Optimizing Math and Science Instruction with Essential Literacy Strategies

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QUEBEC ENGLISH SCHOOL BOARDS
PROVINCIAL ORGANIZATION
OF CONTINUING EDUCATION
DIRECTORS,ENGLISH
PROCEDE Lifelong Learning

Agenda

9:45 -10:45:

Math:

- Goal of the program
- How the goal of the program impacts instruction and evaluation.
- Literacy strategies that are aligned with competencies 1 & 2.

10:45: Break

11:00-11:45:

Science:

- Goal of the program
- How the goal of the program impacts instruction and evaluation.
- Literacy strategies that are aligned with competencies 1,2, and 3.

Math

1) Goal of the Program

The DBE program is a competency-based program that is centered on developing mathematical knowledge and skills that are useful in dealing with many practical situations.

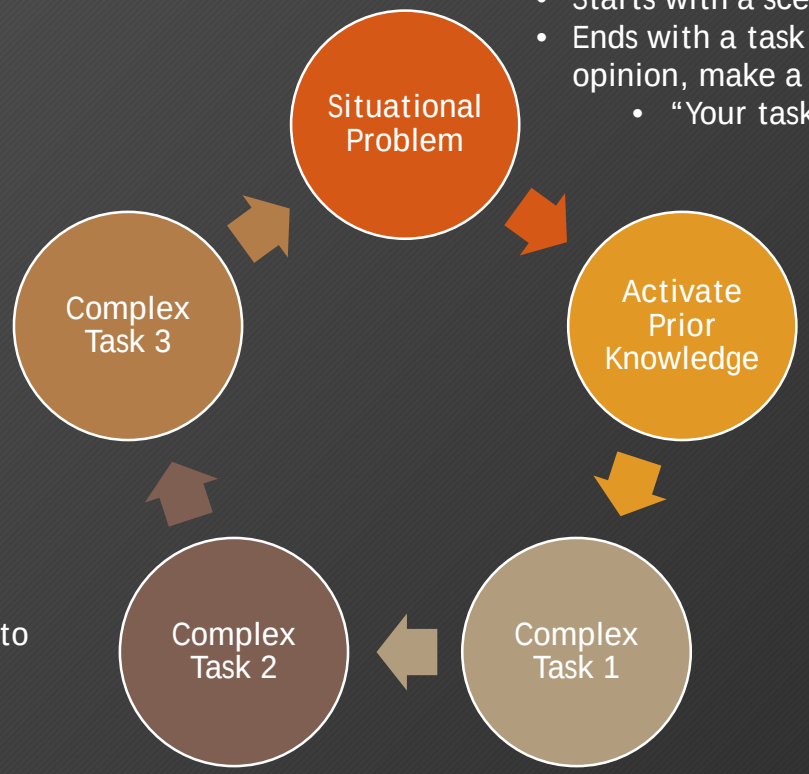
The DBE Math program promotes a teaching approach that aims to help students:

1) interpret reality
2) make predictions
3) make generalizations
4) make decisions

2) How the Goal of the DBE Program Impacts the Teaching and Learning Process

Competency Based Program = Learning Situations
Learning Situations = Series of Complex Tasks

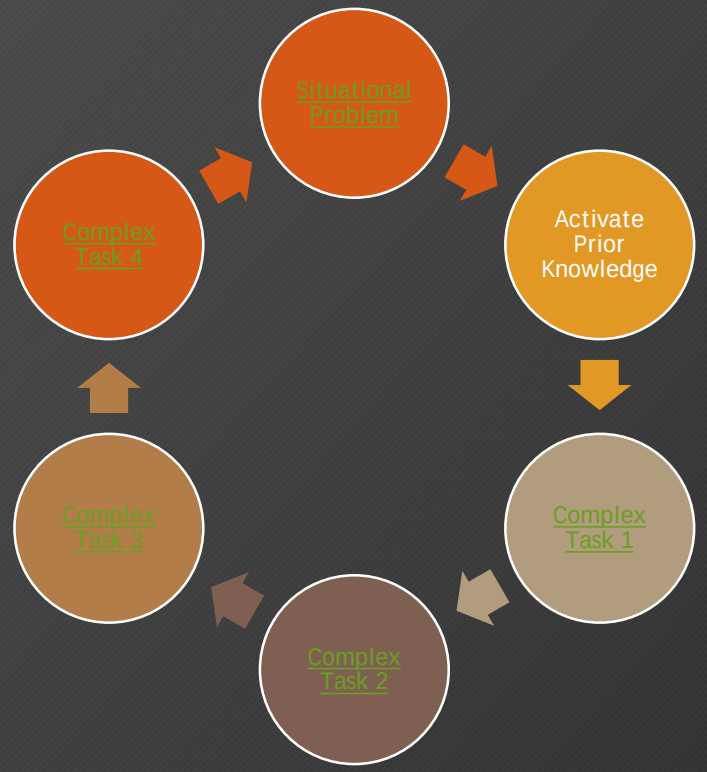
- Starts with a scenario that is meaningful/relevant to the adult learner.
- Ends with a task that ultimately asks student to provide an explanation, state an opinion, make a decision, etc
  - "Your task is to state/explain/justify/…"



