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Academic Experience

Tennessee State University / Vanderbilt University
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Multiple presentations and contributions to scholarly publications

Honors

1999-2000 recipient of the Burke Award
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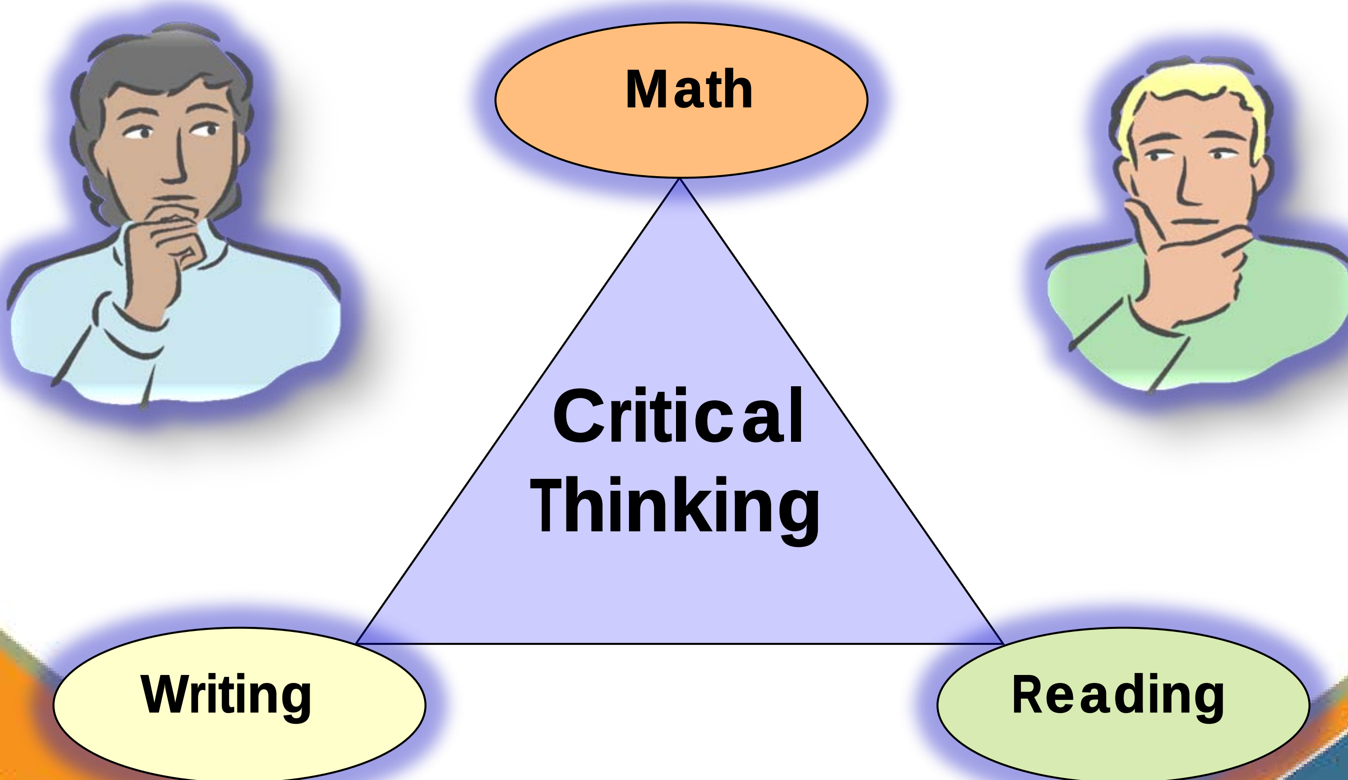
Critical Thinking

CRITICAL THINKING: THE VITAL CONNECTION AMONG DEVELOPMENTAL COURSES



Critical Thinking

ASSUMPTION #1

"The goal of instruction should be to allow students to deal sensibly with problems that often involve evidence, quantitative consideration, logical arguments, and uncertainty; without the ability to think critically and independently, citizens are easy prey to dogmatists, flimflam artists, and purveyors of simple solutions to complex problems." —American Association for the Advancement of Science, 1989

