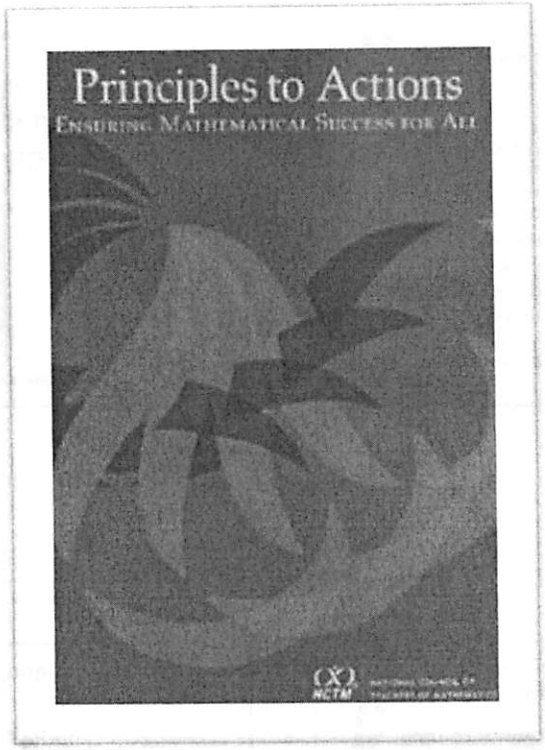

Empowering Pre-Service Teachers with NCTM's Principles to Action

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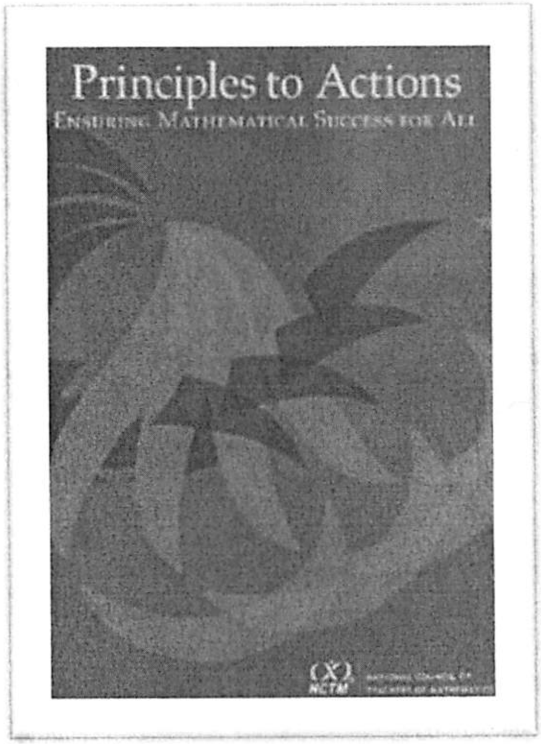

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Implement tasks that promote reasoning and problem solving.

- *Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies. (Principles to Action, 2014)*
  - Dan Meyer: Math Class Needs a Makeover (2010)
  - Teaching Secondary and Middle Mathematics (Brahier, 2014)
    - Problems versus Exercises
  - Jo Boaler: Why US Students need the Common Core (YouTube)
  - 5 Practices for Orchestrating Productive Mathematics Discussions (Smith & Stein, 2011)

Session Outcomes

- Share information and resources based on *Principles to Actions: Ensuring Mathematical Success for All*
- Share information and resources based on *5 Practices for Orchestrating Productive Mathematics Discussions*
- Demonstrate how the Swivl Robot can be used to develop reflective practitioners of interns and teachers

•5 Practices for Orchestrating Productive Mathematics Discussions (Smith & Stein, 2011)

- Anticipating
- Monitoring
- Selecting
- Sequencing
- Connecting

Effective Mathematics Teaching Practices

- Establish mathematics goals to focus learning.
- Implement tasks that promote reasoning and problem solving.
- Use and connect mathematical representations.
- Facilitate meaningful mathematical discourse.
- Pose purposeful questions.
- Build procedural fluency from conceptual understanding.
- Support productive struggle in learning mathematics.
- Elicit and use evidence of student thinking.
- .