Review of pre-requisite knowledge

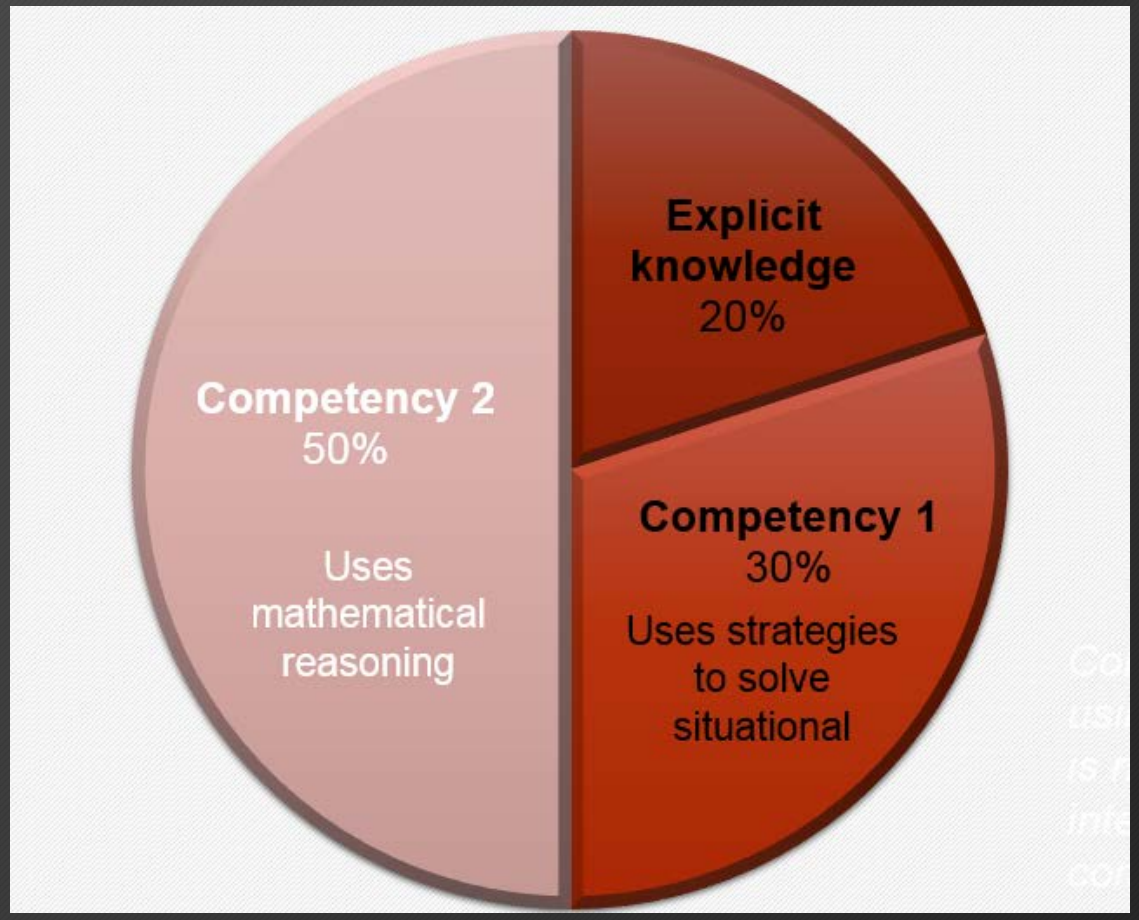
Complex tasks build the mathematical knowledge and processes that are required to solve the situational problem. They can be purely mathematical by design.

