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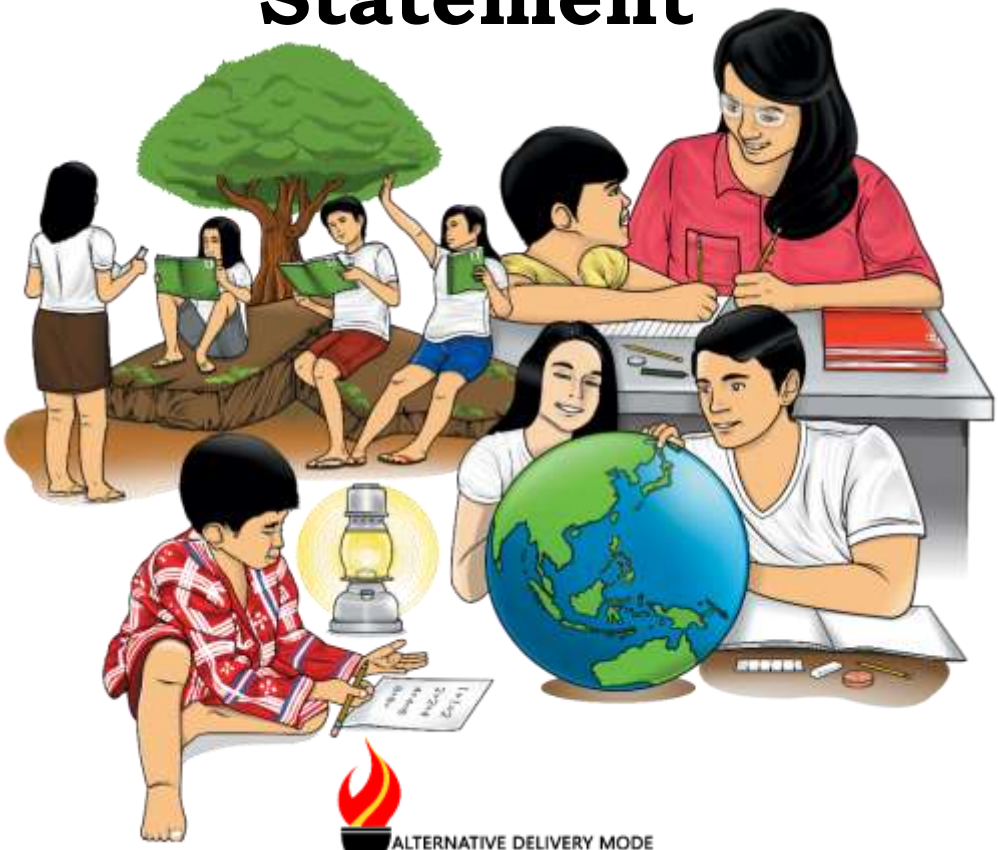
Mathematics

Quarter 2 – Module 12: "Illustrating the Equivalences of (a) the Statement and its Contrapositive; and (b) the Converse and Inverse of a Statement"



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Mathematics

Quarter 2 – Module 12:
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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

This module is designed to help you master the skills of illustrating the equivalences of (a) the statement and its contrapositive; and (b) the converse and inverse of a statement. You are provided with different activities which will help you to process knowledge and skills learned. The scope of this module enables you to communicate mathematical thinking with coherence and clarity in logic and reasoning. The lesson is arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the text book you are now using.

This module contains lesson on illustrating the equivalences of (a) the statement and its contrapositive, and (b) the converse and inverse of a statement.

After going through this module, you are expected to:

1. identify the truth value of the converse, inverse, and contrapositive of a statement;
2. show the equivalences of (a) the statement and its contrapositive, and (b) the converse and inverse of the statement using the truth value; and
3. relate the equivalences of statements in real-life situations.

What I Know

Pre-Assessment:
Directions: Choose the letter of the correct answer. Write your answer on a separate sheet of paper.

1. What do you call the statements having the same corresponding truth values?
   A. congruent C. equivalent
   B. equal D. similar

2. Which of the following has the same truth value to an if-then statement?
   A. contrapositive C. hypothesis
   B. converse D. inverse

3. Which of the following is logically equivalent to an inverse statement?
   A. conclusion C. converse
   B. contrapositive D. hypothesis

4. What should be the truth value of an if-then statement if its equivalent statement is true?
   A. true C. sometimes true
   B. false D. necessarily true

For items 5-6, consider the statement "If the house is clean, then my mother is happy" and refer to the truth table provided.