Principles to Action, 2014

Selecting Appropriate Tasks

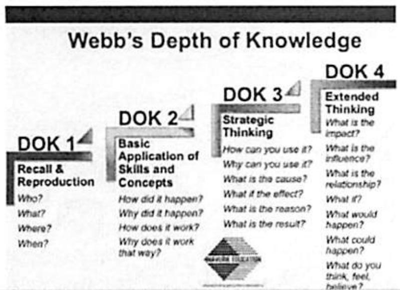
Task Analysis Guide (Stein & Smith, 1998)

Lower Level Demands	Higher Level Demands
• Memorization	• Procedures with Connections
• Procedures without Connections	• Doing Mathematics

All tasks are ***not*** created equal– different tasks require different levels and kinds of student thinking!

5 Practices for Orchestrating Productive Mathematics Discussions (p. 16)
Principles to Actions (pp. 18 & 19)

Norman Webb's Depth of Knowledge Levels



What is the connection between cognitive demand levels and DoK ?

Facilitate meaningful mathematical discourse.

The Case of Shalunda Shackelford and the Bike and Truck Task

What are teachers doing?	What are students doing?
Engaging students in purposeful sharing of mathematical ideas, reasoning, and approaches, using varied representations.	Presenting and explaining ideas, reasoning, and representations to one another in pair, small-group, and whole-class discourse.
Selecting and sequencing student approaches and solution strategies for whole-class analysis and discussion.	Listening carefully to and critiquing the reasoning of peers, using examples to support or counterexamples to refute arguments.
Facilitating discourse among students by positioning them as authors of ideas, who explain and defend their approaches.	Seeking to understand the approaches used by peers by asking clarifying questions, trying out others' strategies, and describing the approaches used by others.
Ensuring progress toward mathematical goals by making explicit connections to student approaches and reasoning.	Identifying how different approaches to solving a task are the same and how they are different

Thinking Through a Lesson Protocol

Smith, Bill, and Hughes (2008, p. 134)

5 Practices for Orchestrating Productive Mathematics Discussions (p. 79)

Pose Purposeful Questions (pp.35-37)

The Case of Debra Campbell and the Building a New Playground Task

Question type		Description	Examples
1	Gathering information	Students recall facts, definitions, or procedures.	When you write an equation, what does the equal sign tell you? What is the formula for finding the area of a rectangle? What does the interquartile range indicate for a set of data?
2	Probing thinking	Students explain, elaborate, or clarify their thinking, including articulating the steps in solution methods or the completion of a task.	As you drew that number line, what decisions did you make so that you could represent 7 fourths on it? Can you show and explain more about how you used a table to find the answer to the Smartphone Plans task? It is still not clear how you figured out that 20 was the scale factor, so can you explain it another way?

The Case of Wobberson Torchon and the Calling Plans 1 Task

Question type		Description	Examples
3	Making the mathematics visible	Students discuss mathematical structures and make connections among mathematical ideas and relationships.	What does your equation have to do with the band concert situation? How does that array relate to multiplication and division? In what ways might the normal distribution apply to this situation?
4	Encouraging reflection and justification	Students reveal deeper understanding of their reasoning and actions, including making an argument for the validity of their work.	How might you prove that 51 is the solution? How do you know that the sum of two odd numbers will always be even? Why does plan A in the Smartphone Plans task start out cheaper but become more expensive in the long run?

Principles to Actions Professional Learning Toolkit

- www.nctm.org/PtA
- The Teaching and Learning Modules were developed in collaboration with the Institute for Learning (IFL) at the University of Pittsburgh.
  - Presentation
  - Presenter notes
  - Required materials to support professional learning through analyzing artifacts of teaching (e.g., mathematical tasks, narrative and video cases, student work samples, vignettes)

Pose Purposeful Questions

Focusing Questions

Funneling Questions

Support Productive Struggle (pp.48-53)

The Case of Debra Campbell and the Building a New Playground Task

The Case of Jeffrey Ziegler and the S-Pattern Task

What are teachers doing?	What are students doing?
Anticipating what students might struggle with during a lesson and being prepared to support them productively through the struggle.	Struggling at times with mathematics tasks but knowing that breakthroughs often emerge from confusion and struggle.
Giving students time to struggle with tasks, and asking questions that scaffold students' thinking without stepping in to do the work for them.	Asking questions that are related to the sources of their struggles and will help them make progress in understanding and solving tasks.
Helping students realize that confusion and errors are a natural part of learning, by facilitating discussions on mistakes, misconceptions, and struggles.	Persevering in solving problems and realizing that is acceptable to say, "I don't know how to proceed here," but it is not acceptable to give up.
Praising students for their ***efforts*** in making sense of mathematical ideas and perseverance in reasoning through problems.	Helping one another without telling their classmates what the answer is or how to solve the problem.

