Supporting Conflicts and the Development of Executive Function Skills in STEM Classrooms

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What is the best experience you can remember you had in grade school?
Share this with the person next to you.
What is the **worst** experience you can remember you had in grade school?

Share this with the person next to you.

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**Research on Peer Relationships**

**Aggressive Children**

- Poor peer relationships
- Friendlessness
- Peer rejection
A Child Rejected by Peers is in High Risk of…

- Poor academic performance
- Dropping out
- Delinquency

“Children who get in fights with other children…who are constantly in conflict with other children and teachers- are on a path where they're not learning now and they're going to learn less in the future.“

"If children are sad or mad, they can't add."
How we engage with a child…
**matters!**

How we arrange the educational environment…
**matters!**

How we challenge a child intellectually…
**matters!**

Samantha –
A first grader
32 years ago

Joseph–
A first grader
21 years ago

Socio-Moral Environment  Physical Environment  Intellectual Environment
How can we make our educational environments less prone to conflicts?

Aspects of a Socio-Moral Environment That Can Lead to Conflict

- Trying to remember (or resenting) teacher rules
- Unrealistic wait time
- Many, many transitions
Aspects of a Physical Environment That Can Lead to Conflict

crowding in a part of the classroom

-or-

cluttering of the classroom

Aspects of a Physical Environment That Can Lead to Conflict

Insufficient amount of materials

and/or

experiences
Aspects of an Intellectual Environment That Can Lead to Conflict

Activities that do not engage children

But should we make our educational environments conflict free?
Two types of Conflict

1. Intra-individual Conflict
   - Occurs within the individual
   - Involves a contradiction between what a person knows or believes and what he or she experiences or observes.

Two types of Conflict

2. Inter-individual Conflict
   - Occurs between two or more individuals
   - Involves a clash between the individuals’ goals, behaviors, beliefs, knowledge, or expectations
This is why I can’t have nice things.

The Role of Conflict in Piaget’s Theory of Cognitive Development

- Conflict plays a central role in the development of knowledge
- Experiences of conflict prompt individuals to change how they think and feel

Perspective Taking
Misbehavior vs. Mistaken Behavior

“This child is misbehaving in the center and needs some discipline. I have to be patient until he learns proper behavior.”

1.) adult is making a moral judgement about the behavior
2.) Adult is making a moral judgement about the child.

In this reaction, adults:
1. make a moral judgment about behavior
2. make another moral judgment about the child
3. are calling on their ability to be patient rather than understanding.

“This child is having some mistaken behavior in the center. I’m not sure he understands what is possible to figure out in this center. I wonder how I could
a) arrange the classroom;
b) change how I introduce the experience
c) improve the experience
so he understands what he can figure out in the center.”

In this response, adults:
1. reason why a child behaved in a certain way
2. wonder what he/she could do differently to help the child understand
3. are calling on their ability to be understanding and patient

Dan Gartell: The Power of Guidance: Teaching Social-Emotional Skills in Early Childhood Classrooms
Thomson: Delmar Learning 2004 Chapter 2 pg 6

Executive Functions

Inhibitory Control (self-control)
● resisting habits, temptations, or distractions

Working Memory
● mentally holding and using information

Cognitive Flexibility
● adjusting to change
Executive Functions
Inhibitory control

- Resist temptations
- Resist distractions
- Resist habits
- Selective focused, and sustained attention
- Prioritize and then take action
- Pause and think before we act
- “Bite our tongue”
- Control emotions

Examples of Inhibitory control in preK-2 children

- Wait to be called on
- Wait at games
- Stop themselves from yelling or hitting
- Ignore distractions to keep working
Executive Functions
Working Memory

Hold and manipulate information in our heads over short periods of time
- Remember a phone number long enough to dial it
- Return to place in a book before interrupted
- Recall whether we had added the salt to a recipe

Examples of Working Memory in preK-2 children

- Remember and connect information from one page to the next
- Follow directions with several steps
- Keep track of moves and make a logical move in a game of checkers
- Plan and act out a story
- Take turns in group activities
- Are able to leave and rejoin game
Executive Functions
cognitive or mental flexibility

- Switch gears and adjust to changed demands, priorities, or perspectives
- Apply different rules in different settings
- Catch mistakes and fix them
- Revise ways of doing things in light of new information
- Consider something from a fresh perspective
- "Think outside the box"

EXAMPLES of cognitive or mental flexibility in preK-2 children

- Exceptions to how letters appear in different fonts
- Try different strategies when they are working out a conflict with another child
- Approach a question about how the world works in different ways
- Approach a problem in different ways in order to solve it
7 Essential Life Skills identified by Ellen Galinsky

1. Focus and self-control
2. Perspective taking
3. Communicating
4. Making connections
5. Critical thinking
6. Taking on challenges
7. Self-directed, engaged learning

Young children who have problems with these skills will not necessarily outgrow them.
What helps develop executive function skills?