Implications	Hypothesis (p)	Conclusion (q)	Truth Value
1. If my mother is happy, then the house is clean.	T	T	T
2. If my mother is not happy, then the house is not clean.	F	F	T
3. If my mother is happy, then the house is not clean.	T	F	F
4. If my mother is not happy, then the house is clean.	F	T	T

5. What is the truth value when implication 1 is used?
   A. true C. undefined
   B. false D. necessarily true

6. What is the sequence of the four truth values of the converse of the original statement using the truth table?
   A. T, F, T, T
   B. T,T, T, F
   C. T, T, F, T
   D. F, T, T, T

For items 7-8, refer to statement, ***"If a shape is a quadrilateral, then it is a polygon".***

7. What is the truth value of its contrapositive if the hypothesis is true and the conclusion is false?
   A. true
   B. false
   C. undefined
   D. necessarily true

8. Which among pairs of statements are logically equivalent?

   A. If-then: If a shape is a quadrilateral, then it is a polygon.
      Converse: If a shape is a polygon, then it is a quadrilateral.
   B. If-then: If a shape is a quadrilateral, then it is a polygon.
      Inverse: If a shape is not a quadrilateral, then it is not a polygon.
   C. If-then: If a shape is a quadrilateral, then it is a polygon.
      Contrapositive: If a shape is not a polygon, then it is not a quadrilateral
   D. Inverse: If a shape is not a quadrilateral, then it is not a polygon.
      Contrapositive: If a shape is not a polygon, then it is not a quadrilateral

For items 9-10, refer to statement: ***"If there is a puppy in your house, then you feel happy."***

9. What is the truth value of its inverse if both hypothesis and conclusion are false?
   A. true
   B. false
   C. undefined
   D. necessarily true

10. Which of the following pairs of statements are equivalent?

   A. Converse: If $< B$ is acute, then $m < B = 45^0$.
      Inverse: If $m < B \neq 45^0$, then $< B$ is not acute.

   B. If-then: If $m < B = 45^0$, then it is acute.
      Converse: If $< B$ is acute, then $m < B = 45^0$.

   C. If-then: If $m < B = 45^0$, then it is acute.
      Inverse: If $m < B \neq 45^0$, then $< B$ is not acute.

   D. Converse: If $< B$ is acute, then $m < B = 45^0$.
      Contrapositive: if $< B$ is not acute, then $m < B \neq 45^0$.

11. Which of the following is equivalent to the statement, "If I am wearing a facemask, then I am safe from COVID-19"?
    A. If I am not wearing a facemask, then I am safe from COVID-19.
    B. If I am not safe from COVID-19, then I am wearing a facemask.
    C. If I am not safe from COVID-19, then I am not wearing a facemask.
    D. If I am not wearing a facemask, then I am not safe from COVID-19.

12. What is the truth value of its converse if the hypothesis is false and the conclusion is true?
    A. true
    B. false
    C. undefined
    D. necessarily true

13. Given a converse statement, "If an animal barks, then it is a dog", what is its equivalent statement?
    A. If an animal is a dog, then it barks.
    B. If an animal barks, then it is a dog.
    C. If an animal does not bark, then it is not a dog.
    D. If an animal is not a dog, then it does not bark.

14. Which of the statements below is equivalent to the conditional (if-then) statement, "If the number is divisible by 2, then it is even"?
    A. If the number is even, then it is divisible by 2.
    B. If the number is divisible by 2, then it is even.
    C. If the number is not divisible by 2, then it is not even.
    D. If the number is not even, then it is not divisible by 2.

15. Which of the following statements is the equivalent to the inverse statement "If you are not a class officer, then you are not a leader" ?
    A. If you are a leader, then you are a class officer.
    B. If you are a class officer, then you are a leader.
    C. If you are not a class officer, then you are a leader.
    D. If you are not a leader, then you are not a class officer.

Lesson 1 Illustrating Equivalences

Consider the statement: "*If you are in Mathematics Class, then you are in school today"*. If this statement is written this way: "*If you are not in school today, then you are not in Mathematics Class".* What do you observe with the two statements?

Statements like the two above are said to be equivalent. To elaborate further, let us begin our new lesson by recalling how to transform a statement into its converse, inverse, and contrapositive.

