375:Learning Styles.

VARK website

La Jolla Study.

Pashler et.al.

La Jolla Study.

Pashler et.al.

The learning-styles view has acquired great influence within the education field, and is frequently encountered at levels ranging from kindergarten to graduate school. There is a thriving industry devoted to publishing learning-styles tests and guidebooks for teachers, and many organizations offer professional development workshops for teachers and educators built around the concept of learning styles.

La Jolla Study.

Pashler et.al.

The learning-styles view has acquired great influence within the education field, and is frequently encountered at levels ranging from kindergarten to graduate school. There is a thriving industry devoted to publishing learning-styles tests and guidebooks for teachers, and many organizations offer professional development workshops for teachers and educators built around the concept of learning styles.

Our review of the literature disclosed ample evidence that children and adults will, if asked, express preferences about how they prefer information to be presented to them. There is also plentiful evidence arguing that people differ in the degree to which they have some fairly specific aptitudes for different kinds of thinking and for processing different types of information.

La Jolla Study.

Pashler et.al.

The learning-styles view has acquired great influence within the education field, and is frequently encountered at levels ranging from kindergarten to graduate school. There is a thriving industry devoted to publishing learning-styles tests and guidebooks for teachers, and many organizations offer professional development workshops for teachers and educators built around the concept of learning styles.

Our review of the literature disclosed ample evidence that children and adults will, if asked, express preferences about how they prefer information to be presented to them. There is also plentiful evidence arguing that people differ in the degree to which they have some fairly specific aptitudes for different kinds of thinking and for processing different types of information.

However, we found virtually no evidence for the interaction pattern mentioned above, which was judged to be a precondition for validating the educational applications of learning styles.

Snippy, snippy

Science Samples.

Snippy, snippy

Science Samples.

Psychologist Robert Sternberg of Tufts University in Medford, Massachusetts, says the paper “does not even begin to be a serious review of the field. ... [In] limiting themselves to random-assignment studies, they ignored almost the entire literature.”

Snippy, snippy

Science Samples.

Psychologist Robert Sternberg of Tufts University in Medford, Massachusetts, says the paper “does not even begin to be a serious review of the field. ... [In] limiting themselves to random-assignment studies, they ignored almost the entire literature.”

Just so, says Pashler – most of it is “weak.”

Snippy, snippy

Science Samples.

Psychologist Robert Sternberg of Tufts University in Medford, Massachusetts, says the paper “does not even begin to be a serious review of the field. ... [In] limiting themselves to random-assignment studies, they ignored almost the entire literature.”

Just so, says Pashler – most of it is “weak.”

Vark

Vark response.

Vark

Vark response.

Why do some experts say that knowing your learning style does not contribute to improved learning?

Vark

Vark response.

Why do some experts say that knowing your learning style does not contribute to improved learning?

The statement is true, in the same way that knowing you have a disease does not cure the disease or weighing yourself does not fix obesity. It is the next step that is important - When people make changes to their learning, based on their VARK preferences, their learning will be enhanced. They do this by using strategies that align with their preferences. It is what you do after you learn your preferences that has the potential to make a difference.

Willingham Video.

Willingham video.

Willingham Video.

Willingham video.

People have different capabilites:

Willingham Video.

Willingham video.

People have different capabilites:
- visual,

Willingham Video.

Willingham video.

People have different capabilites:
visual, auditory,

Willingham Video.

Willingham video.

People have different capabilites:
visual, auditory, kinesthetic.

Willingham Video.

Willingham video.

People have different capabilites:
visual, auditory, kinesthetic.

Information is inherent content:

Willingham Video.

Willingham video.

People have different capabilites:
visual, auditory, kinesthetic.

Information is inherent content: visual,

Willingham Video.

Willingham video.

People have different capabilites:
visual, auditory, kinesthetic.

Information is inherent content: visual, hearing,

Willingham Video.

Willingham video.

People have different capabilites:
visual, auditory, kinesthetic.

Information is inherent content: visual, hearing, meaning.

What do students mean...

“Professor should use more figures, because I am a visual leaner.”

What do students mean...

“Professor should use more figures, because I am a visual leaner.”

