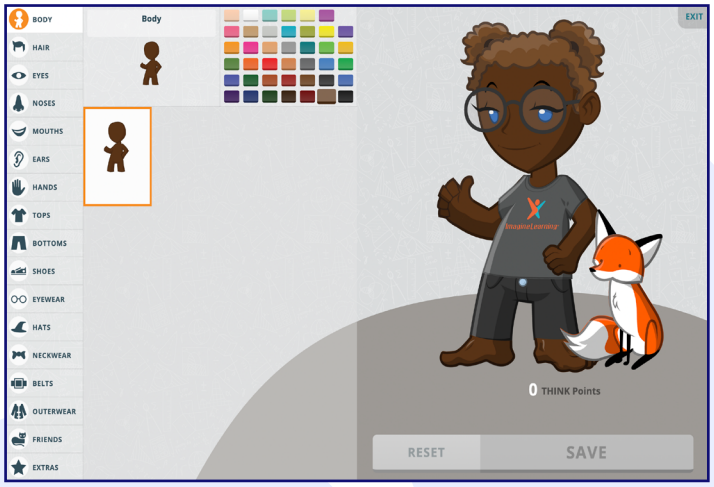
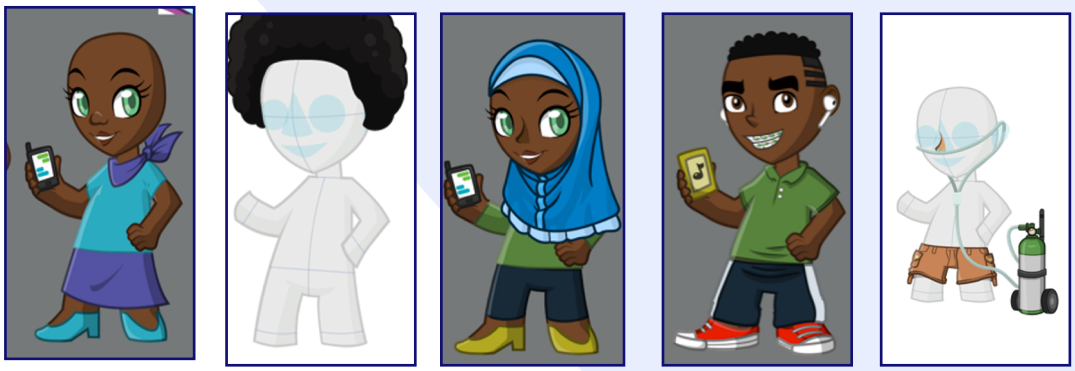


Figure 3. *Example of a student reward dashboard*

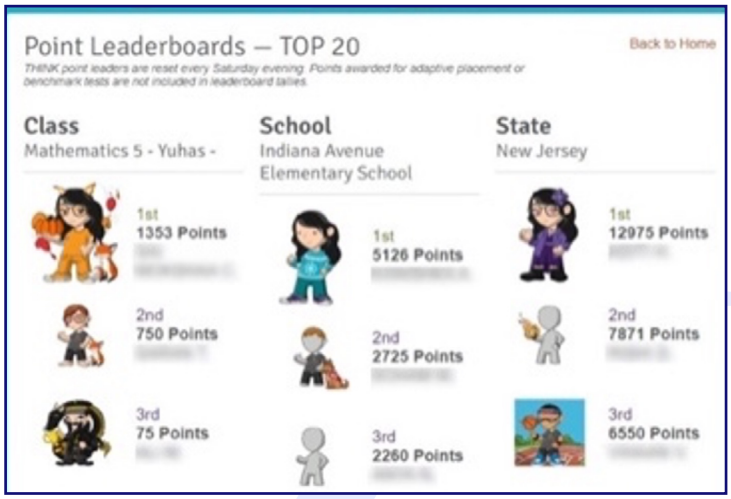
Students can use Think! Points to build their avatars. In building avatars, students choose from a variety of characters, accessories, and attributes. Many avatar pieces allow students to select attributes reflective of themselves and their social environments. Students make personalized design choices that allow them to own the process and connect their work in Imagine Math to what they value (Figure 4).