A Sample Learning Situation



3) How the Goal of the Program Impacts the Evaluation Scheme

Competency-Based Evaluation Scheme



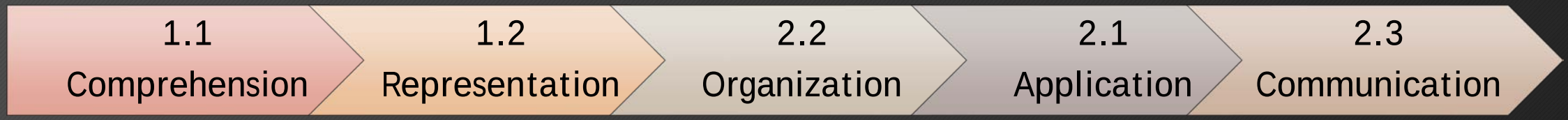
4) How the Goal of the Program Influences the Evaluation Criteria

Competency 1: Uses Strategies to Solve Situational Problems

- 1.1 Indication that the situational problem has been understood.
- 1.2 Application of strategies and appropriate mathematical knowledge.

Competency 2: Uses Mathematical Reasoning

- 2.2 Proper implementation of mathematical reasoning suited to the situation.
- 2.1 Correct use of appropriate mathematical concepts and processes.
- 2.3 Proper organization of the steps in an appropriate procedure.



A Case for Literacy Instruction in the DBE Math Classroom

Competency 1:
Uses Strategies to Solve Situational Problems

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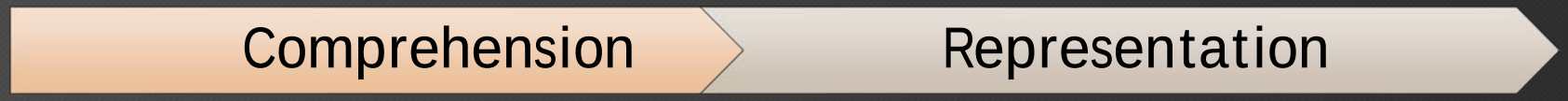

Problem Areas With Competency 1

- Mathematical texts can contain more concepts per line, sentence, and paragraph than any other kind of texts.
- Students must be able decode and comprehend mathematical signs, symbols, and graphics.
- Students also need to read and interpret information presented in unfamiliar ways—not only left to right, but also right to left (number lines), top to bottom (tables), and even diagonally (graphs).
- Words that are common in the English language may have a different meaning in mathematics.

(Kester Phillips, Bardsley, Bach, Gibb-Brown, 2009; p. 468
Barton, Heidema, and Jordan, 2002, p.24)

Literacy Strategies that Assist With Competency 1: (Comprehension & Representation)

Strategies	Description	Why Use This Strategy	How to Use This Strategy (Methods and Tools)
Vocabulary			
Identify Key Words and Content-Area Vocabulary	Identifying and decoding words that are essential to the conceptual understanding of the problem. (Students may struggle with concept words or difficult vocabulary).	Words in the English language sometimes mean something different in the math classroom. Allows students to concentrate on words that will allow them to eventually solve the problem.	• Vocabulary Table • Verbal Visual Word Association • Frayer Model • Word Wall
Comprehension and Representation			
Guided Comprehension of Word Problems	A list of questions that help the student process the math problem and make them metacognitive aware of what they are reading.	Helps students fully understand the problem solving thought process. Good strategy for low achieving math students.	• CUBE Method • Guided Question
Graphics Organizers	Graphical tool for organizing and representing knowledge.	Provides a visual representation of key concepts and related terms. This helps students make connections, explain relationships and retain information.	• Concept Maps • Classification Diagrams • Venn Diagrams • Tables • Graphs

Capelli, 2015

Competency 2:
Uses Mathematical Reasoning

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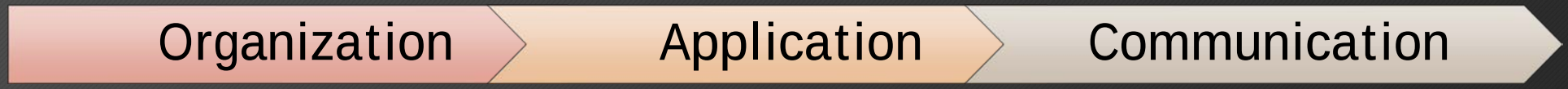