Critical Thinking

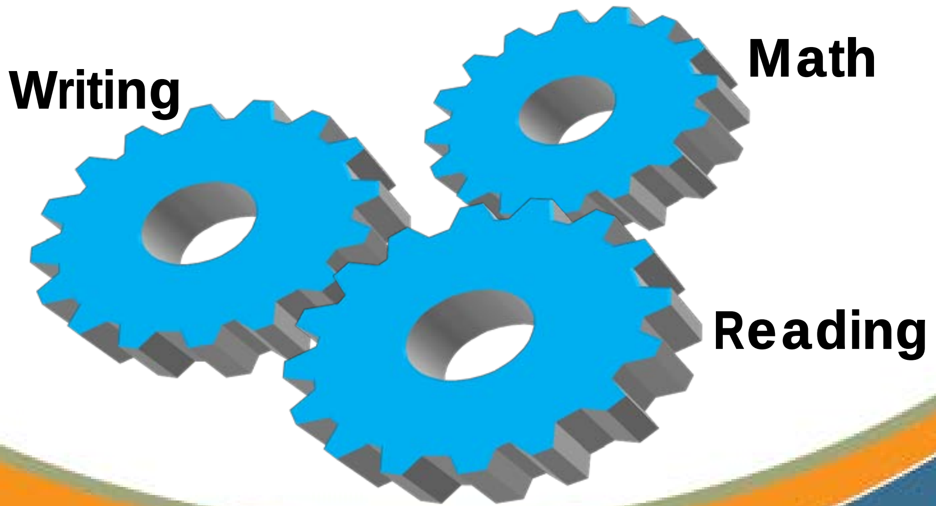
ASSUMPTION #2

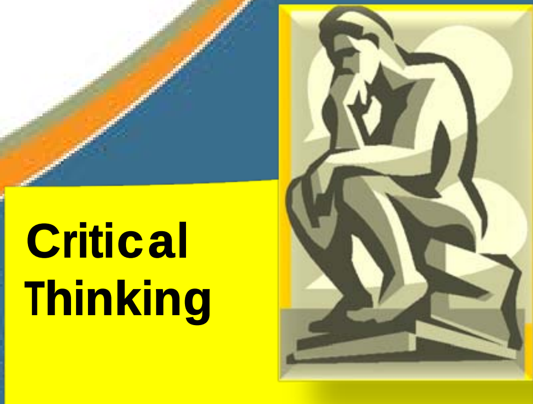
"For logic, by perfecting and by sharpening the tools of thought, makes men and women more critical—and thus makes less likely their being misled by all the pseudo-reasonings to which they are incessantly exposed in various parts of the world today." —Alfred Tarski, *Introduction to Logic and to the Methodology of Deductive Sciences*, 1994

Critical Thinking

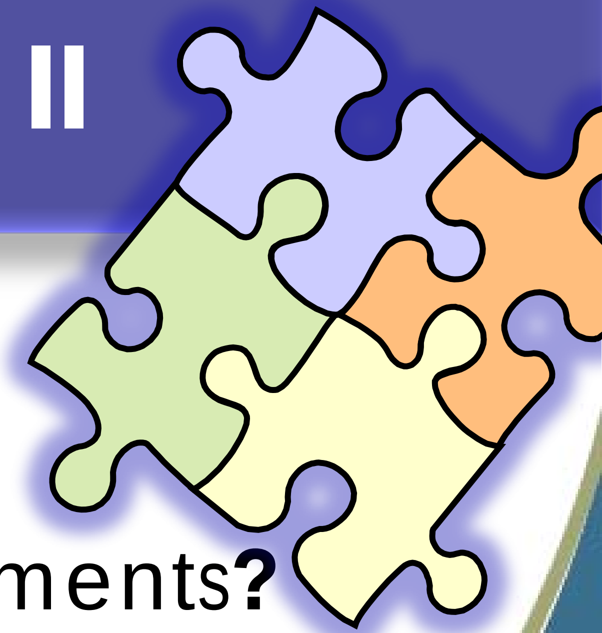
OBJECTIVES: PART I

- **1.** Why is critical thinking the vital **connection** among developmental courses**?**
- **2.** What exactly is **critical thinking?**





OBJECTIVES: PART II



- **3.** What is an **argument?**
- **4.** How do we **identify** arguments**?**
- **5.** How do we identify **deductive** and **inductive** arguments**?**

Critical Thinking

OBJECTIVES: PART III

- **6.** Why is the **translation** of **verbal** statements to **symbolic** statements (and symbolic statements back to verbal statements) a key aspect of critical thinking in developmental mathematics, reading, and writing**?**

