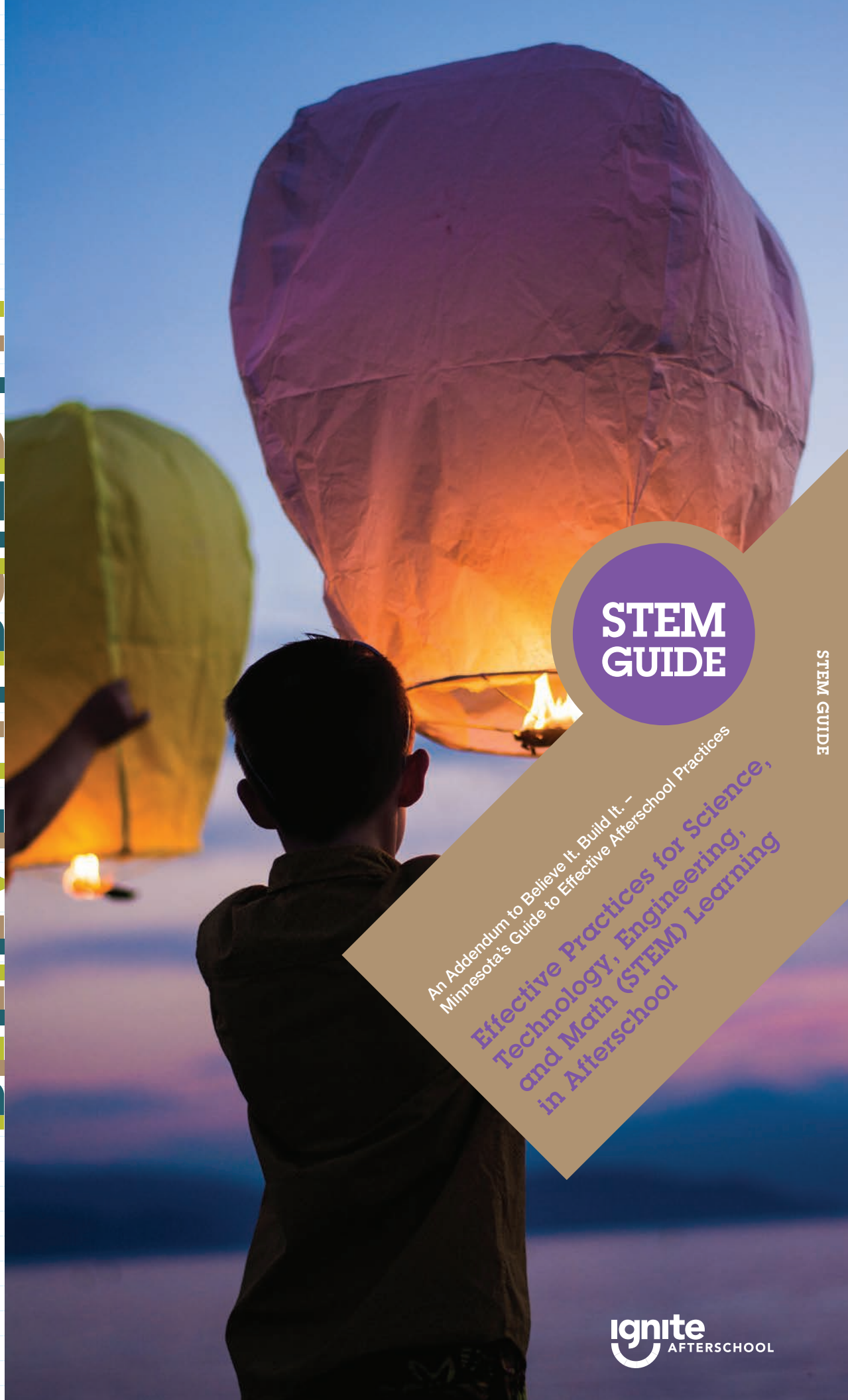
BELIEVE IT. BUILD IT.



STEM GUIDE

An Addendum to Believe It. Build It. – Minnesota's Guide to Effective Afterschool Practices

Effective Practices for Science, Technology, Engineering, and Math (STEM) Learning in Afterschool

STEM GUIDE

ignite AFTERSCHOOL

HOW TO USE THE *BELIEVE IT. BUILD IT. STEM GUIDE*

This STEM Guide includes the following sections, designed to complement *Believe It. Build It.* and help your program incorporate STEM in baby steps or giant leaps.