Problem-Areas With Competency 2

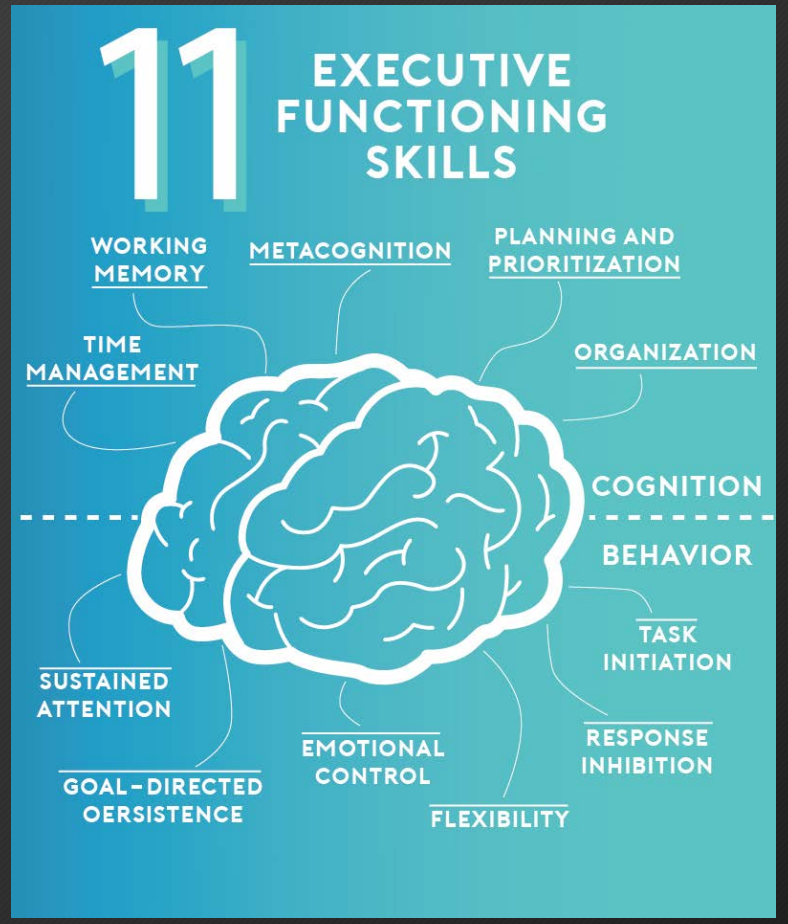
Criteria 2.1 and 2.2:

Require strong Executive Function (EF)

Individuals with executive function problems have

difficulty with planning, organizing and managing time and space.

National Center for Learning Disabilities (NCLD)



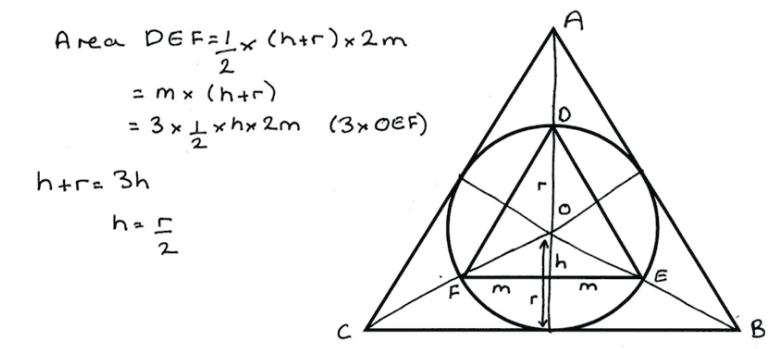
Problem Areas With Competency 2

Criterion 2.3:

Writing in math class differs from other subjects.

- Must use various registers of representation (e.g. words, symbols, figures, diagrams/graphs, tables) to convey the solution.
- Must use the rules and conventions of mathematical language.

This diagram shows a circle with one equilateral triangle inside and one equilateral triangle outside.