Example: **"If I am not hungry, then I am tired." translates to "$\sim H \rightarrow T$."**

Critical Thinking

OBJECTIVES: PART IV

- **7.** How do we **analyze** reasoning and **evaluate** that reasoning according to the intellectual standards of

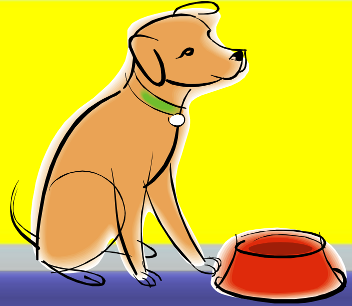
(i) validity and **soundness** for **deductive** arguments, and

(ii) strength and **cogency** for **inductive** arguments**?**

Critical Thinking

PROPOSAL: To improve the theory and practice of developmental education at all levels by highlighting the common ground of developmental courses: critical thinking.

Critical Thinking



SOME OBSERVATIONS

✓Developmental students have problems recognizing premises and conclusions within passages. This may reveal the logical connections and arguments in reading.

✓Developmental students have problems recognizing the logical connections and arguments. This may clarify meaning in reading, writing, and mathematics.

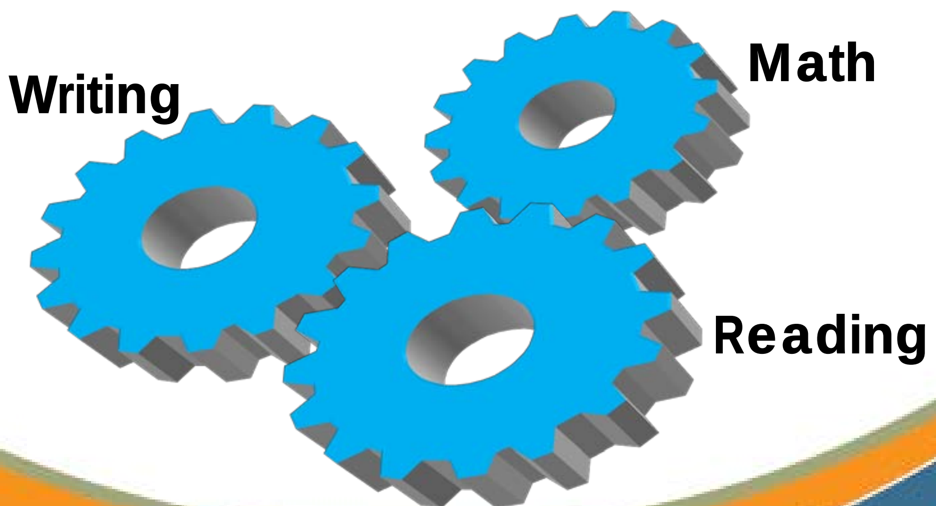
✓Developmental students have problems choosing statements carefully and making proper inferences. This is imperative for justifying a thesis in expository writing or a solution in a math problem.

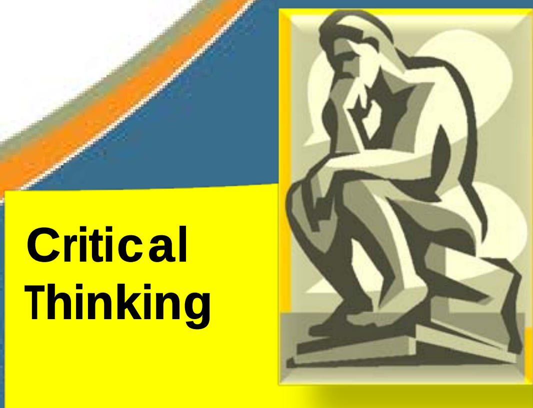
✓Developmental students have problems showing why something is the case. This is important in connecting -the-dots (evaluating the reasoning and information involved) and developing critical thinking skills.

Critical Thinking

OBJECTIVES: PART I

- **1.** Why is critical thinking the vital **connection** among developmental courses**?**
- **2.** What exactly is **critical thinking?**





Why is critical thinking the vital connection among developmental courses?

- Every developmental course has its logical structure and so can be understood through logic—reasoning, thinking, argument, or proof.
- Critical Thinking enables learners to face challenges within and across subjects by learning how to formulate and evaluate arguments.