Principles to Actions (p. 52)

What is Discourse Rubric

Level 1: Ineffective	Level 2: Developing	Level 3: Effective	Level 4: Highly Effective
• Teacher asks no, or only non- math questions or provides no wait time or questions lead learners to misunderstandings. • No linking in class discourse. • No student linking in discourse • Non math student talk OR Math ideas not generated by students (i.e. repeating what teacher said or only asking questions.) • Zero, one or two students participate in the math discussion. • Participation learning structures for student participation and/or discourse are not evident.	• Teacher asks yes/no recalling of fact questions. • Students link their answers or ideas to others but do not use the connection to compare strategies, generate ideas or build upon knowledge. • Student talk that only conveys procedural knowledge (i.e. definitions, procedures, rules and/or correctness of answer or providing an answer.) • More than one or two but less than ¼ of students in class participate in discussion around the math topic. • Participation learning structures with limited structure for equitable student participation are evident. • Some seating arrangements allow for discourse in pairs/small groups.	• Teacher asks 1-2 students to explain their thinking using reasoning and appropriate evidence. • Teacher revoices, acknowledges or questions student response to further the discussion 1-2 times. • Students link their answers or ideas to others 1-2 times in ways that compare strategies, generate ideas or build upon knowledge. • Student talk conveys procedural knowledge in relation to conceptual understanding or mathematical reasoning. • About 1/2 of students in class participate in discussion around the math topic. • Participation learning structures with some structure for equitable student participation are evident. • Seating arrangements are in pairs/small groups to allow for discourse.	• Teacher asks 3 or more students to explain their thinking using reasoning and appropriate evidence. • Teacher revoices, acknowledges or questions student response to further the discussion 3 or more times. • Students link their answers or ideas to others 3 or more times in ways that compare strategies, generate ideas or build upon knowledge. • Student talk conveys procedural knowledge in relation to conceptual understanding and mathematical reasoning. • Majority of students in class participate in discussion around the math topic. • Participation learning structures with structure for equitable student participation are evident. -Pair sharing -Small groups have individual roles and responsibilities.

Council of Chief State School Officers Cross State Collaborative

Iowa

Montana

North Dakota

South Dakota

Effective Questioning Rubric

Level 1: Ineffective	Level 2: Developing	Level 3: Effective	Level 4: Highly Effective
• The teacher's questions are of low cognitive challenge and are asked in rapid succession.* • Questions are rapid-fire and convergent, with a single correct answer. Questions do not invite student thinking.* • Teacher calls on a few students whom he knows will have a correct answer.	• The teacher's questions lead students through a single path of inquiry, with answers seemingly determined in advance.* • The teacher frames some questions designed to promote student thinking but many have a single answer, and the teacher calls on students quickly.* • Teacher asks students questions that require students to respond with a one-to-two word answer. Teacher waits only a few seconds for a response.	• While the teacher may use some low-level questions, he poses questions designed to promote student thinking and understanding.* • The teacher uses open-ended questions, inviting students to think and/or offer multiple possible answers.* • Teacher asks students questions that are open-ended, but tone of voice implies the teacher is looking for a specific response. Teacher curtails student responses.	• The teacher uses a variety or series of questions or prompts to challenge students cognitively, advance high-level thinking and discourse, and promote metacognition.* • The teacher builds on and uses student responses to questions in order to deepen student understanding.* • Teacher listens, observes, identifies key strategies, keeps track of approaches and asks questions that will make students' thinking visible and help students clarify their thinking. • Teacher frequently asks students questions that require students to synthesize information, generate hypotheses, or form generalizations, allowing ample wait time.