STEM

MYTH BUSTER!

If you're someone who doubts their STEM skills, don't let that stop you from helping youth learn STEM! You can build your STEM skills by working alongside youth to explore and find answers to your questions.

WELCOME

BELIEVE IT. BUILD IT. STEM

WELCOME TO *THE BELIEVE IT. BUILD IT.* STEM GUIDE

Afterschool programs inspire creativity and curiosity, and support young people as they discover and understand the world around them. They thrive when youth's interests and identity are at the center, and when adults and youth connect in caring relationships.[1]

That's what STEM learning in afterschool is about too. The difference lies in how it uses a shared set of concepts and methods from **S**cience, **T**echnology, **E**ngineering, and **M**athematics to guide young people's exploration of their world.

Research shows us how closely the values and practices of high-quality STEM learning align with afterschool learning. Hands-on activities, flexibility and choice, a focus on inquiry — these are just a few of the values we share.[2]

This significant overlap is great news for afterschool programs! It means that doing quality STEM learning in your program takes just a few extra steps beyond the foundational practices for quality afterschool programs. If you haven't already, read up on these effective afterschool practices in *Believe It. Build It.* — Minnesota's Guide to Effective Afterschool Practices (BiBi) at igniteafterschool.org/bibi.

Know your *Believe It. Build It*? Then you're ready to start using this *BiBi STEM Guide*!

STEM

Each page in this BELIEVE IT. BUILD IT. STEM Guide links to online resources to bring the book to life through:

- Activity ideas and planning guides to inspire your STEM practices
- Research and reports on quality STEM learning afterschool
- Data and assessment tools for afterschool STEM

BRING IT TO LIFE

MYTH BUSTER!

Youth truly are interested in STEM learning! The problem is that they slowly lose interest – 57% of Minnesota 4th graders report high interest in science, but this drops to 10% by the time they graduate. The good news is afterschool STEM programs keep them interested as they grow!"

WHY CONNECT STEM AND AFTERSCHOOL?

It's tempting to see STEM as just another trend that will come and go, but the reality is it's important and here to stay. Besides the values and practices we share, here are a few research-backed reasons why connecting STEM and afterschool matters[3]:

- The flexible, hands-on learning environments in quality afterschool STEM programs provide an ideal place for youth to get interested in STEM, build their STEM skills, and make STEM concepts relevant to their lives.
- Youth need a variety of ways to plug in to STEM learning. Schools, afterschool programs, museums, parks, libraries, and communities all have a role in creating the dynamic ecosystem that powers STEM learning for young people.
- Afterschool STEM programs are critical in sustaining young people's STEM identity and revealing career pathways to youth of all backgrounds, who may not otherwise see themselves as future scientists, engineers, or mathematicians.
- Afterschool can help narrow the achievement and opportunity gap by expanding young people's access to and engagement with STEM learning.

By connecting STEM and afterschool, we can improve learning opportunities for all Minnesota's young people, and create a stronger foundation for our state's shared prosperity.

WE BELIEVE

The reasons for fostering quality STEM learning in afterschool goes beyond hard facts. Like all worthy goals, it's based in a set of values and a vision for a better world. When it comes to STEM learning in afterschool, WE BELIEVE that…

- **All young people deserve the opportunity to experience the creative power of STEM and envision themselves in a STEM career, regardless of which career they choose.**
- **The skills and attitudes young people learn when they do STEM – problem-solving, a willingness to fail and try again, and critical thinking – are essential for lifelong learning and civic engagement.**
- **Afterschool STEM programs are essential for preparing a STEM-literate generation that can explore innovative ways to address societal issues and challenges.**
- **The principles that guide afterschool and youth work practitioners in Minnesota are also essential for high-quality STEM learning in afterschool (See the *We Believe* statements in *Believe It. Build It.*).**