1. Calculate the ratio of the areas of the two triangles.
   Show all your work.

Triangle OEF is similar to triangle OBC.
The height of OBC is double the height of OEF,
so CB is double EF.
It follows that the area of OBC is
double × double - four times bigger than OEF.
Area ABC : Area DEF = 3 × OBC : 3 × OEF = 4 : 1

Literacy Strategies that Assist with Competency 2: Mathematical Reasoning (Organization, Application, Communication)

Strategies	Description	Why Use the Strategy	How to Use This Strategy (Methods and Tools)
Organization & Application Strategies			
Creating Task Lists	A "to-do" list that breaks the problem into sub-problems.	Helps students organize their thoughts, deliver a structured response, and show their line of reasoning.	• Task List Template * Teachers should model for the first couple of times.
More Than One Strategy exercise	Asking students to offer more than one way to arrive at an answer.	Helps students become flexible in their mathematical thinking and to look at problems from different perspectives.	• Multiple Solution Representation Sheet
Class Inventories	Collecting and reviewing a list of strategies that students use to solve a particular math problem.	Students learn different strategies from one another. Teacher gets a sense of the class's progress.	• Solution Inventory Sheet
Communication/ Writing Strategies			
Correcting "other students" answers.	Student corrects another student's answer to a problem.	Helps the student convey a mathematical message using mathematical rules and conventions.	• *Correct the Student's Answer Sheet*
Summative Writing Prompts	Student summary of math learning (can be done at the end of each chapter, mid-session, end-of-session).	Requires students to reflect and write about the rules, formulas, shapes, etc, that they learned.	• N/A

Capelli, 2015; Adams & Pegg, 2012;Burns, 2005; Burns, 2004;

Tying it all together :

- Problem Solving Template
- Problem Solving Checklist
- Decision Guide (to come)

The DBE Science and Technology Program

1) Goals of the Program

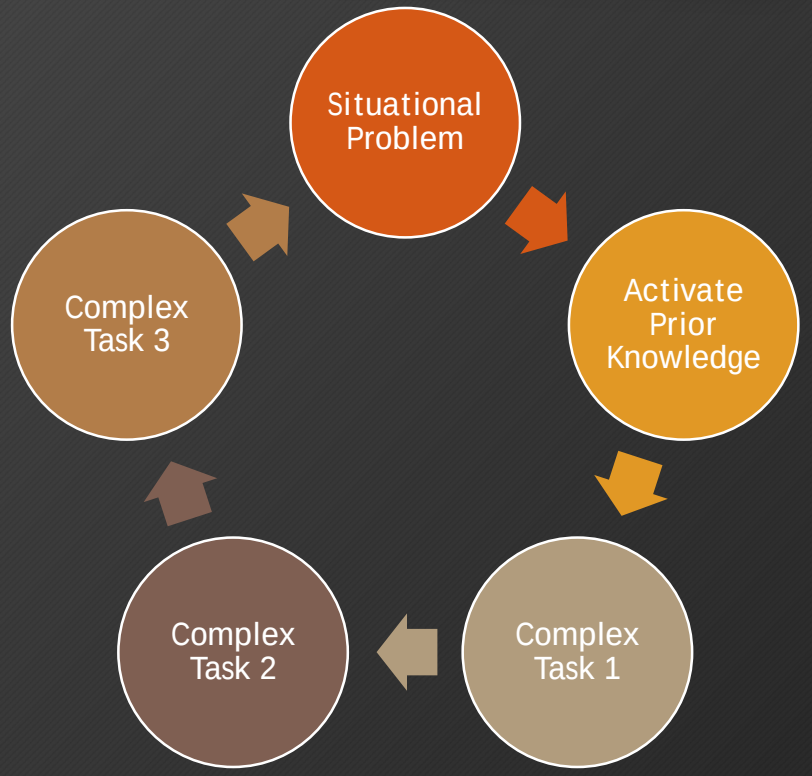
The DBE Science & Technology program promotes a teaching approach that aims to help students:

- acquire scientific knowledge, methods, and techniques.
- develop their scientific and technological literacy so that they can make informed decisions
- adopt a critical attitude toward ethical issues related to science and technology
- adopt careful and methodological work habits