What's In

Directions: Transform the following statements into its converse, inverse and contrapositive and answer the guide questions. Write your answers on a separate sheet of paper.

1. Statement:	***If a polygon is a rectangle, then it has four sides.***
Converse :	
Inverse :	
Contrapositive:	
2. Statement:	***If you are a human, then you are a vertebrate.***
Converse :	
Inverse :	
Contrapositive:	

Guide Questions:

a. How did you transform the statements into its converse?
b. How did you transform the statements into its inverse?
c. How did you transform the statements into its contrapositive?

What's New

Given the fact that you are attending a Mathematics Class, is it true that you are in school? What if you are not in school today, does it mean that you are not in a Mathematics Class? Do you think both of the statements are true or both are false? Do you rather believe that the first statement is true and the second is false? Or is it the other way around? To answer these questions perform the activity below.

What's My Truth Value?

Directions: Consider the given conditional (if-then) statement: ***"If the last digit is zero, then it is divisible by 5"***. Identify whether the following implications are TRUE or FALSE.

1. If the last digit of a number is 0, then it is divisible by 5.
2. If the last digit of a number is 0, then it is not divisible by 5.
3. If the last digit of a number is not 0, then it is divisible by 5.
4. If the last digit of a number is not 0, then it is not divisible by 5.

Guide Questions:

A. Which implications above are true? and which are false?
B. How would you validate the truthfulness or falsehood of each implication above?

What is It

Recall that an if-then statement is divided into parts as hypothesis and conclusion, represented by letters *p* and *q,* respectively. From this statement, four implications, namely: conditional, contrapositive, converse, and inverse can be derived, which again are divided into hypothesis (*p*) and conclusion (*q*). Normally, the truthfulness and falsehood of implications are validated through formulating lengthy factual reasons.

In this lesson, instead of writing lengthy factual reasons to validate the truthfulness or falsehood of the parts of the implication and the whole implication itself, letters T and F, respectively for True and False will be assigned, without undermining reasons. These letters are called Truth Values. When these values are written into a table, the table is called Truth Table.

The truth table required to answer Question B in the previous activity will look like the one presented below. As reflected in the table, the hypotheses of implications 1, 2, 3 and 4 are validated as True, True, False, and False, respectively. Furthermore, the conclusions of implications 1, 2, 3 and 4 are validated True, False, True, and False, respectively.

Implications	**Hypothesis (*p*)**	**Conclusion (*q*)**
1. If the last digit of a number is 0, then it is divisible by 5.	T	T
2. If the last digit of a number is 0, then it is not divisible by 5.	T	F
3. If the last digit of a number is not 0, then it is divisible by 5.	F	T
4. If the last digit of a number is not 0, then it is not divisible by 5.	F	F

Given that the hypothesis and conclusion of the implications are already validated as either true or false, the following rules have to be followed to futher validate the truthfulness of the implication as a whole:

Rule	**Hypothesis**	**Conclusion**	**Truth Value**	**Explanation**
1	T	T	T	When the conditional statement has a True hypothesis and True conclusion, then, the whole statement is True.
2	T	F	F	When the hypothesis of the conditional statement is True but its conclusion is False, then the whole statement is False.
3	F	T	T	When the hypothesis of the conditional statement is false but its conclusion is True, then the whole statement is True.
4	F	F	T	When both the hypothesis and conclusion of the condicitional statement are False, then the whole statement is False.

The rules above can be applied in validating the truthfulness or falsehood of the implications used in the previous activity. The table that follow is shown to illustrate.

Implications	Hypothesis (*p*)	Conclusion (*q*)	Truth Value
1. If the last digit of a number is 0, then it is divisible by 5.	T (The same with the hypothesis of the original statement)	T (The same with the conclusion of the original statement)	T
2. If the last digit of a number is 0, then it is not divisible by 5.	T (The same with the hypothesis of the original statement)	F (Not the same with the conclusion of the original statement)	F
3. If the last digit of a number is not 0, then it is divisible by 5.	F (Not the same with the hyothesis of the original statement)	T (The same with the conclusion of the original statement)	T
4. If the last digit of a number is not 0, then it is not divisible by 5.	F (Not the same with the hypothesis of the original statement)	F (Not the same with the conclusion of the original statement)	T

Looking at the truth table in the previous page, implications 1, 3, and 4 are validated as True using Rules 1, 3, and 4, respectively. On the other hand, implication 2 is validated as False using Rule 2.