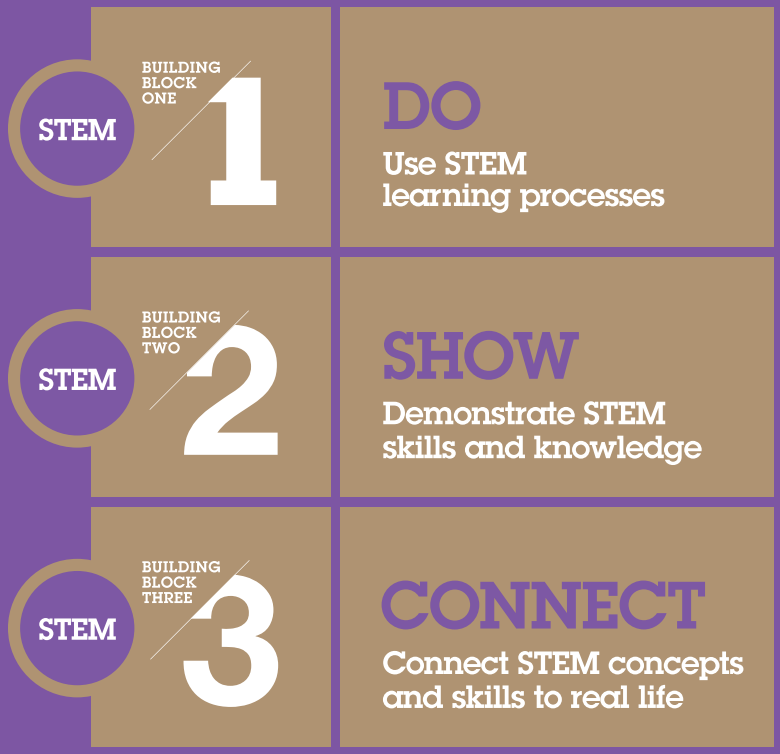
STEM BUILDING BLOCKS

There are three Building Blocks for quality STEM learning in afterschool. Each STEM Building Block contains a set of evidence-based effective practices, intended to be accessible and practical for the program staff who plan and directly provide afterschool STEM learning.[4]

While each STEM Building Block is distinct, they also work together and build upon the effective practices for afterschool programs as noted in *Believe It. Build It*.

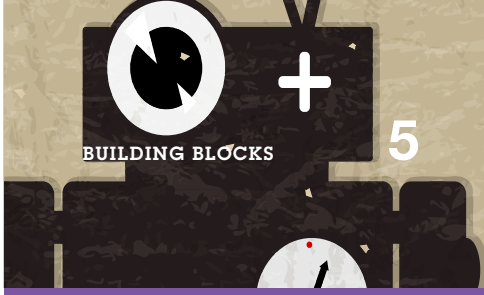
MYTH BUSTER!

Remember the "Scientific Method" from your science classes? Don't get boxed in by it! There's no single step-by-step approach to STEM – it's about continuously asking questions and testing your ideas to improve your understanding.



Remember Continuous Program Improvement (CPI)!

The CONTINUOUS PROGRAM IMPROVEMENT (CPI) process laid out in *Believe It. Build It. (BiBi)* applies to STEM Building Blocks too! Check out the *BiBi* book or igniteafterschool.org/bibi/cpi/ to see how the CPI process of "Plan, Do, Check, Adjust" can help strengthen your program.



STEM BUILDING BLOCK ONE DO

STEM BUILDING BLOCK ONE 1

What it means:

Youth and adults use STEM learning processes to understand the topic they are exploring — even if the topic isn't explicitly STEM-based.

Why it matters:

Research shows that one of the best ways to *learn* STEM is to *do* STEM. Through STEM processes, young people learn to be curious, question, gather data and make sense of it in everyday life. This helps them develop rigorous, focused and systematic ways of solving problems and understanding our world.[5]

What Effective Practices look like:

Programs are intentionally designed with opportunities for youth to practice learning methods unique to STEM fields to understand they topic they are exploring. The effective practices include:

- Programs provide opportunities for youth to solve problems by investigating issues and developing solutions. *(Problem solving)*
- Programs encourage youth to think about many variables at the same time, develop a hypothesis, and systematically test it. *(Scientific reasoning)*
- Programs provide opportunities for youth to watch and listen carefully *(observing)*, then record what occurs *(measuring)*.
- Programs encourage youth to understand problems in a logical way (e.g., representing the problem with data) that enables the use of computers and others tools to help solve it. *(Computational thinking)*[6]

OVER

USE THIS BOOK!

Put a ✳ next to your strongest effective practice. Circle the one that needs the most attention.