Critical Thinking

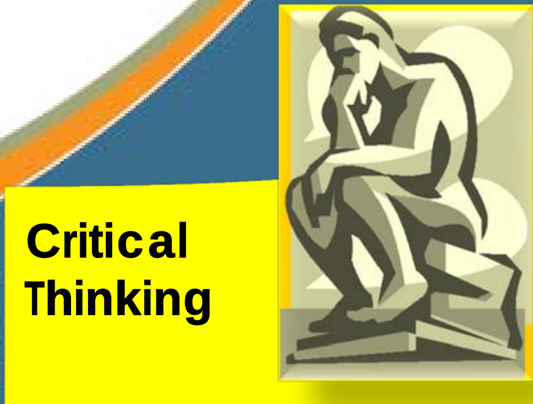
Moreover…

- Critical Thinking also provides a solid foundation for overcoming obstacles to reliable reasoning and clear thinking.
- Accordingly, the goal of teaching is to create a context in which students can think.

Critical
Thinking

What exactly is critical thinking?

- **Critical thinking** is a purposeful mental activity that takes something apart, via **analysis**, and **evaluates** it on the basis of an intellectual standard (Mayfield).
- In this discussion that "something" is an **argument**.



OBJECTIVES: PART II

- **3.** What is an **argument?**
- **4.** How do we **identify** arguments**?**
- **5.** How do we identify **deductive** and **inductive** arguments**?**

Critical Thinking

What is an argument?

- **Logic** is the study of arguments.
- An **argument** is a sequence of statements (claims): a set of premises and a conclusion.
- A **statement** (claim) is a declarative sentence that is either true or false, but not both.

Critical Thinking

1) All cats have four legs.
2) I have four legs.
----
3) Thus, I am a cat.

- The **conclusion** is the **statement** that one is trying to establish by offering the argument.
- **Premises** are also statements, but are intended to **prove** or at least provide **some evidence** for the conclusion.

Critical Thinking

How do we identify arguments?

LOOK for Inference indicators:

1. Premise Indicators:

Words used for **giving reasons**: For, Since, Because, Assuming that, Seeing that, Granted that, This is true because, The reason is that, In view of the fact that, ...etc.

2. Conclusion indicators:

Words used for **adding up consequences**: So, Thus, Therefore, Hence, Then, Accordingly, Consequently, This being so, It follows that, ...etc.

(Nolt).

Critical Thinking

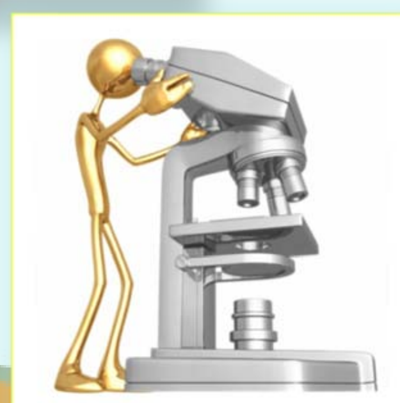
Inference indicators (example)

Students who don’t come to class are **thus** depriving themselves of the learning process. **This is true because** coming to class is an essential part of learning the subject matter.

1) Coming to class is an essential part of learning the subject matter.

----

2) Thus, students who don’t come to class are depriving themselves of the learning process.



Critical Thinking

How do we identify deductive and inductive arguments?

Look for how the premises logically support the conclusion:

1. In **deductive** arguments, the premises are intended to **prove** the conclusion and so the conclusion follows with certainty.

2. In **inductive** arguments, the premises are intended to provide **some (strong or weak) evidence** for the conclusion and so the conclusion follows with some uncertainty.

Critical Thinking

DEDUCTION: Look for how the premises logically support the conclusion (example)

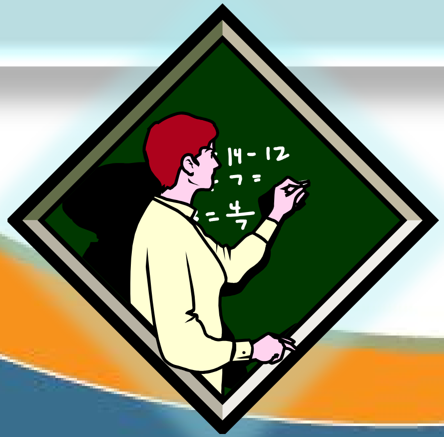
Deductive Argument:

1) ***x*** is greater than ***y***.
2) ***y*** is greater than ***z***.
----

3) Thus, ***x*** is greater than ***z***. (Where ***x***, ***y***, and ***z*** are real numbers)

The conclusion follows with **certainty** because ***if*** each premise used to demonstrate the conclusion is true, then the conclusion also must be true. So, truth is preserved.