In computer science, inherent content may lend itself to pictures, or different views to understanding.

What do students mean...

“Professor should use more figures, because I am a visual leaner.”

In computer science, inherent content may lend itself to pictures, or different views to understanding.

Example:
Recursion:
  code

What do students mean...

“Professor should use more figures, because I am a visual leaner.”

In computer science, inherent content may lend itself to pictures, or different views to understanding.

Example:
Recursion:
- code
- stack

What do students mean...

“Professor should use more figures, because I am a visual leaner.”

In computer science, inherent content may lend itself to pictures, or different views to understanding.

Example:
Recursion:
- code
- stack
- tree

What do students mean...

“Professor should use more figures, because I am a visual leaner.”

In computer science, inherent content may lend itself to pictures, or different views to understanding.

Example:
Recursion:
- code
- stack
- tree
- inductive proof.

What do students mean...

“Professor should use more figures, because I am a visual leaner.”

In computer science, inherent content may lend itself to pictures, or different views to understanding.

Example:
Recursion:
- code
- stack
- tree
- inductive proof.
- environment diagram

What do students mean...

“Professor should use more figures, because I am a visual leaner.”

In computer science, inherent content may lend itself to pictures, or different views to understanding.

Example:
Recursion:
- code
- stack
- tree
- inductive proof.
- environment diagram

What do students mean...

“Professor should use more figures, because I am a visual leaner.”

In computer science, inherent content may lend itself to pictures, or different views to understanding.

Example:
Recursion:
- code
- stack
- tree
- inductive proof.
- environment diagram

Connect views even.

Example: coloring.

Thm: Any graph with degree at most d can be $d+1$ colored.

Example: coloring.

Thm: Any graph with degree at most d can be $d+1$ colored.

DasGupta, Papadimitriou, Vazirani, “Algorithms”

Example: coloring.

Thm: Any graph with degree at most d can be $d+1$ colored.

DasGupta, Papadimitriou, Vazirani, “Algorithms” -like.

Example: coloring.

Thm: Any graph with degree at most d can be $d+1$ colored.

DasGupta, Papadimitriou, Vazirani, “Algorithms” -like.

“Greedily consistently color nodes with one of $d+1$ colors. At least one color is available when a node is colored.”

Example: coloring.

Thm: Any graph with degree at most d can be $d+1$ colored.

DasGupta, Papadimitriou, Vazirani, “Algorithms” -like.

“Greedily consistently color nodes with one of $d+1$ colors. At least one color is available when a node is colored.” □

Example: coloring.

Thm: Any graph with degree at most d can be $d+1$ colored.

DasGupta, Papadimitriou, Vazirani, “Algorithms” -like.

“Greedily consistently color nodes with one of $d+1$ colors. At least one color is available when a node is colored.” □

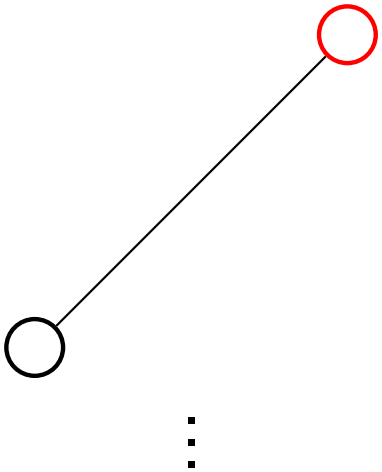
Available = Green, Red, Yellow, Blue

Example: coloring.

Thm: Any graph with degree at most d can be $d+1$ colored.

DasGupta, Papadimitriou, Vazirani, “Algorithms” -like.

“Greedily consistently color nodes with one of $d+1$ colors. At least one color is available when a node is colored.” □



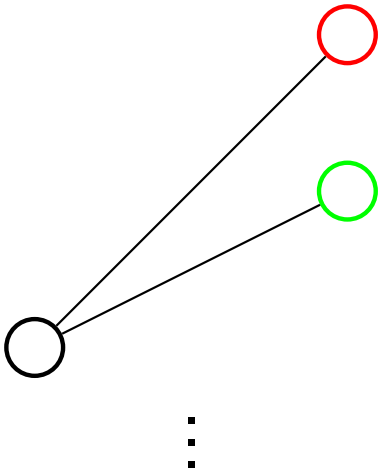
Available = Green, Red, Yellow, Blue
Available = Green,Yellow, Blue

Example: coloring.