DID YOU KNOW?

Looking for concrete examples that illustrate the STEM effective practices? Just turn the page! There you'll find case studies and guided reflection questions that help you move from *Thought to Action*.

NEED HELP?

Check out online resources at **igniteafterschool.org/bibi/stem**

Thought to Action:

BUILDING BLOCK ONE 1

Applying 'Scientific Reasoning'

Based on The Bakken Museum's Science Assets™ Model

To illustrate the effective practice of 'Scientific Reasoning,' describe it as a process where we **wonder, try, discover, and share**. Framing scientific reasoning this way reminds youth (and staff) that scientific reasoning isn't one rigid process — it's a way of thinking that is flexible enough to apply in your daily life.

***Case Study:* Scientific Reasoning in Afterschool** **Review the following example of an activity using scientific reasoning, then discuss the reflection questions in your group to move from thought to action.**

> Program staff ask young people to play with a collection of materials or things on their table. The collection could include circuit building materials or parts of something the staff have partially taken apart, like an old clock or a broken toy.
>
> After some time, the staff ask youth to stop and write down questions they have, or things they are curious about in their collection of things **(Wonder)**. The youth then **Try** to answer their own questions through activities they decide themselves (e.g., manipulating materials, talking to other youth, searching online), while staff ask targeted questions or provide help as needed. To close the activity, youth reflect on what they **Discovered** as they tried to answer their question, and **Share** their discoveries with the program staff and other youth in the program.

A. How have you already done something with young people that included wonder, try, discover or share?

B. Think about recent activities that you've done with youth in your program. How could you apply scientific reasoning to these activities?

C. If you changed an activity to include scientific reasoning, how would it affect the learning experiences of young people in the program?

Need more inspiration before using Scientific Reasoning and other DO STEM practices in your program? Check out **igniteafterschool.org/bibi/stem/practices**.

STEM BUILDING BLOCK TWO

SHOW

STEM BUILDING BLOCK TWO 2

What it means:

Young people demonstrate STEM skills with hands-on explorations and activities.

Why it matters:

Young people show what they know. By demonstrating STEM skills, youth prove that they have learned to apply the ways of gathering, processing and analyzing information that are embedded in STEM learning. These skills are valuable for all young people, regardless of their future career choice.[7]

What Effective Practices look like:

Programs foster opportunities for youth to learn and demonstrate STEM skills through hands-on practice and lots of "try, try again."

- Program staff and youth attribute successes to *effort* (not just results!) and encourage youth to continue work on a problem even after a difficult or early failure occurs. *(Persistence)*
- Program activities are collaborative, prompting young people to work together in teams to conduct investigations. *(Collaboration)*
- Program activities are flexible and interactive; encouraging youth to use creativity and curiosity to solve problems or answer questions. *(Innovation)*
- Program activities provide opportunities for youth to experience and effectively apply STEM tools and techniques to their investigations. *(Competence with Tools & Techniques)*
- Program staff and youth share their knowledge, process, and results using precise language and terms from STEM disciplines, including concepts that recur across STEM fields, like energy and matter. *(Precise Language)*

OVER

USE THIS BOOK!

Put a ✳ next to your strongest effective practice(s) you're already doing. Circle the ones you want to try to implement.

DID YOU KNOW?

Many of the skills youth develop through quality STEM learning align with the social-emotional and 21st century skills that are critical for youth success.

NEED HELP?

Check out online resources at **igniteafterschool.org/bibi/stem**

Thought to Action:

BUILDING BLOCK TWO 2

Applying 'Precise Language'

Precise language allows two people to have a shared understanding of the same thing. Asking for a "big" scoop of ice cream will mean something different to different people. But asking for an ice cream scoop the size of two tennis balls is more specific. To be even more specific — that is, more precise — you would ask for four ounces of ice cream. We use precise language in measuring things everyday — from inches, to pounds, to seconds — and this specific language make us think more clearly in all aspects of STEM learning.