We will call arguments that satisfy this condition, VALID arguments.



Critical Thinking

INDUCTION: Look for how the premises logically support the conclusion (example)

Inductive Argument:

1) 90% of smokers get lung cancer.
2) John is a smoker.

----

3) Thus, John will **probably** get lung cancer.

The conclusion follows with some **uncertainty** because even ***if*** the premises were true, the conclusion could still be false (some people smoke all their lives and don't get the disease). So, truth may not be preserved.

Critical Thinking

Unlike the previous Inductive Argument that only called for few premises, in the example below we have n premises (as many as you want to list).

1) Smoking gives person #1 lung cancer.

2) Smoking gives person #2 lung cancer.

3) Smoking gives person #3 lung cancer.

i) …Etc.

n) Smoking gives person #n lung cancer.

----

n+1) Thus, smoking **probably** causes lung cancer in **all** people.

The conclusion follows with some **uncertainty** because even **if** each premise of the sequence of statements used to demonstrate the conclusion were true, the conclusion could still be false. So, truth may not be preserved.

But, as the observed number of cases of people who smoke and get lung cancer increases, the argument gets **stronger**; as the observed number of cases decreases, the argument gets **weaker**.

Critical Thinking

OBJECTIVES: PART III

- **6.** Why is the **translation** of **verbal** statements to **symbolic** statements (and symbolic statements back to verbal statements) a key aspect of critical thinking in developmental mathematics, reading, and writing**?**

Example: "If I am not hungry, then I am tired." translates to "~H → T."

Critical Thinking

Why is translation a key aspect of critical thinking?

- **Translation** of a **verbal** statement to a **symbolic** statement helps one to examine the structure of the declarative sentence (analysis) to reveal logical connections.
- And, recognizing logical connections may clarify meaning in reading, writing, and mathematics.

Critical Thinking

Moreover…

- **Translation** of **verbal** statements to **symbolic** statements helps one to examine the structure of an argument (a sequence of statements) in detail (analysis).
- Symbolizing this structure can show how premises and a conclusion are related in **valid**, or **invalid**, argument forms (evaluation).

Critical Thinking

To symbolize a statement we need:

- A **statement indicator**, an uppercase letter, used to symbolize a simple statement (e.g., "**H**" used to indicate "**I am hungry**").
- A **connective indicator** (e.g., "**&**" used to indicate "**and**")used with statement indicators to symbolize a complex statement. **Connectives** are words like **AND, OR, NOT,** and **IF-THEN**.

Critical Thinking

For instance, given the following conditions:

- Let the statement indicator **H** substitute **I am hungry**.
- Let the statement indicator **T** substitute **I am tired.**
- Let connective indicator **&** substitute the connective **AND.**
- Let connective indicator **v** substitute the connective **OR** .
- Let connective indicator **~** substitute the connective **NOT.**
- Let connective indicator → substitute the connective **IF-THEN.**

Critical Thinking

Practice translating the following statements:

- **1.** I am hungry. **ANSWER: H**
- **2.** I am not hungry. **ANSWER: ~H**
- **3.** I am both hungry and tired. **ANSWER: H & T**
- **4.** I am hungry or I am tired. **ANSWER: H *v* T**
- **5.** If I am not hungry, then I am tired. **ANSWER: ~H → T**
- **6.** ~ T → ~ H

ANSWER: If I am not tired, then I am not hungry.

Critical Thinking

Practice translating the following arguments:

- **EXERCISE #1:**
  1) If **I am hungry**, then **I am tired.**
  2) I am hungry.
  ----
  3) Thus, **I am tired.**
- ***Note: Use lower case letters when designating the basic form of the valid deduction.***

- **ANSWER:**
  1) H $\rightarrow$ **T**.
  2) H.
  ----
  3) Thus, **T**.
- ***Modus Ponens:***
  1) If **p**, then **q**.
  2) p.
  ----
  3) Thus, **q**.