Thm: Any graph with degree at most d can be $d+1$ colored.

DasGupta, Papadimitriou, Vazirani, “Algorithms” -like.

“Greedily consistently color nodes with one of $d+1$ colors. At least one color is available when a node is colored.” □



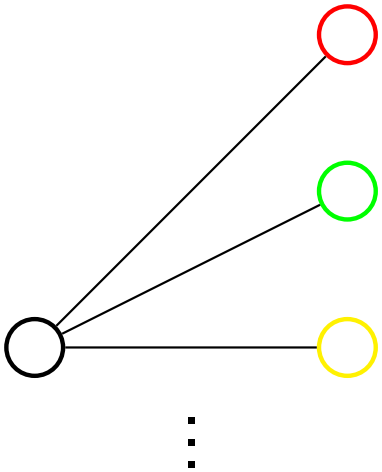
Available = Green, Red, Yellow, Blue
Available = Green,Yellow, Blue
Available = Yellow, Blue

Example: coloring.

Thm: Any graph with degree at most d can be $d+1$ colored.

DasGupta, Papadimitriou, Vazirani, “Algorithms” -like.

“Greedily consistently color nodes with one of $d+1$ colors. At least one color is available when a node is colored.” □



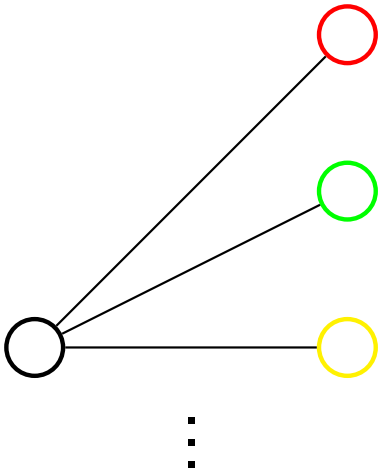
Available = Green, Red, Yellow, Blue
Available = Green,Yellow, Blue
Available = Yellow, Blue
Available = Blue

Example: coloring.

Thm: Any graph with degree at most d can be $d+1$ colored.

DasGupta, Papadimitriou, Vazirani, “Algorithms” -like.

“Greedily consistently color nodes with one of $d+1$ colors. At least one color is available when a node is colored.” □



Available = Green, Red, Yellow, Blue
Available = Green,Yellow, Blue
Available = Yellow, Blue
Available = Blue

...so 4 is enough!

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False
For $u \in V$:

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False
For $u \in V$:
   Available = Colors

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False
For $u \in V$:
   Available = Colors
   for v in $N(u)$:

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False
For $u \in V$:
   Available = Colors
   for v in $N(u)$:
      if color[v] != NULL

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False
For $u \in V$:
   Available = Colors
   for v in $N(u)$:
      if color[v] != NULL
        Available = Colors - color[v]

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False
For $u \in V$:
   Available = Colors
   for v in $N(u)$:
      if color[v] != NULL
        Available = Colors - color[v]
  color[u] = Available.first()

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False
For $u \in V$:
   Available = Colors
   for v in $N(u)$:
      if color[v] != NULL
        Available = Colors - color[v]
  color[u] = Available.first()

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False
For $u \in V$:
   Available = Colors
   for v in $N(u)$:
      if color[v] != NULL
        Available = Colors - color[v]
  color[u] = Available.first()

Proof:

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False
For $u \in V$:
   Available = Colors
   for v in $N(u)$:
      if color[v] != NULL
        Available = Colors - color[v]
  color[u] = Available.first()

Proof: Invariant 1:

The MIT-way...(CLRS)...

Thm: Any graph with degree at most d can be $d+1$ colored.

Graph: $G = (V, E)$.
Colors = $\{1, \ldots d+1\}$.
For $u \in V$:
    color[u] = False
For $u \in V$:
   Available = Colors
   for v in $N(u)$:
      if color[v] != NULL
        Available = Colors - color[v]
  color[u] = Available.first()

Proof: Invariant 1: Invariant 2.