Planning for Discourse Using the 5 Practices Rubric

Level 1: Ineffective	Level 2: Developing	Level 3: Effective	Level 4: Highly Effective
• Teacher does not plan for the whole class discussion and/or there is no whole-class discussion. • There is no evidence of anticipating possible student responses • Teacher does not attend to students working	• Teacher allows student sharing in a random order during the whole-class discussion. • There is evidence that the most common student response has been identified • Teacher observes and listens to student's conversations while they are working with little interaction. • The teacher provides the summary based on their mathematical understanding.	• Teacher plans for whole-class discussion without consideration of the mathematical goals of the lesson. • There is evidence that most student responses have been identified • Teacher observes and listens and identifies some student thinking as it emerges and asks questions to keep students on task. • Teacher orchestrates the whole-class discussion based on the work of the students without connecting the mathematical ideas.	• Teacher uses a focused model for planning a successful whole-class discussion that builds on student thinking while continuing to advance the mathematical goals of the lesson. • There is evidence that all possible student responses have been identified • Teacher listens, observes, identifies key strategies, keeps track of approaches and asks questions that will make students' thinking visible and help students clarify their thinking. • Teacher decides what aspects of the task to highlight, how to organized and orchestrate the work of the students, what questions to ask to challenge those with varied levels of expertise and how to support students without taking over the process of thinking of them and thus eliminating the challenge.

June Apaza, Center for the Advancement of Math and Science Education, BHSU

How to Facilitate Discourse Rubric

Level 1: Ineffective	Level 2: Developing	Level 3: Effective	Level 4: Highly Effective
• Patterns of teacher-student interactions are mostly negative, inappropriate or insensitive.* • Teacher is at the front of the room and dominates conversation • Teacher is only questioner. Questions serve to keep students listening to teacher. • Students give short answers and respond to teacher only. • Teacher questions focus on correctness. Students provide short answer-focused responses. Teacher may even give answers. • Representations are missing, or teacher shows them to students. • Culture supports students keeping ideas to themselves or just providing answers when asked.	• Patterns of teacher-student interactions are generally appropriate.* • Teacher encourages the sharing of math ideas and directs speaker to talk to the class, not to the teacher only. • Teacher questions begin to focus on student thinking and less on answers. Only teacher asks questions. • Teacher probes student thinking somewhat. One or two strategies may be elicited. • Teacher may fill in an explanation. Students provide brief descriptions of their thinking in response to teacher probing. • Students learn to create math drawings to depict their mathematical thinking.	• Teacher-student interactions are caring and demonstrate respect.* • Teacher facilitates conversation between students, and encourages students to ask questions of one another. • Teacher asks probing questions and facilitates some student-to-student talk. Students ask questions of one another with prompting from teacher. • Teacher probes more deeply to learn about student thinking. Teacher elicits multiple strategies. Students respond to teacher probing and volunteer their thinking. Students begin to defend their answers. • Students label their math drawings so that others are able to follow their mathematical thinking.	• Teacher-student interactions are highly caring and demonstrate genuine sensitivity and respect.* • Students carry the conversation themselves. Teacher only guides from the periphery of the conversation. Teacher waits for students to clarify thinking of others. • Student-to-student talk is student initiated. Students ask questions and listen to responses. Many questions ask "why" and call for justification. Teacher questions may still guide discourse. • Teacher follows student explanations closely. Teacher asks students to contrast strategies. Students defend and justify their answers with little prompting from the teacher. • Students follow and help shape the descriptions of others' math thinking through math drawings and may suggest edits in others' math drawings.

Strategies for Modifying Tasks Rubric

Level 1: Ineffective	Level 2: Developing	Level 3: Effective	Level 4: Highly Effective
• Tasks involve either reproducing previously learned rules or formulas with no cognitive effort. • The tasks lack rigor* • Tasks are boring and/or not well aligned to the instructional goals** • Tasks do not lead students to a deeper understanding of content	• Tasks call for a specific procedure or one that is practiced after a procedure has been introduced with little cognitive effort • The tasks represents a mixture of low expectation and rigor* • Tasks are moderately challenging** • Tasks lead some students to a deeper understanding of content	• Tasks requires the use of broad general procedures for the purpose of developing deeper levels of understanding requiring some degree of cognitive effort. • The tasks represents high expectations and rigor* • Tasks provide opportunity for high level thinking** • Tasks lead all students to a deeper understanding of content	• Tasks requires complex and non-algorithm thinking- an approach is not explicitly suggested requiring considerable cognitive effort • The task represents high-level learning in mathematics* • Tasks permit student choice** • Tasks lead all students to a deeper understanding of content and an opportunity to reflect on the rigor of the task.