Figure 4. *Example of attributes students can choose when updating their avatars*



Imagine Math further motivates students by embedding leaderboards (Figure 5) to drive positive learning behaviors. As students see their points in the class, school, or state leaderboards, they are motivated to continue completing lessons to improve their standing.

Figure 5. *Example of a leaderboard*



Students earn Think! Points each time they engage in a mathematics activity or in local or national contests. For example, students can earn Think! Points by participating in national and statewide contests that target a range of relevant and engaging themes, such as "Ready, Set…Solve!" This fun contest kicks off the school year by motivating teachers to set up their classes, and by encouraging all students to engage in mathematics lessons. Students who pass at least two math lessons at any point during the month will receive 5,000 bonus points that they can spend as they choose.

Imagine Learning has also established the Think 30 Club to help motivate students to complete and pass lessons. After a student passes 30 math lessons—the recommended minimum number of lessons for students to complete in a school year—they become part of the club and earn 30,000 Think! Points. Together, these motivational systems support students in thinking about, doing, and succeeding in mathematics. Students are motivated by their own desire to succeed, to contribute to learning efforts within their school and community, and to support society as they contribute to various charities.

Finally, in Imagine Math, students can work independently or as a team to earn points and donate them to special events or charities, such as Feeding America or Boys & Girls Club of America (see Appendix A for more information on criteria for Imagine Math charity selection). Giving students the opportunity to donate their math points to charities allows them to act as agents for good and to celebrate accomplishments with classmates and teachers (Kegan, 1982). For example, in 2021, students who used Imagine Math donated Think! Points to the American Red Cross (see Figure 6). Students joined together in local school communities to give their checks to the organization and celebrate what they had accomplished.

Figure 6.
Children donate Think! Points to the American Red Cross

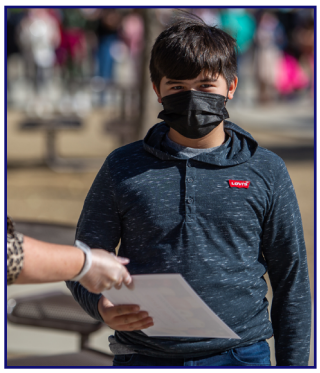
Donating to charities is particularly meaningful and motivational for students. In February 2022, Imagine Math named Yash Anand, a fifth-grade student at Vista Hills Elementary School in the Ysleta Independent School District (YISD), the nation's top donor to the American Red Cross Tornado Relief Fund. He says:

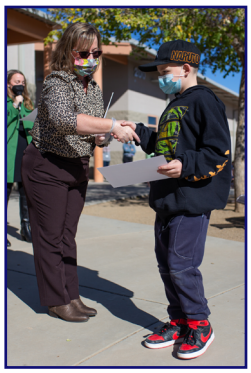
> **"I wanted to be the No. 1 on the leaderboard in the state of Texas, so I had to do a lot of lessons—and that's how I racked up the points. I knew that giving is always better than receiving, and that's why I decided to donate to the Red Cross. It makes me very proud that I can be of some help to the people in need."**

Figure 7.
Yash Anand, the nation's top donor to the American Red Cross Tornado Relief Fund in 2022

Similarly, another top student donor described the joy he experienced in donating his points to charity. Lahari, a student from Moreland Middle School in California, shared the following regarding his contribution to the Hurricane Florence Relief Fund:

> **"If I donate [my points] to someone in need of help, I have this happy feeling that I might've helped save one's life. To me, this feeling will bring me a lot more joy than [upgrading] my avatar. It makes me feel extremely happy that someone in this world got the help they needed, and I was a part of it."**



Conclusion

Imagine Math incorporates research-based principles that promote self-efficacy and motivation for engaging with mathematics. Automatic feedback and personalized, targeted feedback from Live Teachers help students monitor their performance, reflect on their understanding, and master grade-level mathematics concepts, which build confidence for learning new and more complex concepts and support self-efficacy for mathematics.

Imagine Math's instructional approach and unique motivation systems provide intrinsic and extrinsic motivation for learning mathematics. Students are motivated to complete lessons as they connect mathematics to their worlds outside of the classroom. Think! Points help students connect their efforts to tangible rewards, which motivate them to persevere in learning mathematics.