Experiences that require:

- strategy and reflection
- logic and reasoning
- problem-solving
- a challenge to hold in mind previous beliefs while they develop and discard potential theories (cognitive flexibility)
- thinking about categorization

This is why I can’t have nice things.
Which of these skills are necessary in order for children to participate in Conflict Resolution?

1. Focus and self-control
2. Perspective taking
3. Communicating
4. Making connections
5. Critical thinking
6. Taking on challenges
7. Self-directed, engaged learning

How can we promote perspective taking in children?

- Listen to children.
- Help children feel known and understood.
- Develop warm and trusting relationships.
- Talk about feelings—yours and theirs.
- Use everyday moments to talk about other people's perspectives.
- View teaching children to be with others is as important to teaching them independence.
Write down their names.

Under each name, list things in which he or she is interested.

If you are here with colleagues who know these same children check with them to see if your ideas are compatible.

Think of three children in your care.

Your Children’s Interests

<table>
<thead>
<tr>
<th>Control and Power</th>
<th>What is In the World</th>
<th>How Things Work</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superhero</td>
<td>Rocks</td>
<td>taking things apart</td>
<td></td>
</tr>
<tr>
<td>Video games</td>
<td>Insects</td>
<td>toy cars</td>
<td></td>
</tr>
<tr>
<td>Moving</td>
<td>The color purple</td>
<td>puzzles</td>
<td></td>
</tr>
<tr>
<td>Pretend Play</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Interest in the World and How it Works is the fuel that ignites the development of all of these essential life skills.

1. Focus and self-control
2. Perspective taking
3. Communicating
4. Making connections
5. Critical thinking
6. Taking on challenges
7. Self-directed, engaged learning

Inhibitory Control
Working Memory
Cognitive Flexibility

This is why I can’t have nice things.
Gray matter is brain tissue critical for processing of information and execution of actions.

What inhibits the development of gray matter in young children?

- Unsafe environment
- Parental stress
- Lack of sleep
- Poor nutrition
- Lack of books
- Lack of educational toys
- Limited enriching conversation

The absence of enriching activities and interactions are of particular importance.
“When we say enrichment, we’re not talking about flashcards or special software…”

It is about adults:

- having conversations with children (socio-moral)
- giving children time to play (physical)
- giving children time to explore (intellectual)

-Jamie Hanson
University of Wisconsin-Madison

How can I embrace conflict in designing the educational environments for my children?

Your Children’s Interests often Include Concepts Within STEM

Investigate
Control and Power
Superhero
Video games
Moving
Pretend Play

Science
What is In the World
Rocks
Insects
The color purple

Engineering
How Things Work
taking things apart
toy cars
puzzles

Other
Your Children’s Interests often Include Concepts Within STEM

- **Investigate**
  - Control and Power
    - Superhero
    - Video games
    - Moving
    - Pretend Play

- **Science**
  - What is In the World
    - Rocks
    - Insects
    - The color purple

- **Engineering**
  - How Things Work
    - Taking things apart
    - Toy cars
    - Puzzles

- **Other**

*Children need experiences in which they can investigate their interests to develop intelligence.*

**Dr. Judy Cameron**
Harvard University
What can adults do to teach children about STEM?

Engage
What can adults do to teach in children about STEM?
Unpacking STEM

What is science?
Science: Systematic knowledge of the physical or material world gained through observation and experimentation.

Science: Figuring out what and why
If you looked, and you watched, and you paid attention, you got a great reward from it.

I learned then what science was about: patience.

Richard Feynman

Noticing
Taking Science to School

Asking their own questions
Pursuing the answers through investigations
Gather data and communicate
Revise their question and pursue answers …

Scientific Habits of Mind

• I want to observe
• I have questions
• I need to gather information
• I have more questions or a different question
• I need to gather more information
• I thought I wanted to figure this out, but now I think I need to…
What is technology?