Todo: graph coloring.

Make lecture active!

Todo: graph coloring.

Make lecture active!

Make into discussion activity!

Todo: graph coloring.

Make lecture active!

Make into discussion activity!

Example: Use idea in problems:

Todo: graph coloring.

Make lecture active!

Make into discussion activity!

Example: Use idea in problems:
Graph and Complemnt can be colored with $n+1$ colors.

Just for fun..

Every planar graph has a node of degree 6.

Just for fun..

Every planar graph has a node of degree 6.

6 color a planar graph!

Completing the square

Version 1:

Completing the square

Version 1: “Just the facts, Ma’am”

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \rightarrow a = \frac{16}{2} = 8$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

$x^2 + 16x \qquad = 57 \qquad$ Move 57 over.

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \to a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \to a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

$2ax = 16x$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?
$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!
Not a perfect square.

$x^2 + 16x = 57$ Move 57 over.
$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!
Can take square root!
$2ax = 16x \rightarrow a$, .

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?
$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!
Not a perfect square.

$x^2 + 16x = 57$
$x^2 + 2ax + a^2 = 57 + a^2$

Move 57 over.
Make left hand side a perfect square!
Can take square root!
$2ax = 16x \rightarrow a = \frac{16x}{2x}$, .

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

$x^2 + 16x = 57$

$x^2 + 2ax + a^2 = 57 + a^2$

Move 57 over.

Make left hand side a perfect square!

Can take square root!

$2ax = 16x \rightarrow a = \frac{16x}{2x} = 8,$.

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \to a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

$x^2 + 16x = 57$

$x^2 + 2ax + a^2 = 57 + a^2$

Move 57 over.

Make left hand side a perfect square!

Can take square root!

$2ax = 16x \to a = \frac{16x}{2x} = 8, \quad a^2 = 8^2 = 64.$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

$x^2 + 16x = 57$

$x^2 + 2ax + a^2 = 57 + a^2$

$x^2 + 16x + 64 = 57 + 64$

Move 57 over.

Make left hand side a perfect square!

Can take square root!

$2ax = 16x \rightarrow a = \frac{16x}{2x} = 8, \quad a^2 = 8^2 = 64.$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?
$2a = 16 \to a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!
Not a perfect square.

$x^2 + 16x = 57$
$x^2 + 2ax + a^2 = 57 + a^2$

$x^2 + 16x + 64 = 57 + 64$
$x^2 + 16x + 64 = 121$

Move 57 over.
Make left hand side a perfect square!
Can take square root!
$2ax = 16x \to a = \frac{16x}{2x} = 8, \quad a^2 = 8^2 = 64.$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?
$2a = 16 \to a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!
Not a perfect square.

$x^2 + 16x = 57$
$x^2 + 2ax + a^2 = 57 + a^2$

$x^2 + 16x + 64 = 57 + 64$
$x^2 + 16x + 64 = 121$
$(x+8)^2 = 121$

Move 57 over.
Make left hand side a perfect square!
Can take square root!
$2ax = 16x \to a = \frac{16x}{2x} = 8, \quad a^2 = 8^2 = 64.$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?
$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!
Not a perfect square.

$x^2 + 16x = 57$
$x^2 + 2ax + a^2 = 57 + a^2$

$x^2 + 16x + 64 = 57 + 64$
$x^2 + 16x + 64 = 121$
$(x+8)^2 = 121$
$(x+8) = \quad 11$

Move 57 over.
Make left hand side a perfect square!
Can take square root!
$2ax = 16x \rightarrow a = \frac{16x}{2x} = 8, \quad a^2 = 8^2 = 64.$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?
$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!
Not a perfect square.

$x^2 + 16x = 57$
$x^2 + 2ax + a^2 = 57 + a^2$

$x^2 + 16x + 64 = 57 + 64$
$x^2 + 16x + 64 = 121$
$(x+8)^2 = 121$
$(x+8) = \pm 11$

Move 57 over.
Make left hand side a perfect square!
Can take square root!
$2ax = 16x \rightarrow a = \frac{16x}{2x} = 8, \quad a^2 = 8^2 = 64.$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?
$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!
Not a perfect square.