***Case Study:* Precise Language in Afterschool** **Review the following example of an activity using precise language, then discuss the reflection questions in your group to move from thought to action.**

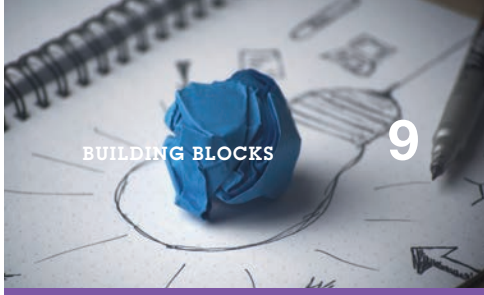
> Program staff do an ice breaker activity where they ask youth to pair up and sit back-to-back on the floor. One young person is given a picture and directs their partner on how to draw the picture without saying what it is. After they finish their drawing, the youth switch places so they each get a chance to give instructions and be the illustrator.

A. Where is it helpful for you to use precise language in your life (i.e. cooking)? What happens when you do not use precise language?

B. Where would it be helpful for you to use more precise language when working with youth?

C. What is an example of an activity you are doing that you could expand to have youth practice using precise language?

Need more inspiration before using Precise Language and other SHOW STEM practices in your program? Check out **igniteafterschool.org/bibi/stem/practices**.



STEM BUILDING BLOCK THREE

CONNECT

STEM BUILDING BLOCK THREE 3

What it means:

Youth are able to connect the ways of thinking, understanding, and problem-solving they learn from their afterschool STEM experiences to other aspects of their lives.

Why it matters:

Making STEM relevant to other areas of young people's lives is critical for building a positive "STEM Identity." Through practical applications (and role models who shatter stereotypes of older men in lab coats!) youth build excitement, confidence and competence in STEM, and see that *yes, they can do STEM* and *yes, STEM is for them*.[8]

What Effective Practices look like:

Programs help young people make STEM connections to the real world. Youth link their STEM learning to culturally relevant topics, broader civic and social issues, and career prospects.

- Program activities provide opportunities for youth to reflect on how the STEM skills they are practicing relate to everyday life, as well as broader civic and social issues.
- Program tailors STEM learning activities to young people's interests, experiences and cultures.
- Program helps youth imagine connections between activities and possible careers by introducing them to caring adults who relate to youth's culture and practice real-world STEM skills in their careers or hobbies.

OVER

USE THIS BOOK!

Put a ✳ next to your strongest effective practice. Circle the one that needs the most attention.

DID YOU KNOW?

The Bureau of Labor Statistics projects that jobs in STEM-related fields will increase by 1 million. Fostering youth's STEM skills matters for many reasons beyond careers, but the job opportunities are a nice perk!

NEED HELP?

Check out online resources at **igniteafterschool.org/bibi/stem**

Thought to Action:

BUILDING BLOCK THREE 3

Relate Stem Processes to Social and Civic Issues

Connecting STEM skills to everyday life and broader social and civic issues is essential for sparking young people's interest and engagement in STEM. The good news is that STEM shows up in so many areas of our lives, making it easy to connect STEM to young people's experiences.

***Case Study:* Connecting STEM Processes to Civic and Social Issues** **Review the following example of an activity that connects STEM processes to social and civic issues. Then discuss the reflection questions in your group.**

> Program staff provide youth with a brief overview of the current issues surrounding "Nanosilver" — an emerging technology that involves using silver nanoparticles in consumer products. Staff don't just lecture, but keep youth engaged with samples of nanosilver products and a demonstration that uses a plume of diet cola to show how particle size affects reactions.[9] After providing this background information, program staff facilitate a debate with youth, posing questions such as, "who might benefit from Nanosilver and whom or what might be harmed?" and "Who should have access to this technology and why?" Youth then get into groups to debate their ideas about how this technology connects to their daily lives and larger issues of the costs, risks, and benefits of technological change to society.

A. What social and civic issues do you think would be of interest to the young people you work with? Make sure to ask for their ideas too?

B. Where are local resources or organizations that could support you in creating relevant STEM learning experiences for your youth? If not local, what about online resources?

C. What are ways you could help your youth make STEM relevant beyond broad societal issues, to seeing how it relates to their individual interests and identity?

Need more inspiration before using the CONNECT STEM practices in your program? Check out **igniteafterschool.org/bibi/stem/practices**.

Guided Reflection

***Reflection 1:* Why do STEM learning in afterschool?** These reflection questions are a great way to think through why engaging youth in quality afterschool STEM learning matters.

1. Review the *We Believe* statements, a set of principles that guide why we want to engage all youth in STEM learning. Select one of the "We Believe" principles and describe how this matters to the young people in your program.