Critical Thinking

EXERCISE #2:

- **1)** If **I am hungry**, then **I am tired**.
  2) I am not tired.
  ----
  3) Thus, **I am not hungry**.
- ***Note: Use lower case letters when designating the basic form of the valid deduction.***

- **ANSWER:**
  1) H → T.
  2) ~ T.
  ----
  3) Thus, **~ H**.
- ***Modus Tollens:***
  1) If **p**, then **q**.
  2) Not **q**.
  ----
  3) Thus, not **p**.

Critical Thinking

OBJECTIVES: PART IV

- **7.** How do we **analyze** reasoning and **evaluate** that reasoning according to the intellectual standards of

(i) validity and **soundness** for **deductive** arguments, and

(ii) strength and **cogency** for **inductive** arguments**?**

Critical Thinking

ANALYSIS: Examine the structure of the argument in detail and symbolize this structure or component parts.

Consider the following **deductive** argument.

1) All people grow old.
2) Mary is a person.
----
3) Thus, Mary grows old.

Critical Thinking

The key to translating All people grow old in the argument above is to interpret the universal statement as the conditional statement If it is a person, then it grows old (for every member of its subject class: people).

- Again, let the connective indicator → substitute the connective **IF-THEN**. Interpreting **P** (for **it is a person**) and **O** (for **it grows old**) as statement indicators, **If P, then O** is finally translated as **P → O**.
- The symbolized argument is as follows.

1) P → O
2) P
----
3) Thus, **O**

Critical Thinking

EVALUATION: Is the deductive argument valid? Is it sound (= valid + true premises)?

- This argument about people growing old is a **valid** deductive argument because it has the following underlying **valid** argument form we studied.

Modus Ponens:
1) If **p**, then **q**.
2) **p**.
----
3) Thus, **q**.

- Moreover, it is also a **sound** deductive argument because it has true premises.

Critical Thinking

Consider the following deductive argument.

1) All cats have four legs.
2) I have four legs.
----
3) Thus, I am a cat.

Critical Thinking

ANALYSIS: Examine the structure of the argument in detail.

- The key to translating **All cats have four legs** in the argument above is to interpret the universal statement as the conditional statement **If it is a cat, then it has four legs** (for every member of its subject class: **cats**).

Critical Thinking

The argument depicted by the cartoon becomes...

1) If **it is a cat**, then **it has four legs**. (**Assume this is a true premise**)

2) It has four legs. (**Assume this is a true premise**)

----

3) Thus, **it is a cat.** (**A false conclusion**)

What is wrong with this argument?

Critical Thinking

EVALUATION: Is the deductive argument valid? Is it sound (= valid + true premises)?

- The little dog is guilty of using his reasoning and the information involved to derive something false from something true.
- Since this argument has **true** premises and a **false** conclusion, it is an **invalid** deductive argument.
- Symbolized, the argument reveals its **invalid** form….

Critical Thinking

ANALYSIS: Symbolize the structure or component parts.

- Again, let the connective indicator → substitute the connective **IF-THEN**. Interpreting **C** (for **it is a cat**) and **F** (for **it has four legs**) as statement indicators, **If C, then F** is finally translated as **C → F**.
- The symbolized argument is as follows.

1) **C → F**
2) **F**

----

3) Thus, **C**

Generally speaking, arguments that share the same INVALID deductive form below commit the fallacy of AFFIRMING THE CONSEQUENT.

Affirming the Consequent:

1) **p** → **q**
2) **q**
----
3) Thus, **p**

1) **C** → **F**
2) **F**
----
3) Thus, **C**

1) **S** → **G**
2) **G**
----
3) Thus, **S**

Interpret **S** (for **I study**) and **G** (for **I get good grades**) as statement indicators above.

Critical Thinking

ANALYSIS: Consider the following inductive argument.

1) Legalized marijuana eliminates criminal profiteering.

2) Criminal profiteering is **bad**.

3) Legalized marijuana eliminates many health dangers by controlling quality.

4) Eliminating health dangers is **good**.

5) Legalized marijuana permits its medical use.

6) The medical use of marijuana is **good**.

----

7) Thus, marijuana **should** be legalized.

Critical Thinking

EVALUATION: Is the inductive argument strong? Is it cogent (= strong + true premises)?

The conclusion that marijuana should be legalized follows with some uncertainty because even if each premise of the sequence of statements used to demonstrate the conclusion were true, the conclusion could still be false.

But, as the number of relevant reasons/premises about the legality of marijuana increases, the argument gets **stronger**; as the number decreases, the argument above for the conclusion that marijuana should be legalized gets **weaker**. **Cogency** here would require a strong argument with true premises.