What Is A SWIVL?

- Robot that works with an iPhone,an iPad, Android, or a DSLR camera
  - Marker: Uses line of sight technology
  - Works from 3ft – 30 ft, best at 5ft-15ft

Sources

- www.Swivl.com
- Swivl: Personal Cameraman for Recording Lessons and Presentations
  - https://www.youtube.com/watch?v=zQGZRs5XYbY
- A Guide to Recording Your Lectures and Slides with Swivl (YouTube)
  - https://www.youtube.com/watch?v=68J98PGMoS8

Thank you for attending!

Smith, M.S., Bill, V., & Hughes, E.K. (2008). Thinking through a lesson protocol: A key for successfully implementing high-level tasks. *Mathematics Teaching in the Middle School 14,* 132-138.

Part 1: SELECTING AND SETTING UP A MATHEMATICAL TASK

What are your mathematical goals for the lesson *(i.e. do you want students to know and understand about mathematics as a result of this lesson)?*

In what ways does the task build on students' previous knowledge, life experiences, and culture? What definitions, concepts, or ideas do students need to know to begin to work on the task? What questions will you ask to help students access their prior knowledge and relevant life and cultural experiences?

What are the ways the tasks can be solved?

- Which of these methods do you think your students will use?
- What misconceptions might students have?
- What errors might students make?

What particular challenges might the task present to struggling students or students who are English Language Learners (ELL)? How will you address these challenges?

What are your expectations for students as they work on and complete this task?

- What resources or tools will students have to use in their work that will give them entry into, andhelp them reason through the task?
- How will the students work - independently, in small groups, or in pairs - to explore this task? How long will they work individually or in small groups or pairs? Will students be partnered in a specific way? If so, in what way?
- How will students record and report their work?

How will you introduce students to the activity so as to provide success to all students while maintaining the cognitive demands of the task? How will you ensure that students understand the context of the problem? What will you hear that lets you know students understand what the task? How will you ensure that students understand the context of the problem? What will you hear that lets you know students understand what the task is asking them to do?

Part 2: SUPPORTING STUDENTS' EXPLORATION OF THE TASK

As students work independently or in small groups, what questions will you ask to

- help a group get started or make progress on the task?
- focus students' thinking on the key mathematical ideas in the task?
- assess students' understanding of key mathematical ideas, problem-solving strategies, or the representations?
- advance students' understanding of the mathematical ideas?

How will you ensure that students remain engaged in the task?

- What assistance will you give or what questions will you ask a student (or group) who becomes quickly frustrated and requests more direction and guidance in solving the task?
- What will you do if a student (or group) finishes the task almost immediately? How will you extend the task so as to provide additional challenge?

- What will you do it a student (or group) focuses on nonmathematical aspects of the activity (e.g. spends most of his or her (or their time) making a poster of their work?

Part 3: SHARING AND DISCUSSING THE TASK

How will you orchestrate the class discussion so that you accomplish your mathematical goals?

- Which solution paths do you want to have shared during the class discussion? In what order will the solutions be presented? Why?
- In what ways will the order in which the solutions are presented help develop students' understanding of the mathematical ideas that are the focus of the lesson?
- What specific questions will you ask so that students will -
    - make sense of the mathematical ideas that you want them to learn?
    - expand on, debate, and questions the solutions being shared?
    - make connections among the different strategies that are presented?
    - look for patterns?
    - begin to form generalizations?

How will you ensure that, over time, each student has the opportunity to share his or her thinking and reasoning with their peers?

What will you see or hear that lets you know that all students in the class understand the mathematical ideas that you intended for them to learn?

What will you do tomorrow that will build on this lesson?

Appendix D
Sources for Higher-Level-Cognitive-Demand Tasks

Common Core Conversation

www.commoncoreconversation.com/math-resources.html

Common Core Conversation is a collection of more than fifty free website resources for the Common Core State Standards in mathematics and ELA.

EngageNY Mathematics

www.engageny.org/mathematics

The site features curriculum modules from the state of New York that include sample assessment tasks, deep resources, and exemplars for grades preK–12.