2. Look through the STEM skills mentioned in the STEM Building Blocks (e.g., Collaboration, Computational Thinking). How might young people use these skills now and in the future?

3. While many young people have access to STEM in school, few have places to try out STEM learning in flexible, hands-on ways. What youth do you think most need access to this kind of STEM learning and why?

4. What do you think would be different for the young people in your program if you "STEM it up" and provide quality afterschool STEM learning? How would this impact them, both short- and long-term?

Guided Reflection

Reflection 2: **Applying the STEM Building Blocks** Use these reflection questions with your staff to increase your understanding of how your program already does afterschool STEM learning, and how you can improve your practices.

1. How does your program already DO, SHOW & CONNECT STEM?

2. Did you notice synergies with the STEM Building Blocks and your program's current practices? Did that surprise you?

3. Which STEM Building Blocks are strongest for your program? Which are lacking?

4. Are there some easy adjustments you can make to add (or strengthen) STEM learning in your program? What can you do now? What's next after that?

5. How can your program help young people connect STEM learning to their school, home and community?

6. Who can you partner with to bring more STEM processes, skills and connections to your program?

Guided Reflection

***Reflection 3:* Exploring Your Personal STEM Experience?** These reflection questions will help you explore the attitudes and experiences that shape how you think about STEM learning.

1. How do you use STEM practices (problem solving, measuring, reasoning) in your everyday life?

2. What are the positives and challenges of STEM practices for you?

3. What do you feel like you would need to do to better provide STEM learning experiences?

4. How are you already engaging youth in being curious, exploring, or testing out their ideas in your program?

A great big thanks

The process of conceiving and crafting this guidebook involved lots of thoughtful discussion and shared learning between afterschool and STEM stakeholders. While the initial draft originated from the Afterschool-STEM Joint Work Group members, this final guidebook owes much to the ideas and feedback of afterschool and STEM stakeholders at 4 regional input sessions across Minnesota. We gratefully acknowledge the individuals and organizations who dedicated their time, talent, wisdom, and resources to the common project of creating a shared language for afterschool and STEM learning in Minnesota — the *Believe It. Build It. STEM Guide*.

Afterschool-STEM Joint Work Group

- Deborah Moore, University of Minnesota Youth Work Learning Lab
- Doug Paulson, Minnesota Department of Education
- Erik Skold, Sprockets
- Aiyana Sol Machado, Science Museum of Minnesota — Kitty Andersen Youth Science Center
- Anika Taylor, The Bakken Museum
- Hayley Tompkins, Minneapolis Beacons Network
- Jocelyn Wiedow, Sprockets

Regional Input Session Conveners

- Duluth Area Family YMCA
- Itasca Networks for Youth
- Northland Foundation
- Minneapolis Beacons Network
- Minnesota Department of Education
- Rochester Area Youth Programs Network
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- University of Minnesota Extension Center for Youth Development — Moorhead Regional Office

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- Erin Gibbons, Launch Lab Creative
- Janine Hanson, Janine Hanson Communications, LLC

A whole lot of research

Research Notes

[1]Durlak, Joseph A., Roger P. Weissberg, and Molly Pachan (2010). "A meta-analysis of after-school programs that seek to promote personal and social skills in children and adolescents." *American journal of community psychology* 45, no. 3-4 (2010): 294-309.

[2]National Research Council (2015). *Identifying and Supporting Productive Programs in Out-of-School Settings*. Committee on Successful Out-of-School STEM Learning, Board on Science Education, Division of Behavioral and Social Science and Education. Washington, DC: The National Academies Press.

[3]Krishnamurthi, A., Ballard, M., and Noam, Gil G. (2014). *Examining the impact of afterschool STEM programs*. Afterschool Alliance and Program in Education, Afterschool, and Resiliency at Harvard University. Available: http://files.eric.ed.gov/fulltext/ED546628.pdf [July 2016]

[4]National Research Council (2015) Ibid.

[5]National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on Conceptual Framework for the New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

[6]International Society for Technology in Education and the Computer Science Teachers Association. (2011). "Operational Definition of Computational Thinking" Available: https://csta.acm.org/Curriculum/sub/CurrFiles/CompThinkingFlyer.pdf [July 2016]

[7]Afterschool Alliance. (2013). *Defining Youth Outcomes for STEM Learning in Afterschool*. Available: http://www.afterschoolalliance.org/STEM_Outcomes_2013.pdf [July 2016].