$x^2 + 16x = 57$
$x^2 + 2ax + a^2 = 57 + a^2$

$x^2 + 16x + 64 = 57 + 64$
$x^2 + 16x + 64 = 121$
$(x+8)^2 = 121$
$(x+8) = \pm 11$
$x = \pm 11 - 8$

Move 57 over.
Make left hand side a perfect square!
Can take square root!
$2ax = 16x \rightarrow a = \frac{16x}{2x} = 8, \quad a^2 = 8^2 = 64.$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?
$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!
Not a perfect square.

$x^2 + 16x = 57$
$x^2 + 2ax + a^2 = 57 + a^2$

$x^2 + 16x + 64 = 57 + 64$
$x^2 + 16x + 64 = 121$
$(x+8)^2 = 121$
$(x+8) = \pm 11$
$x = \pm 11 - 8$
$\rightarrow x = \quad 19$

Move 57 over.
Make left hand side a perfect square!
Can take square root!
$2ax = 16x \rightarrow a = \frac{16x}{2x} = 8, \quad a^2 = 8^2 = 64.$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?
$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!
Not a perfect square.

$x^2 + 16x = 57$
$x^2 + 2ax + a^2 = 57 + a^2$

$x^2 + 16x + 64 = 57 + 64$
$x^2 + 16x + 64 = 121$
$(x+8)^2 = 121$
$(x+8) = \pm 11$
$x = \pm 11 - 8$
$\rightarrow x = \quad 19$ Doh!

Move 57 over.
Make left hand side a perfect square!
Can take square root!
$2ax = 16x \rightarrow a = \frac{16x}{2x} = 8, \quad a^2 = 8^2 = 64.$

Completing the square.

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?
$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!
Not a perfect square.

$x^2 + 16x = 57$
$x^2 + 2ax + a^2 = 57 + a^2$

$x^2 + 16x + 64 = 57 + 64$
$x^2 + 16x + 64 = 121$
$(x+8)^2 = 121$
$(x+8) = \pm 11$
$x = \pm 11 - 8$
$\rightarrow x = -19$

Move 57 over.
Make left hand side a perfect square!
Can take square root!
$2ax = 16x \rightarrow a = \frac{16x}{2x} = 8, \quad a^2 = 8^2 = 64.$

Completing the square.

Solve $x^2+16x-57=0$.

Perfect square: $(x+a)^2=x^2+2ax+a^2$

If perfect square can take square root.

Is $x^2+16x-57$ a perfect square?

$2a=16 \rightarrow a=\frac{16}{2}=8$ and $a^2=64\neq -57$!

Not a perfect square.

$x^2+16x = 57$

Move 57 over.

$x^2+2ax+a^2=57+a^2$

Make left hand side a perfect square!

Can take square root!

$2ax=16x \rightarrow a=\frac{16x}{2x}=8,\ a^2=8^2=64.$

$x^2+16x+64=57+64$

$x^2+16x+64=121$

$(x+8)^2=121$

$(x+8)=\pm 11$

$x=\pm 11-8$

$\rightarrow x=-19$

or $x=11-8=3$.

Completing the square.

V2: Engage.

Completing the square.

V2: Engage. “Learn-gage”.

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x + a)^2 =$

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x + a)^2 = ?$

(A) $x^2 + 2ax + a^2$

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x + a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a$

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C.

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.

Is $x^2 + 16x - 57$ a perfect square?

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.
Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.
$2a = 16$

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.

$2a = 16 \rightarrow a = \frac{16}{2} = 8$

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64$

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.

$2a = 16 \to a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

Later in semester.

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

Later in semester. Yes?

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

Later in semester. Yes? No?

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

Later in semester. Yes? No? Uses less space!

Completing the square: engage?

Solve $x^2 + 16x - 57 = 0$.

Recall Perfect square: $(x+a)^2 = ?$

(A) $x^2 + 2ax + a^2$

(B) $x^2 + a^2$

(C) $(x+a)x + (x+a)a = (x^2 + ax) + (xa + a^2)$

A and C. A is simplification.