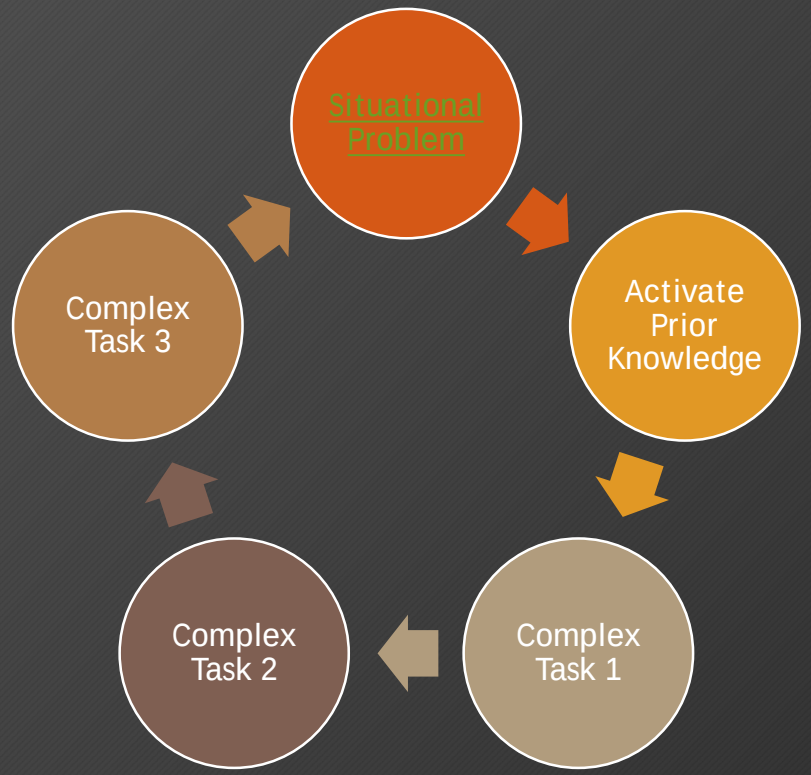
2) How the Goal of the Program Impacts the Teaching and Learning Process

Competency Based Program = Learning Situations

Learning Situations = Series of Complex Tasks



A Sample Learning Situation



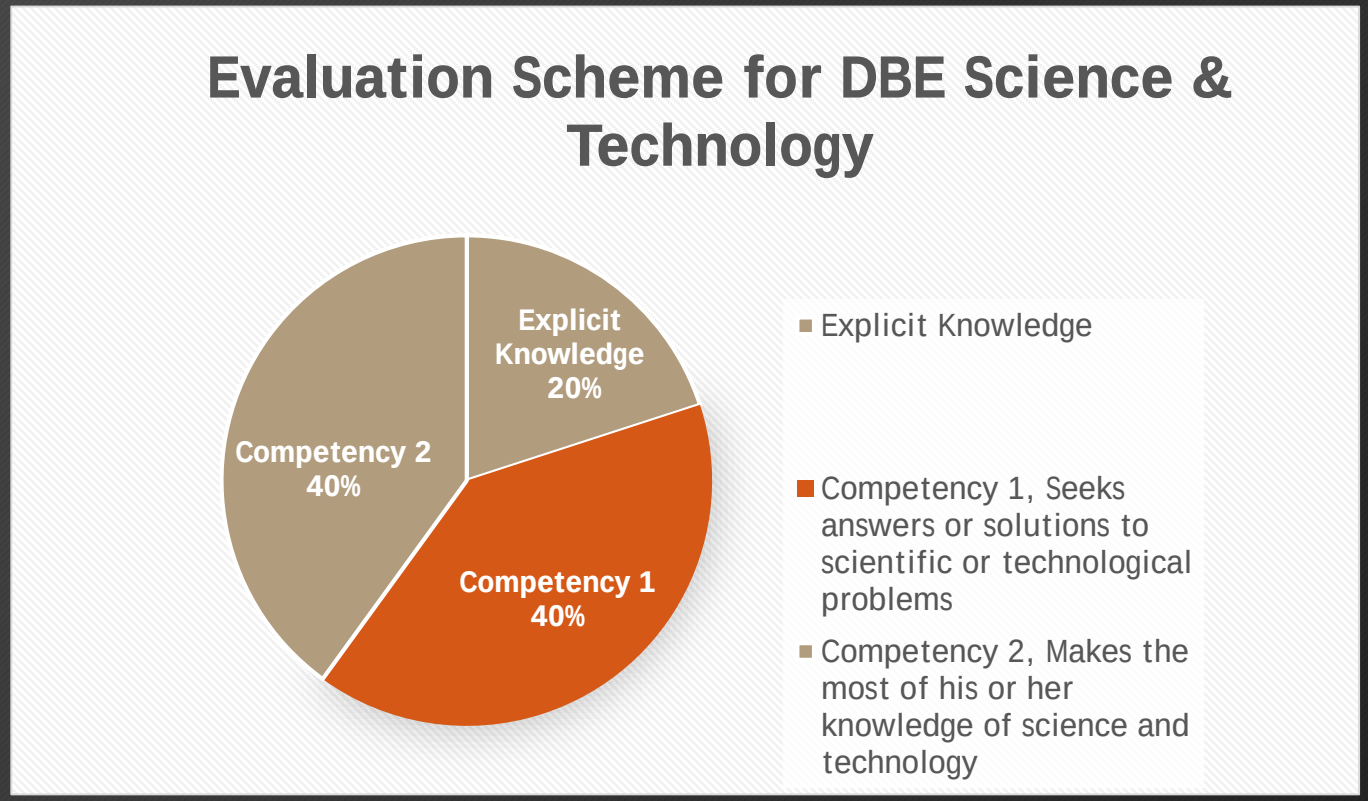
3) How the Goal of the Program Impacts the Evaluation Scheme