[8]National Research Council. (2009). *Learning Science in Informal Environments: People, Places, and Pursuits. Committee on Learning Science in Informal Environments*. P. Bell, B. Lewenstein, A.W. Shouse, and M.A. Feder (Eds.). Board on Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

[9]Full details about this and other activities are available at the National Informal STEM Education Network website (www.nisenet.org/catalog/nanosilver-breakthrough-or-biohazard)

Note: For all "Myth Buster" and "Did You Know?" sources, go to igniteafterschool.org/bibi/stem/research

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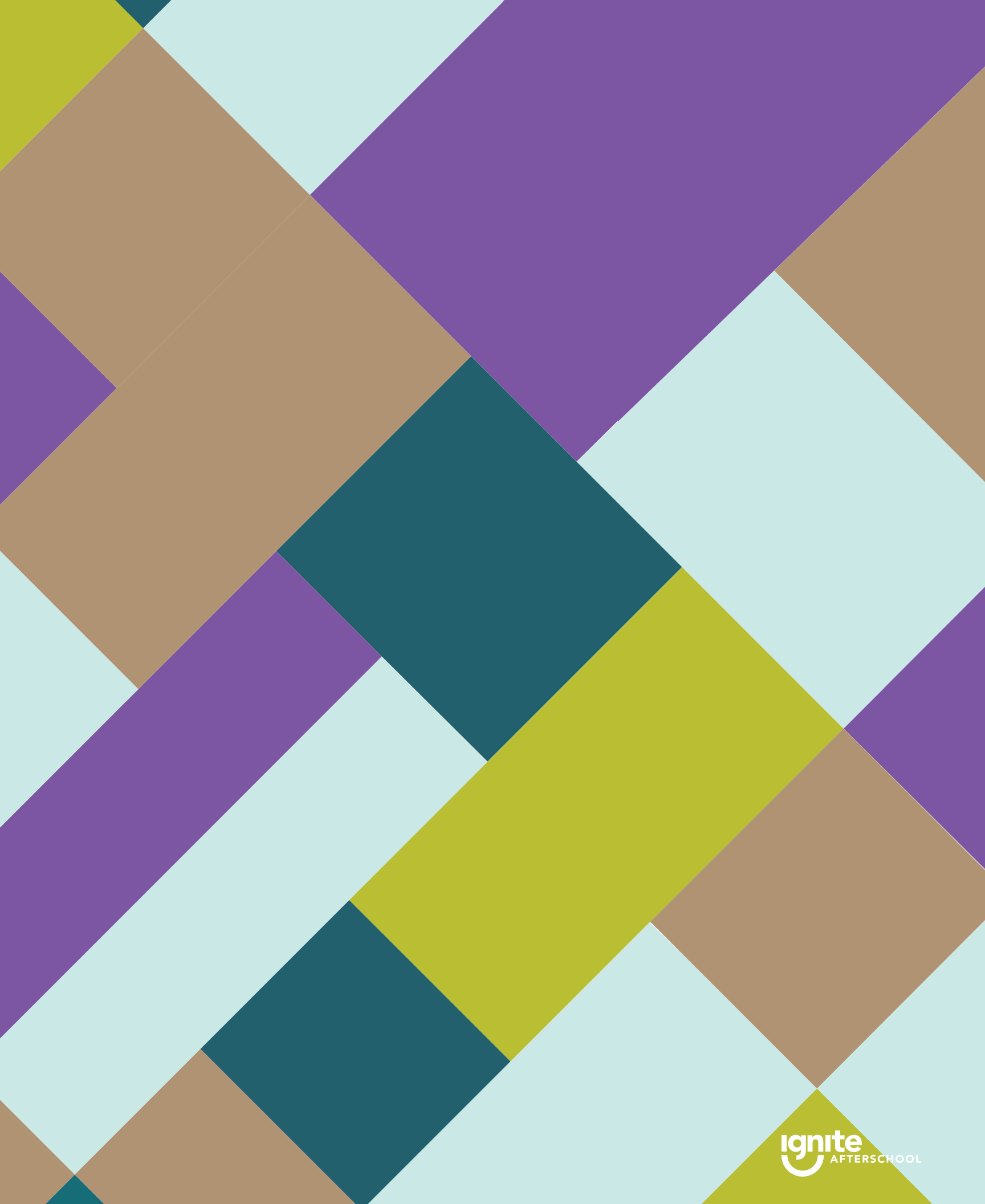
Notes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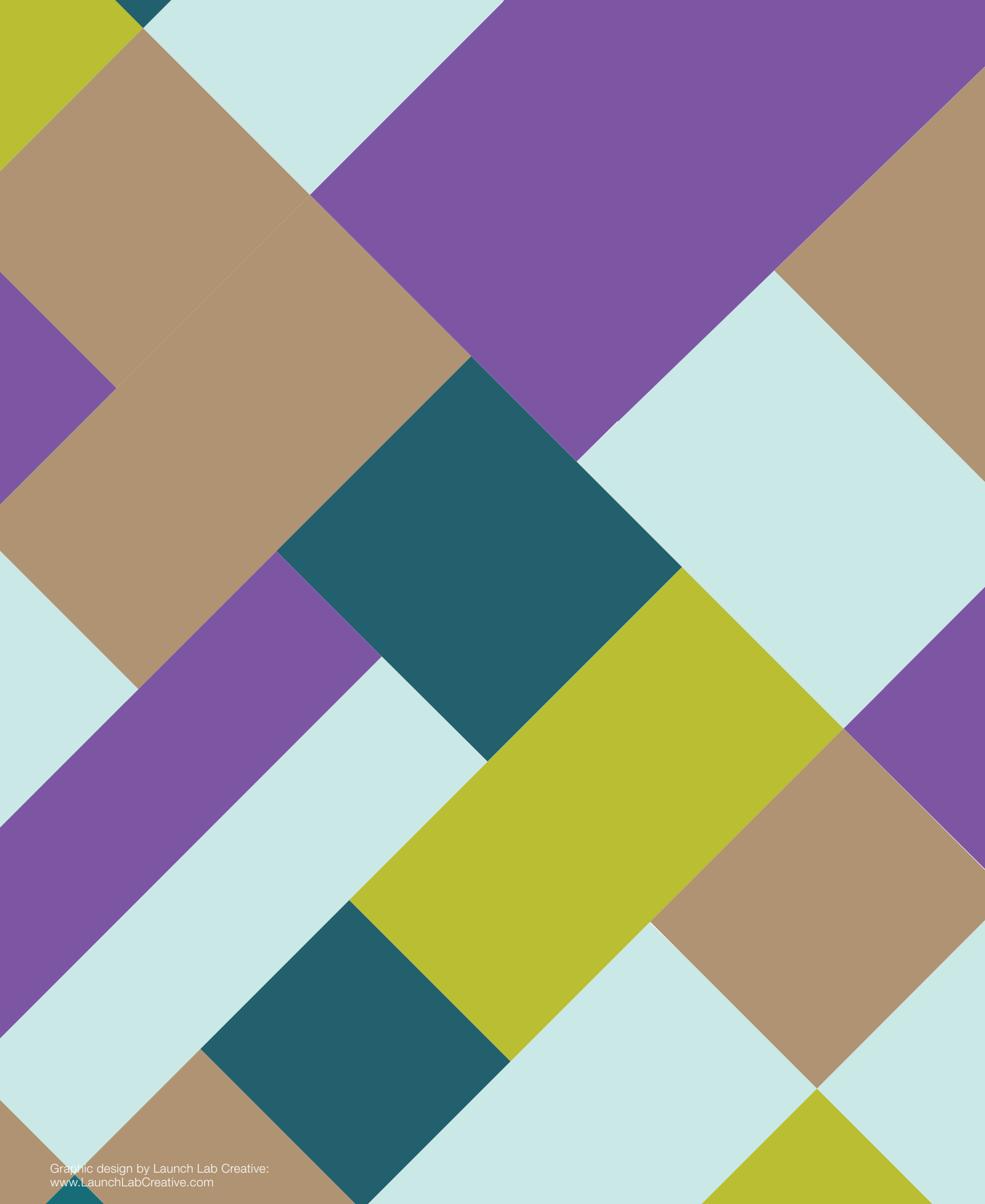

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