If perfect square can take square root.
Is $x^2 + 16x - 57$ a perfect square?

(A) Yes

(B) No

B. No.

$2a = 16 \rightarrow a = \frac{16}{2} = 8$ and $a^2 = 64 \neq -57$!

Not a perfect square.

Later in semester. Yes? No? Uses less space! Students are trained.

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

What should a be?

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

What should a be? 16?

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8?

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8? $2ax = 16x$

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x \qquad\qquad = 57$

Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$

Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8? $2ax = 16x$

$\rightarrow a$, .

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x \qquad = 57$

Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$

Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8? $2ax = 16x$

$\rightarrow a = \frac{16x}{2x}$, .

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8? $2ax = 16x$

$\rightarrow a = \frac{16x}{2x} = 8,$.

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8? $2ax = 16x$

$\rightarrow a = \frac{16x}{2x} = 8$, $a^2 = 8^2 = 64$.

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

$x^2 + 16x + 64 = 57 + 64$ Can take square root!

What should a be? 16? 8? $2ax = 16x$

$\rightarrow a = \frac{16x}{2x} = 8$, $a^2 = 8^2 = 64$.

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

$x^2 + 16x + 64 = 57 + 64$ What should a be? 16? 8? $2ax = 16x$

$x^2 + 16x + 64 = 121$ $\rightarrow a = \frac{16x}{2x} = 8$, $a^2 = 8^2 = 64$.

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$

Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$

Make left hand side a perfect square!

Can take square root!

$x^2 + 16x + 64 = 57 + 64$

What should a be? 16? 8? $2ax = 16x$

$x^2 + 16x + 64 = 121$

$\rightarrow a = \frac{16x}{2x} = 8$, $a^2 = 8^2 = 64$.

$(x+8)^2 = 121$

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$

Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$

Make left hand side a perfect square!

Can take square root!

$x^2 + 16x + 64 = 57 + 64$

What should a be? 16? 8? $2ax = 16x$

$x^2 + 16x + 64 = 121$

$\rightarrow a = \frac{16x}{2x} = 8$, $a^2 = 8^2 = 64$.

$(x+8)^2 = 121$

$(x+8) = \pm 11$

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

$x^2 + 16x + 64 = 57 + 64$ What should a be? 16? 8? $2ax = 16x$

$x^2 + 16x + 64 = 121$ $\rightarrow a = \frac{16x}{2x} = 8$, $a^2 = 8^2 = 64$.

$(x+8)^2 = 121$

$(x+8) = \pm 11$

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8? $2ax = 16x$

$\rightarrow a = \frac{16x}{2x} = 8$, $a^2 = 8^2 = 64$.

$x^2 + 16x + 64 = 57 + 64$

$x^2 + 16x + 64 = 121$

$(x+8)^2 = 121$

$(x+8) = \pm 11$

$x = \pm 11 - 8$

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$

Move 57 over.

Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8? $2ax = 16x$

$\rightarrow a = \frac{16x}{2x} = 8, \; a^2 = 8^2 = 64.$

$x^2 + 16x + 64 = 57 + 64$

$x^2 + 16x + 64 = 121$

$(x+8)^2 = 121$

$(x+8) = \pm 11$

$x = \pm 11 - 8$

$\rightarrow x = \quad 19$

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$ Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$ Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8? $2ax = 16x$

$\rightarrow a = \frac{16x}{2x} = 8$, $a^2 = 8^2 = 64$.

$x^2 + 16x + 64 = 57 + 64$

$x^2 + 16x + 64 = 121$

$(x+8)^2 = 121$

$(x+8) = \pm 11$

$x = \pm 11 - 8$

$\rightarrow x = \quad 19$ Doh!

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$

Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$

Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8? $2ax = 16x$

$\rightarrow a = \frac{16x}{2x} = 8, \ a^2 = 8^2 = 64.$

$x^2 + 16x + 64 = 57 + 64$

$x^2 + 16x + 64 = 121$

$(x+8)^2 = 121$

$(x+8) = \pm 11$

$x = \pm 11 - 8$

$\rightarrow x = -19$

Completing the square

Solve $x^2 + 16x - 57 = 0$.