Engaging in activities that have a positive impact on society promotes collaboration and community among all learners, and sparks intrinsic motivation by increasing awareness of the agentic power that is in them. In giving students a Think! Points account, Imagine Learning allows students to use their agency in creating their study plan and in acting for good by donating money to help others. Thus, Imagine Learning helps students experience the human developmental joy that comes from shifting from a self-centered perspective to an altruistic perspective, and from becoming creative and capable agents for themselves (Kegan, 1982).

By providing extrinsic motivation for students, Imagine Math ultimately helps them increase their intrinsic motivation and self-efficacy for mathematics. Research shows that self-regulation is a central component of mathematics achievement and predicts successful transitions from secondary curricula to university (Vosniadou, 2020; Blackmore et al., 2021). Thus, Imagine Math supports students' growth in their ability to work, study, and experience success in mathematics—and, ultimately, create and achieve successful and productive careers.

APPENDIX A

CRITERIA TO BE CHOSEN AS A FEATURED IMAGINE MATH GRADE 3–HIGH SCHOOL CHARITY:

- The charity must be a national or a statewide charity that focuses on supporting healthy, well-educated children in their everyday lives.
- Charities are researched and must be vetted by Charity Navigator, a charity-assessment organization that evaluates charitable organizations in the United States.
- The charity must donate at least 80% of all donations to the cause.
- **The charity does not have any political or religious overtones, and does not preference one population over another.** For example, no charity that only supports girls or boys will be selected.
- Charity donations help all students, not just one student or a small group of students.

APPENDIX B

The 2022–2023 Imagine Math Charity Calendar:

September		**4-H** is America's largest youth-development organization—empowering nearly 6 million young people with the skills to lead for a lifetime. For more than 100 years, 4-H has welcomed young people of all beliefs and backgrounds, giving kids a voice to express who they are and how they make their lives and communities better. Learn more at https://4-H.org.
October		**PACER's National Bullying Prevention Center** unites, engages, and educates kids, teens, parents, and communities nationwide to address bullying through creative, relevant, and interactive resources. Learn more about PACE by visiting http://www.pacer.org/bullying/ during National Bullying Prevention month.
November		**The Special Operations Warrior Foundation** helps support surviving children of Army, Navy, Air Force, and Marine Corps special-operations personnel in receiving a secondary education. Learn more by visiting http://specialops.org/. The Special Operations Warrior Foundation will be available during the "Do Math! Support a Veteran" contest from November 1–11.
November		**Feeding America** is the nation's largest domestic hunger-relief organization. The Feeding America network of food banks, pantries, and meal programs serves virtually every community in the United States—46 million people, including 12 million children. Learn more at https://www.feedingamerica.org. Feeding America will be available during the "Do Math! Pay It Forward" contest from November 12–30.
December		**Juvenile Diabetes Research Foundation** is the leading global organization funding type 1 diabetes (T1D) research. Learn more about JDRF by visiting http://jdrf.org/.
January		**DonorsChoose.org** is an online charity that allows public-school teachers from every corner of America to post requests for essential classroom materials. Learn more by visiting http://www.donorschoose.org/.
February		**The Boys & Girls Club of America's** main mission is to enable young people to reach their full potential as productive, caring, responsible citizens. Learn more about the Boys & Girls Club of America by visiting http://www.bgca.org/.
March		**Big Brothers Big Sisters** of America is a mentoring organization in the United States. Local volunteers provide support and advice to students. Learn more about Big Brothers Big Sisters by visiting http://www.bbbs.org/.
April		**Autism Speaks** is the largest autism-advocacy organization in the United States. It sponsors autism research and conducts awareness and outreach activities aimed at families, governments, and the public. Learn more at https://www.autismspeaks.org/.
May		**No Kid Hungry** will be featured to support the Summer Meals program. Kids who rely on school meals struggle to get enough to eat during the summer months. Free meals served at schools and community centers are the answer. Donate to the No Kid Hungry Summer Meals initiative to help students all summer long. Learn more at https://www.nokidhungry.org/what-we-do/summer-meals.

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