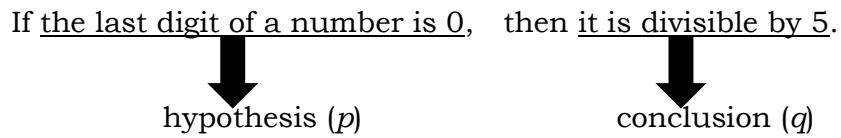
This time, let use these concepts in determining the truth values of an if-then statement, converse, inverse, and contrapositive; and to determine which of these statements are equivalent.

A. Truth Values of an If-Then Statement

Consider the if-then statement: *If the last digit of a number is 0, then it is divisible by 5.*

Follow the steps to determine its truth values.

Step 1: Identify the hypothesis (*p*) and conclusion (*q*) of the given if-then statement.



Step 2: State the implications following the formats illustrated.

Format	Implication
p, q	If the last digit of a number is 0, then it is divisible by 5.
p, not q	If the last digit of a number is 0, then it is not divisible by 5.
not p, q	If the last digit of a number is not 0, then it is divisible by 5.
not p, not q	If the last digit of a number is not 0, then it is not divisible by 5.

Note that the formats of writing the implications can be rearranged. This means that format not p, not q may come first before fomat p,q and so on and forth.

Step 3: Compare the hypothesis and conclusion of the implication with the hypothesis and conclusion of the original if-then statement. If a part has the same thought or words as the original part, then its truth value is true. If a part has a thought opposite of the original, then the truth value is false. Determine truth value of each implication and rule used. See the next table.

Implication	Hypothesis (p)	Conclusion (q)	Truth Value	Rule Used
1. If the last digit of a number is 0, then it is divisible by 5.	**T** *(The same with the hypothesis of the original statement)*	**T** *(The same with the conclusion of the original statement)*	**T**	Rule 1
2. If the last digit of a number is 0, then it is not divisible by 5.	**T** *(The same with the hypothesis of the original statement)*	**F** *(Not the same with the conclusion of the original statement)*	**F**	Rule 2
3. If the last digit of a number is not 0, then it is divisible by 5.	**F** *(Not the same with the hypothesis of the original statement)*	**T** *(The same with the conclusion of the original statement)*	**T**	Rule 3
4. If the last digit of a number is not 0, then it is not divisible by 5.	**F** *(Not the same with the hypothesis of the original statement)*	**F** *(Not the same with the conclusion of the original statement)*	**T**	Rule 4

B. Truth Values of the Converse of an If-Then Statement

Remember that for every if-then statement, a converse is one of the other three conditionals that can be derived from it. Similar to Section A, a converse will also generate four implications, four truth value combinations, and four decisions. See the process below.

Step 1: State the converse of the original if-then statement.

Original If-then Statement: If the last digit of a number is 0, then it is divisible by 5

Converse ($If\ q, then\ p$) : If a number is divisible by 5, then its last digit is 0.

Step 2: Identify the hypothesis (q) and conclusion (p) of the converse statement.

If a number is divisible by 5, then its last digit is 0.

hypothesis (q) conclusion (p)

Step 3: State the implications following the formats illustrated.

Format	Implication
q, p	If a number is divisible by 5, then its last digit is 0.
not q, p	If a number is not divisible by 5, then its last digit is 0.
q, not p	If a number is divisible by 5, then its last digit is not 0.
not q, not p	If a number is not divisible by 5, then its last digit is not 0.

Step 4: To determine the truth values of q and p of each implication of a converse.

Remember the truth values of the original statement. Interchange the truth values

of the hypothesis and conclusion of the implications of the original if-then statement.

Hypothesis of the original statement (p)	**Conclusion of the original statement** (q)
T	T
T	F
F	T
F	F

Step 5: To determine the truth values of the implications of the converse statement and the rule used in each implication. See the table below.

Implication	Hypothesis of the converse (q)	Conclusion of the converse (p)	Truth Value	Rule Used
1. If a number is divisible by 5, then its last digit is 0.	**T**	**T**	**T**	Rule 1
2. If a number is not divisible by 5, then its last digit is 0.	**F**	**T**	**T**	Rule 3
3. If a number is divisible by 5, then its last digit is not 0.	**T**	**F**	**F**	Rule 2
4. If a number is not divisible by 5, then its last digit is not 0.	**F**	**F**	**T**	Rule 4

C. Truth Values of the Inverse of an If-Then Statement

Step 1: State the inverse of the original if-then statement.