Perfect square: $(x+a)^2 = x^2 + 2ax + a^2$

$x^2 + 16x = 57$

Move 57 over.

$x^2 + 2ax + a^2 = 57 + a^2$

Make left hand side a perfect square!

Can take square root!

What should a be? 16? 8? $2ax = 16x$

$\rightarrow a = \frac{16x}{2x} = 8$, $a^2 = 8^2 = 64$.

$x^2 + 16x + 64 = 57 + 64$

$x^2 + 16x + 64 = 121$

$(x+8)^2 = 121$

$(x+8) = \pm 11$

$x = \pm 11 - 8$

$\rightarrow x = -19$

or $x = 11 - 8 = 3$.

Completing the square.

Discover.

Completing the square: discover.

Find x when $16x = 4$?

Completing the square: discover.

Find x when $16x = 4$? Here it is!

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How?

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16.

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

x

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$?

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x =$ 3.

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$?

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do?

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x - 4)^2$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x =$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does x

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$?

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$? $= \pm\sqrt{10}$?

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$? $= \pm\sqrt{10}$? $= 4 \pm \sqrt{10}$?

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$? $= \pm\sqrt{10}$? $= 4 \pm \sqrt{10}$?

$(x-4)^2 = 10$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$? $= \pm\sqrt{10}$? $= 4 \pm \sqrt{10}$?

$(x-4)^2 = 10 \rightarrow (x-4) = \pm\sqrt{10}$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$? $= \pm\sqrt{10}$? $= 4 \pm \sqrt{10}$?

$(x-4)^2 = 10 \rightarrow (x-4) = \pm\sqrt{10} \rightarrow x = 4 \pm \sqrt{10}$

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$? $= \pm\sqrt{10}$? $= 4 \pm \sqrt{10}$?

$(x-4)^2 = 10 \rightarrow (x-4) = \pm\sqrt{10} \rightarrow x = 4 \pm \sqrt{10}$

If left hand side is perfect square...can solve!

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$? $= \pm\sqrt{10}$? $= 4 \pm \sqrt{10}$?

$(x-4)^2 = 10 \rightarrow (x-4) = \pm\sqrt{10} \rightarrow x = 4 \pm \sqrt{10}$

If left hand side is perfect square...can solve!
Can we always

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$? $= \pm\sqrt{10}$? $= 4 \pm \sqrt{10}$?

$(x-4)^2 = 10 \rightarrow (x-4) = \pm\sqrt{10} \rightarrow x = 4 \pm \sqrt{10}$

If left hand side is perfect square...can solve!
Can we always make

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$? $= \pm\sqrt{10}$? $= 4 \pm \sqrt{10}$?

$(x-4)^2 = 10 \rightarrow (x-4) = \pm\sqrt{10} \rightarrow x = 4 \pm \sqrt{10}$

If left hand side is perfect square...can solve!
Can we always make it

Completing the square: discover.

Find x when $16x = 4$? Here it is!
How? Divide both sides by 16. Generally: inverse of multiply by 16.

$x = 4/16 = 1/4$.

Find x when $x^2 = 9$? $x = \pm 3$.
Find x when $x^2 = 10$? $x = \sqrt{10}$ or $x = -\sqrt{10}$.

Inverse operation is square root!

Find x when $x^2 - 8x + 16 = 0$?

$x^2 = 8x - 16$, $x = \sqrt{8x - 16}$ Uh oh.

What to do? $x^2 - 8x + 16 = (x-4)^2 = 0$ So $x = 4$!!

Find x when $x^2 - 8x + 16 = 10$?

Does $x = \sqrt{10}$? $= \pm\sqrt{10}$? $= 4 \pm \sqrt{10}$?

$(x-4)^2 = 10 \rightarrow (x-4) = \pm\sqrt{10} \rightarrow x = 4 \pm \sqrt{10}$

If left hand side is perfect square...can solve!
Can we always make it so?

Completing the square:discover.

..complete this.

Wrap up.

Learning styles.

Wrap up.

Learning styles.

Maybe?

Wrap up.

Learning styles.

Maybe?

Still...use hardware of students to get at understanding.