Howard County Public School System Secondary Mathematics Common Core

https://secondarymathcommoncore.wikispaces.hcpss.org

This site is a sample wiki for a district K–12 mathematics curriculum.

Illustrative Mathematics

www.illustrativemathematics.org

The main goal of this project is to provide guidance to states, assessment consortia, testing companies, and curriculum developers by illustrating the range and types of mathematical work that students will experience upon implementation of the Common Core State Standards for mathematics.

Inside Mathematics

www.insidemathematics.org/index.php/common-core-standards

This site provides classroom videos and lesson examples to illustrate the Mathematical Practices.

Mathematics Assessment Project

http://map.mathshell.org/materials/index.php

The Mathematics Assessment Project (MAP) aims to bring to life the Common Core State Standards in a way that will help teachers and their students turn their aspirations for achieving them into classroom realities. MAP is a collaboration between the University of California at Berkeley; the Shell Centre team at the University of Nottingham; and the Silicon Valley Mathematics Initiative (MARS).

Mathematics Vision Project

www.mathematicsvisionproject.org

The site features integrated high school curriculum modules that include mathematics performance tasks and video modules connected to Khan Academy.

National Council of Supervisors of Mathematics

www.mathedleadership.org/ccss/itp/index.html

This site features collections of K–12 mathematical tasks for illustrating the Standards for Mathematical Practice. The website includes best-selling books, numerous journal articles, and insights into the teaching and learning of mathematics.

National Council of Teachers of Mathematics Illuminations

http://illuminations.nctm.org

This site provides standards-based resources that improve the teaching and learning of mathematics for all students. The materials illuminate the vision for school mathematics set forth in NCTM's *Principles and Standards for School Mathematics*, *Curriculum Focal Points for Prekindergarten Through Grade 8 Mathematics*, and *Focus in High School Mathematics: Reasoning and Sense Making.*

National Science Digital Library

http://nsdl.org/commcore/math

The National Science Digital Library (NSDL) contains digital learning objects and tasks that are related to specific Common Core State Standards for mathematics.

Partnership for Assessment of Readiness for College and Careers Task Prototypes and New Sample Items for Mathematics

www.parcconline.org/samples/math

This page contains sample web-based practice assessment tasks (released items) for your use.

Smarter Balanced Assessment Consortium Sample Items and Performance Tasks

www.smarterbalanced.org/sample-items-and-performance-tasks

This site contains sample higher-level-cognitive-demand tasks and online test-taking and performance-assessment tasks (released items) for your use in class.

Visit **go.solution-tree.com/mathematicsatwork** for continued updates on this resource list.

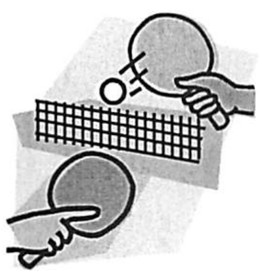
Strategies for Modifying Textbook Tasks

Compare your list of task modifications with the list of task modification strategies identified by others. How is your list similar? Different?

- Ask students to create real-world stories for "naked number" problems.
- Include a prompt that asks students to represent the information another way (with a picture, in a table, a graph, an equation, with a context).
- Include a prompt that requires students to make a generalization.
- Use a task "out of sequence" before students have memorized a rule or have practiced a procedure that can be routinely applied.
- Eliminate components of the task that provide too much scaffolding.
- Adapt a task so as to provide more opportunities for students to think and reason – let students figure things out for themselves.
- Create a prompt that asks students to write about the meaning of the mathematics concept.
- Add a prompt that asks students to make note of a pattern or to make a mathematical conjecture and to test their conjecture.
- Include a prompt that requires students to compare solution paths or mathematical relationships and write about the relationship between strategies or concepts.
- Select numbers carefully so students are more inclined to note relationships between quantities (e.g., two tables can be used to think about the solutions to the four, six or eight tables).

Handout 1: Structured problems

Organizing a table tennis tournament



You have the job of organizing a table tennis tournament.

- 7 players will take part
- All matches are singles.
- Every player has to play each of the other players once.

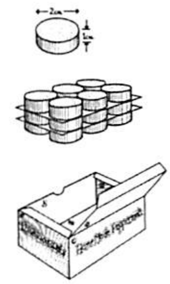
1. Call the players A, B, C, D, E, F, G
   Complete the list below to show all the matches that need to be played.