Technology: The process by which humans modify nature to meet their needs and wants


Technology: The innovation, change, or modification of the natural environment in order to satisfy perceived human wants and needs

International Technology Education Association (ITEA) 2000/2002. ITEA standards for technological literacy: Content for the study of technology p. 242
Technology: The process by which children modify nature to meet their needs and wants


Technology: The innovation, change, or modification of the natural environment in order to satisfy perceived children’s wants and needs

International Technology Education Association (ITEA) 2000/2002. ITEAs standards for technological literacy: Content for the study of technology p. 242

What do you notice children working to modify?

What can I build or make so that...

A curious and creative habit of mind to inspire new technology
What do children modify in your settings?

What is engineering?
**Engineering:** An approach to designing technology (objects, processes, and systems) to meet human needs

Children are engaging in design, the fundamental activity of engineering, every day as they move dirt and sand, stack blocks and cans, and design their own toys and games.

-Engineer Henry Petroski

*Design is rooted in imagination and choice-and play.*
Engineering: Design under Constraint. (Wulf, 1998)

Typical engineering constraints for adults:
- Laws of physics
- Materials and their properties
- Space
- Time
- Budget

Typical engineering constraints for children:
- Laws of physics
- Materials and their properties
- Space
- Time
- Availability of materials

Teaching the steps of the scientific method (which scientists in the field rarely use) keeps students from “doing science”.

Teaching the steps of the scientific method (which scientists in the field rarely use) keeps students from “doing science”.
Teaching the steps of the engineering design process (which engineers do not use in this way) keeps students from “doing engineering.”

- Systems thinking
- Creativity
- Optimism
- Collaboration
- Communication
- Attention to ethical considerations

Engineering Habits of Mind
What is math?

Exploring Geometry Through Block Play
Let’s Explore and Build!

1. Identify a note taker
2. Think from two perspectives as you build – the teacher and the child
3. Take note of:
   - Where could the science be in these materials? The technology? The engineering?
   - How children’s interest in mathematics might be stimulated by these materials?
   - How children’s prior knowledge or experiences could impact their engagement
   - What intra-individual (within self) conflict may children have while working with these materials
   - What inter-individual (with others) conflict

Let’s Discuss…

- How children’s interest in mathematics might be stimulated by these materials
- How children’s prior knowledge or experiences could impact their engagement
- What intra-individual (within self) conflict may children have while working with these materials
- What inter-individual (with others) conflict
Personal Reflection

How might your prior knowledge or experiences impact your engagement with these materials?

In most early childhood settings, block building is...

- Viewed as a self-sustaining center
- Free choice
Lost Opportunities

Block building provides opportunities to develop spatial thinking necessary for STEM.

STEM in Block Building

Science
Technology
Engineering
Mathematics
But isn’t number what is most important for young children?

Why should we care about spatial thinking?

Five Reasons to Care About Spatial Thinking

1. Spatial thinking is different than verbal explanations
2. Strong spatial thinking skills = honors math courses
3. Spatial thinking skills indicate intelligence
4. Spatial thinking is highly related to creative problem solving in mathematics
5. Girls are harmed in mathematics progression due to lack of attention to spatial skills
Daily uses of Spatial Thinking

<table>
<thead>
<tr>
<th>Daily uses of Spatial Thinking</th>
<th>Navigating And Wayfinding</th>
<th>Using Non-verbal Reasoning</th>
<th>Using Proportional Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manipulating Objects</td>
<td>Scaling Up Or Down</td>
<td>Orienting</td>
<td></td>
</tr>
<tr>
<td>Creating And Reading Maps, Graphs, Visual Data</td>
<td>Moving One's Body In Space</td>
<td>Locating Objects And Remembering Their Location</td>
<td></td>
</tr>
<tr>
<td>Shifting Dimensions</td>
<td>Decomposing</td>
<td>Perspective Taking</td>
<td></td>
</tr>
<tr>
<td>(seeing connections between three- dimensional figures and two-dimensional representation)</td>
<td>(physically or mentally taking shapes apart; which involves seeing shapes within shapes)</td>
<td>(considering the perspective of someone who is in a different location, such as how their view of something may be different)</td>
<td></td>
</tr>
<tr>
<td>Creating Or Designing Objects</td>
<td>Composing</td>
<td>Imagining Objects</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(physically or mentally combining two or more shapes to make a new shape)</td>
<td>Moving In Space (mental rotation and transformation)</td>
<td></td>
</tr>
<tr>
<td>Visualizing</td>
<td>Comparing objects</td>
<td>Diagraming</td>
<td></td>
</tr>
</tbody>
</table>

NCTM Geometry Standards for Pre-K to Grade 2 (2000)

- Creating mental images of geometric shapes, predicting the effect of transformations on shapes (e.g., mental rotations)
- Describing spatial relationships (e.g., using words such as inside, outside, top, and bottom)
- Investigating the results of putting together and taking apart shapes (spatial visualization)

http://www.edu.gov.on.ca/eng/literacynumeracy/LNSPayingAttention.pdf
What is geometry for young children?