Practical Exam (40% of final grade)

- Competencies 1 and 3
- Focuses on technique
- Results not as important as concept planning, methodology, explanation.

Theoretical exam (60% of final grade)

- Competencies 2 and 3
- LES-type questions (40%)
- Six to eight explicit knowledge questions (20%).



4) How the Goal of the Program Influences the Evaluation Criteria

Competency 1: Seeks answers or solutions to scientific or technological problems.

- 1.1 Appropriate representation of the situation
- 1.2 Development of a suitable plan of action
- 1.3 Appropriate implementation of the plan of action
- 1.4 Development of relevant explanations, solutions or conclusions.

Competency 2: Makes the most of his or her knowledge of science and technology.

- 2.1 Accurate interpretation of the problem
- 2.2 Relevant use of scientific and technological knowledge
- 2.3 Appropriate formulation of explanations or solutions

Competency 3: Communicates in the languages used in science and technology.

Comprehension → Representation → Organization → Application → Communication

A Case for Literacy Instruction in the DBE Science & Technology Classroom

Competency 1:
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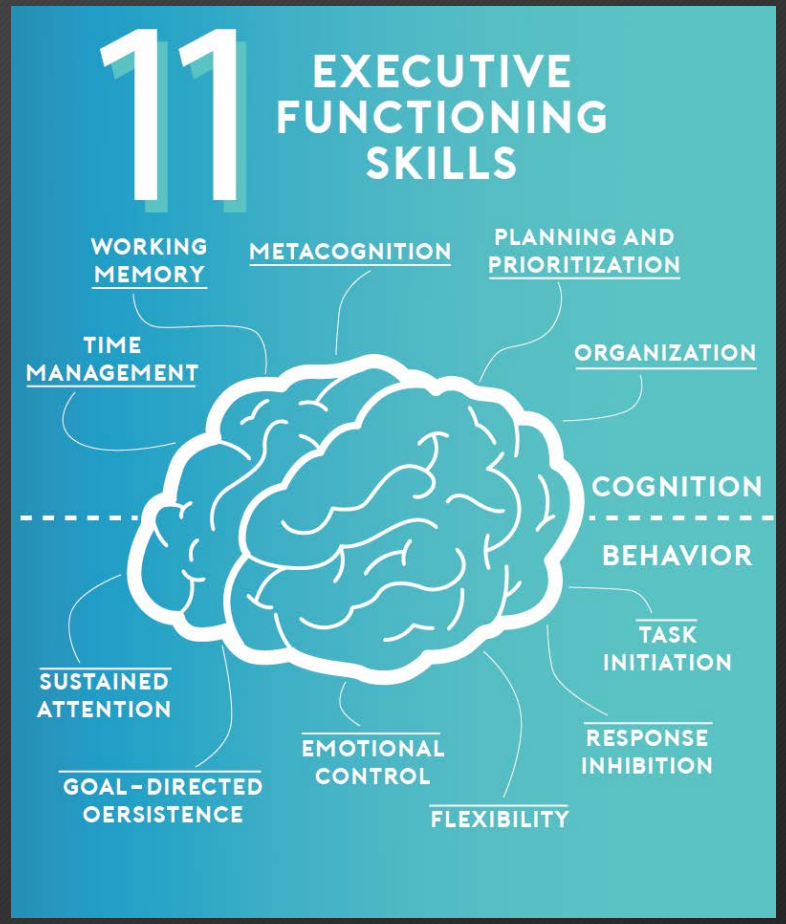
LABS

Problem-Areas for Competency 1

In addition to reading and understanding the problem, the practical component of the course requires strong Executive Function.