A v B	B v C	....
A v C	B v D	....
....	....	

2. There are four tables at the club and each game takes half an hour.
   The first match will start at 1.00pm.

   Copy and complete the poster below to show the order of play, so that the tournament takes the shortest possible time.
   Remember that a player cannot be in two places at once!
   You may not need to use every row and column in the table.

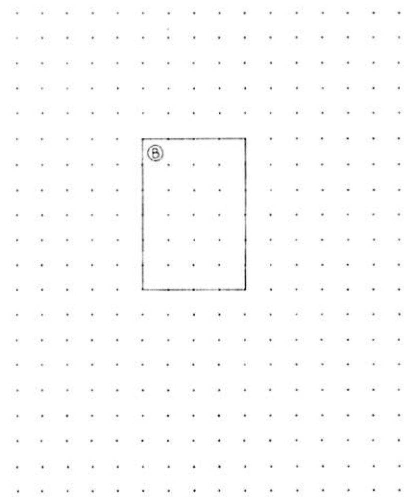
Designing a box for 18 sweets



You work for a design company and have been asked to design a box that will hold 18 mints.
Each mint is 2 cm in diameter and 1 cm thick.
The box must be made from a single sheet of card with as little cutting as possible.

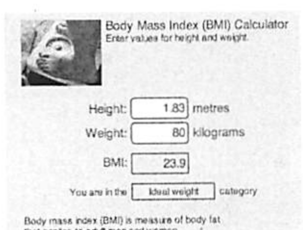
On the grid paper below, show clearly how the card can be folded up and glued together to make the box.

Make your box to check.



Calculating Body Mass Index

This calculator is used to help adults find out if they are overweight.



1. Fix the height at 2 meters - a very tall person!
   Complete the table below and draw a graph to show your results.

Weight (kg)	60	70	80	90	100	110	120	130	140
BMI									

   (a) What is the largest BMI for which someone is underweight?
   (b) What is the smallest BMI for which someone is overweight?
   (c) When you double the weight, what happens to the BMI?
   (d) Can you find a rule for calculating BMI from the weight?

2. Fix the weight at 80 kilograms and try varying the height.

   (a) When you double the height, what happens to the BMI?
   (b) Can you find a rule for calculating BMI from the height?
   (c) Draw a graph to show the relationship between the height and the BMI.

Note for students: If you put your own details into this calculator, *don't take the results too seriously!* It is designed for adults *who have stopped growing* and will give misleading results for children or teenagers!

Planning for Discourse Using the 5 Practices Rubric

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• Teacher does not plan for the whole class discussion and/or there is no whole-class discussion. • There is no evidence of anticipating possible student responses • Teacher does not attend to students working	• Teacher allows student sharing in a random order during the whole-class discussion. • There is evidence that the most common student response has been identified • Teacher observes and listens to student's conversations while they are working with little interaction. • The teacher provides the summary based on their mathematical understanding.	• Teacher plans for whole-class discussion without consideration of the mathematical goals of the lesson. • There is evidence that most student responses have been identified • Teacher observes and listens and identifies some student thinking as it emerges and asks questions to keep students on task. • Teacher orchestrates the whole-class discussion based on the work of the students without connecting the mathematical ideas.	• Teacher uses a focused model for planning a successful whole-class discussion that builds on student thinking while continuing to advance the mathematical goals of the lesson. • There is evidence that all possible student responses have been identified • Teacher listens, observes, identifies key strategies, keeps track of approaches and asks questions that will make students' thinking visible and help students clarify their thinking. • Teacher decides what aspects of the task to highlight, how to organized and orchestrate the work of the students, what questions to ask to challenge those with varied levels of expertise and how to support students without taking over the process of thinking of them and thus eliminating the challenge.