- Noticing shapes
- Noticing congruence
  - they are the same shape and size
- Noticing how shapes can be transformed into others

What are spatial orientation skills?

“Attempting to understand and discuss something like spatial orientation skill, which is by definition intuitive and nonverbal, is like trying to grab smoke: the very act of reaching out to take hold of it disperses it.”

Spatial Orientation Skills

The child's own position and her movement through space...

Spatial Orientation Skills

...and eventually the ability to take a more abstract perspective that includes maps and coordinates at various scales.
Spatial Visualization
Taking the Perspective

• Write down what the child does
• Describe without making judgments

Take Observational Records

• Write down what the child does
• Describe without making judgments
Analyze Observational Records

- On right side, analyze what you noticed.

Observe and Talk With Builders

- Describe what child has done.
- Ask open-ended questions.
Things to note:

• Choice of blocks
• Arrangement of blocks
• Number used
• Similarities
• Striking elements

What building qualities can you see in this arrangement?

Examples of Comments

• “I see you used one block that is longer than the others.”
• “Look, your blocks make a space in the middle.”
• “All of your blocks except one are touching.”
• “You used five blocks. You made the whole building with just five blocks.”
• “All your blocks are rectangles, but they’re not all the same size.”
What other mathematical concepts can be addressed with unit blocks besides shapes?

Mathematical Opportunities Made Meaningful in Block Play

**Number Sense**
- Concepts
  - Number words, names
  - Cardinality/Sequence of #s
    - 1-1 correspondence
    - Tell how many after count
    - Subitize; (how many in small group)
- Numeracy processes
  - Count
  - Compare quantity (less than, more than, equal/same)
  - Operations (put together/add to, take-away; divide; part whole relationships)

**Algebraic Reasoning**
- Concept
  - Recognize pattern
- Pattern processes
  - Describe pattern
  - Copy/complete pattern
  - Create pattern
Mathematical Opportunities Made Meaningful in Block Play

Geometry
(shapes and spatial reasoning)

- Properties/Attributes of Blocks
  - Shapes (identify, name)
  - General attribute of a block
    - Size
    - 2-D, 3-D
    - Recognize in different forms, orientations, perspectives
    - ID in environment
  - Geometric attributes (identify, name)
    - corner, face, point, line, angle, side, face

- Geometric attributes of combined shapes
  § Symmetry
  § Balance
  § Strong foundation

- Equivalence
  - Size

- Spatial relationships
  - Relative positions, direction, distance (above, below, near, far, around…)

Geometric Processes (operations, actions)

- Build
  - Stack, line up

- Construct to represent world

- Sort, math compare (using attributes – size, shape)

- Create model of shapes observed in world (visualize, clay model, draw)

- Compose/decompose shapes into other shapes

- Transform (slide, flip, turn to fit)
Mathematical Opportunities Made Meaningful in Block Play

**Measurement**

- **Concepts**
  - Measurement attributes – length, depth, width, height, weight
  - Things can be measured and represented using common units

- **Measurement & Data Processes**
  - Actively measuring using common units
  - Compare/describe/classify on measurable attribute using unit of measure

**General Mathematical Processes**

- Observe
- Collect/organize, order/sequence
- Compare based on mathematical attributes (quantity, size, length etc.)
- Describe/communicate
- Represent/document/visualize (stands for)
- Reason (reflect on, explain justify)
- Use information to draw conclusions, solve problems
- Make connections
- Predict/infer; probability
Frank Lloyd Wright

Block Building and Math Skills
Spatial Thinking Assessments in Middle School

Spatial Thinking Assessments in Middle School
• How high...
• How many will I need...
• If I put this over...and that under...
• If I need this much space here, I must...
• It doesn’t fit...but if I rotate the block and position it this way...

Mathematical Habits of Mind

STEM