Critical Thinking

Consider the following math problem found in a basic Algebra course: "Given that two more than a number is ten, find the number (i.e., find X)."

- **Analysis**, here, requires that we translate an **open** statement to its corresponding open algebraic expression.
- **Two more than a number is ten** translates to **X + 2 = 10**.
- Accordingly, given that **X + 2 = 10**, we must show or prove what **X** is (Let

  X be *a* real number).

Critical Thinking

We can use open statements as if they were statements, given additional information. For instance, the open statement X + 2 = 10 may simply be given as true.

Further **analysis** requires that we put the **argument** in **natural order** (put the premises first and draw the conclusion at the end):

1) $X + 2 = 10$...................Given.
2) $(X + 2) - 2 = (10) - 2$....Go to Premise#1, Subtract 2.

---

3) Therefore, $X = 8$..........Go to Premise#2, Simplify.

Critical Thinking

EVALUATION: Is the deductive argument valid? Is it sound (= valid + true premises)?

Evaluating this algebraic argument requires that we ask: Is this deductive argument valid? Is it the case that if each premise of the sequence of statements used to demonstrate the conclusion is true, then its conclusion cannot be false? Is it the case that the conclusion also must be true, so, truth is preserved?

Critical Thinking

The open statement X + 2 = 10 is true (we know that because it was Given) and (X + 2) − 2 = (10) – 2 must also true (because Premise#1 is given to us as true and by subtracting the same amount from both sides of the equation we don't change the equality).

On the basis of this sequence of statements, then, the conclusion **X = 8** cannot be false. The conclusion that **X = 8** must also be true. So, the deductive argument is **valid**.

Critical Thinking

So if the critical thinker asks "Why is the solution the number eight?", then one may respond—on the basis of logical reasoning—because ...

- Given that **X + 2 = 10**, we still maintain the equality by subtracting the same amount from both sides of the equation so that **(X + 2) − 2 = (10) − 2**.
- And by simplifying, we conclude that **X = 8**.

But is the deductive argument sound ?

Critical Thinking

This elementary example, therefore, asks students to evaluate the reasoning and information involved in order to solve the problem (find X). And by so doing, it accentuates the crucial difference between showing why the solution is the case and showing how the solution is the case.

A **how** question asks—**how** do you do the problem**?** But, the aim of critical thinking is **not** to have the learner ask the teacher to merely show the class **how to solve the problem**—to just show the class how to **plug-in the values** to solve for instances (i.e., examples) of the problem. Showing **why** something is the case allows the student to connect-the-dots **(evaluate the reasoning and information involved)** and develop critical thinking skills. And in this sense, there certainly is more to teaching than simply giving-out instructions or recipes that show **how** to do a problem.

Critical Thinking

CONCLUSION:

- ✓ Recognizing premises and conclusions within passages may reveal the logical connections and arguments in reading.
- ✓ Recognizing the logical connections and arguments may clarify meaning in reading, writing, and math.
- ✓ Choosing statements carefully and making proper inferences is imperative for justifying a thesis in expository writing or a solution in a math problem.
- ✓ Showing why something is the case allows the student to connect-the-dots (evaluate the reasoning and information involved) and develop critical thinking skills.

Critical Thinking

WHAT NEXT?

- **Caste, N. J., & Kiersky, J. H.** (1995). ***Thinking critically: Techniques for logical reasoning*** (p. 264). St. Paul, MN: West Publishing Co.

- **Epstein, R. L. & Kernberger, C.** (2006). ***The Pocket guide to critical thinking***. Belmont, CA: Wadsworth.

- **Mayfield, M.** (2001). ***Thinking for yourself: Developing critical thinking skills through reading and writing*** (pp. 4-6). USA: Thomson Learning, Inc.

Critical Thinking

WHAT NEXT?…

- **Nolt, J., & Rohatyn, D.** (1988). ***Schaum's outline of theory and problems of logic*** (p. 3). New York, NY: McGraw-Hill, Inc.

- **Tarski, A.** (1994). ***Introduction to logic and to the methodology of deductive sciences***. New York, NY: Oxford University Press, Inc.

- **Weston, A.** (2009). ***A rulebook for arguments***. Indianapolis, IN: Hackett Publishing Co., Inc.

Critical Thinking