Literacy Strategies that Help With Competency 1

Strategies	Description	Why Use the Strategy	Tools and Techniques
Vocabulary:			
Identify Key Words	Identifying and decoding words that are essential to the conceptual understanding of the text.	Words in the English language sometimes mean something different in the math classroom. Allows students to concentrate on words that will allow them to eventually solve the problem.	• Frayer Model • Verbal Visual Word Association (VVWA)
Reading Comprehension and Representation (1.1)			
Graphic Organizers	Visual and spatial representations of information and relationships found within text. They are typically a one page combination of words and diagrams.	Increases comprehension by helping students make connections, explain relationships or scientific principles and retain information. This strategy also develops students' abilities to make predictions and identify patterns.	• Flow charts, • Venn diagrams • T-chart, • Concept maps. Most effective when teachers model how to use them.
Organization, Application, and Communication (1.2-1.4)			
Writing prompts	A sentence starter that keeps the writing focused.	Helps students understand and correctly complete each section of the lab report.	• Lab Report Template with prompts

Seddon, 2017; Adams & Pegg, 2012

Competency 2:
Makes the most of his or her knowledge of science and technology.

- **Evaluation Criteria for Competencies 2 and 3 (Theory)**
  - 2.1 Accurate interpretation of the problem
  - 2.2 Relevant use of scientific and technological knowledge
  - 2.3 Appropriate formulation of explanations or solutions

Problem Areas with Competency 2

Reading scientific texts can be challenging for students due to the high concentration of abstract ideas, technical vocabulary, and various text forms.

Literacy Strategies that Assist with Competency 2

Strategies	Description	Why Use the Strategy	How to Use This Strategy (Methods and Tools)
Vocabulary (2.1)			
Identify Key Words	Identifying and decoding words that are essential to the conceptual understanding of the text.	Words in the English language sometimes mean something different in the math classroom. Allows students to concentrate on words that will allow them to eventually solve the problem.	• Frayer Model • Verbal Visual Word Association (VVWA)
Reading Comprehension & Representation (2.1 & 2.2)			
Annotation of Text	Students make markings in the text in places where they make connections or have questions. Markings including symbols, phrases, and reflections are typically written in the margins or within the text.	The student sees reading as an active process of comprehension or way of learning. Slows the reading down and provides students with a visible record of their thoughts. Encourages students to make predictions, ask questions, make connections, define vocabulary, state opinions, reflect on content, and patterns or trends in the reading.	• Tell students why they are reading a particular piece of text and what they will do with it when they are done reading. • Have a bookmark of symbols that represent categories of annotations.
Anticipation Reading Guides	Before reading a text, students are challenged to agree or disagree to a series of statements and justify their opinions in writing.	Provides students with practice in finding supporting evidence concerning (controversial) topics. Students identify their prior knowledge, reveal preconceptions, and prepare to read with understanding	• Use prior to annotating texts. • Create a sheet of 6-8 statements. • Have students read, react, and justify or revise their positions using evidence from the text.
Graphic Organizers	Visual and spatial representations of information and relationships found within text. They are typically a one page combination of words and diagrams.	Increases comprehension by helping students make connections, explain relationships and retain information. This strategy also develops students' abilities to make predictions and identify patterns. They can be employed during all stages of reading (pre-reading, during reading, or post reading).	• KWS Organizer • Flow chart • Venn diagram • T-chart • Concept map Most effective when teacher models how to use them.
Communication (2.3)			
Journal prompts, guided note-taking, or reflection questions	Serve as brief summaries of concepts or learning activities.	Helps students recall information that they had learned or record information as it is being presented	• Student Reflection Questions (by Edutopia)

(Sedden, 2017, p. 18-26; Adams & Pegg, 2012)

Important to Remember

- Each strategy requires explicit instruction and modeling by the teacher to be effective.

- Purposeful planning of which and when to use literacy strategies is necessary for students to build capacity and take ownership of their reading or writing to learn.

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