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How to Facilitate Discourse Rubric

Level 1: Ineffective	Level 2: Developing	Level 3: Effective	Level 4: Highly Effective
• Patterns of teacher-student interactions are mostly negative, inappropriate or insensitive.* • Teacher is at the front of the room and dominates conversation • Teacher is only questioner. Questions serve to keep students listening to teacher. • Students give short answers and respond to teacher only. • Teacher questions focus on correctness. Students provide short answer-focused responses. Teacher may even give answers. • Representations are missing, or teacher shows them to students. • Culture supports students keeping ideas to themselves or just providing answers when asked.	• Patterns of teacher-student interactions are generally appropriate.* • Teacher encourages the sharing of math ideas and directs speaker to talk to the class, not to the teacher only. • Teacher questions begin to focus on student thinking and less on answers. Only teacher asks questions. • Teacher probes student thinking somewhat. One or two strategies may be elicited. • Teacher may fill in an explanation. Students provide brief descriptions of their thinking in response to teacher probing. • Students learn to create math drawings to depict their mathematical thinking.	• Teacher-student interactions are caring and demonstrate respect.* • Teacher facilitates conversation between students, and encourages students to ask questions of one another. • Teacher asks probing questions and facilitates some student-to-student talk. Students ask questions of one another with prompting from teacher. • Teacher probes more deeply to learn about student thinking. Teacher elicits multiple strategies. Students respond to teacher probing and volunteer their thinking. Students begin to defend their answers. • Students label their math drawings so that others are able to follow their mathematical thinking.	• Teacher-student interactions are highly caring and demonstrate genuine sensitivity and respect.* • Students carry the conversation themselves. Teacher only guides from the periphery of the conversation. Teacher waits for students to clarify thinking of others. • Student-to-student talk is student initiated. Students ask questions and listen to responses. Many questions ask "why" and call for justification. Teacher questions may still guide discourse. • Teacher follows student explanations closely. Teacher asks students to contrast strategies. Students defend and justify their answers with little prompting from the teacher. • Students follow and help shape the descriptions of others' math thinking through math drawings and may suggest edits in others' math drawings.

*FfT-2a

Effective Questioning Rubric

Level 1: Ineffective	Level 2: Developing	Level 3: Effective	Level 4: Highly Effective
• The teacher's questions are of low cognitive challenge and are asked in rapid succession.* • Questions are rapid-fire and convergent, with a single correct answer. Questions do not invite student thinking.* • Teacher calls on a few students whom he knows will have a correct answer.	• The teacher's questions lead students through a single path of inquiry, with answers seemingly determined in advance.* • The teacher frames some questions designed to promote student thinking, but many have a single answer, and the teacher calls on students quickly.* • Teacher asks students questions that require students to respond with a one-to-two word answer. Teacher waits only a few seconds for a response.	• While the teacher may use some low-level questions, he poses questions designed to promote student thinking and understanding.* • The teacher uses open-ended questions, inviting students to think and/or offer multiple possible answers.* • Teacher asks students questions that are open-ended, but tone of voice implies the teacher is looking for a specific response. Teacher curtails student responses.	• The teacher uses a variety or series of questions or prompts to challenge students cognitively, advance high-level thinking and discourse, and promote metacognition.* • The teacher builds on and uses student responses to questions in order to deepen student understanding.* • Teacher listens, observes, identifies key strategies, keeps track of approaches and asks questions that will make students' thinking visible and help students clarify their thinking. • Teacher frequently asks students questions that require students to synthesize information, generate hypotheses, or form generalizations, allowing ample wait time.

* FfT- 3b

Strategies for Modifying Tasks Rubric

Level 1: Ineffective	Level 2: Developing	Level 3: Effective	Level 4: Highly Effective
• Tasks involve either reproducing previously learned rules or formulas with no cognitive effort. • The tasks lack rigor* • Tasks are boring and/or not well aligned to the instructional goals** • Tasks **do not** lead students to a deeper understanding of content	• Tasks call for a specific procedure or one that is practiced after a procedure has been introduced with little cognitive effort. • The tasks represents a mixture of low expectation and rigor* • Tasks are moderately challenging** • Tasks lead **some** students to a deeper understanding of content	• Tasks requires the use of broad general procedures for the purpose of developing deeper levels of understanding requiring some degree of cognitive effort. • The tasks represents high expectations and rigor* • Tasks provide opportunity for high level thinking** • Tasks lead **all** students to a deeper understanding of content	• Tasks requires complex and non—algorithm thinking- an approach is not explicitly suggested requiring considerable cognitive effort. • The task represents high-level learning in mathematics* • Tasks permit student choice** • Tasks lead all students to a deeper understanding of content and an opportunity to **reflect** on the rigor of the task.

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**FfT-1e