Original If-then Statement: If the last digit of a number is 0, then it is divisible by 5.
Inverse ($If\ not\ p, then\ not\ q$): If the last digit of a number is not 0, then it is not divisible by 5.

Step 2: Identify the hypothesis (*not p*) and conclusion (not *q*) of the inverse statement.

If the last digit of a number is not 0, then it is not divisible by 5.

hypothesis (*not p*) conclusion (*not q*)

Step 3: State the implications following the formats illustrated.

Format	Implication
not p, not q	If the last digit of a number is not 0, then it is not divisible by 5.
not p,q	If the last digit of a number is not 0, then it is divisible by 5.
p, not q	If the last digit of a number is 0, then it is not divisible by 5.
p,q	If the last digit of a number is 0, then it is divisible by 5.

Step 4: To determine the truth values of *p* and *q* of each implication of aninverse Remember the thruth values of the original statement. Find the opposite of the truth values of both the hypothesis and conclusion of the original if-then statement.

Hypothesis of the original statement (p)	Conclusion of the original statement (q)
T	T
T	F
F	T
F	F

Opposite Truth Values of the Hypothesis of the Original Statement	Opposite Truth Values of the Conclusion of the Original statement
F	F
F	T
T	F
T	T

Step 5: The truth values of the negation of the original hypothesis and conclusion will be the truth values of the inverse statement. See the table below.

Implication	**Hypothesis (*not p*)**	**Conclusion (*not q*)**	**Truth Value**	**Rule Used**
1. If the last digit of a number is not 0, then it is not divisible by 5.	F	F	T	Rule 4
2. If the last digit of a number is not 0, then it is divisible by 5.	F	T	T	Rule 3
3. If the last digit of a number is 0, then it is not divisible by 5.	T	F	F	Rule 2
4. If the last digit of a number is 0, then it is divisible by 5.	T	T	T	Rule 1

D. Truth Values of the Contrapositive of an If-Then Statement

Step 1: State the contrapositive of the original if-then statement.

Original If-then Statement: If the last digit of a number is 0, then it is divisible by 5.
Contrapositive ($If\ not\ q, then\ not\ p$): If a number is not divisible by 5, then its last digit is not 0.

If a number is not divisible by 5, then its last digit is not 0.

hypothesis (*not q*) conclusion (not *p*)

Step 3: State the implications following the formats illustrated.

Format	Implication
not q, not p	If a number is not divisible by 5, then its last digit is not 0.
q, not p	If a number is divisible by 5, then its last digit is not 0.
not q, p	If a number is not divisible by 5, then its last digit is 0.
q, p	If a number is divisible by 5, then its last digit is 0.

Step 4: To determine the truth values of q and p of each implication of a contrapositive follow the steps below. Determine the truth values of the hypothesis and conclusion of the implications of inverse statement. Interchange the truth values of the hypothesis and conclusion of the inverse statement.

Hypothesis of the Inverse Statement (*not p*)	**Conclusion of the Inverse Statement (*not q*)**
F	F
F	T
T	F
T	T

Step 5: The interchanged truth values will be the truth values of the implications of contrapositive statement. See the table below.

Implications	**Hypothesis (*not q*)**	**Conclusion (*not p*)**	**Truth Value**	**Rule Used**
1. If a number is not divisible by 5, then its last digit is not 0.	F	F	T	Rule 4
2. If a number is divisible by 5, then its last digit is not 0.	T	F	F	Rule 2
3. If a number is not divisible by 5, then its last digit is 0.	F	T	T	Rule 3
4. If a number is divisible by 5, then its last digit is 0.	T	T	T	Rule 1

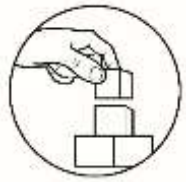
E. Equivalences of the Statement and Its Contrapositive and the Converse and Inverse of a Statement

Let us look at the table below which shows the summary of the Truth Values of the if-then statement, and its respective inverse, converse and contrapositive.

Original (If-then) Statement Truth Value	**Converse** Truth Value	**Inverse** Truth Value	**Contrapositive** Truth Value
T	T	T	T
F	T	T	F
T	F	F	T
T	T	T	T

Notice that in the table above, the corresponding truth values of the original if-then statement and its contrapositive are the same. Then, we can say that the original statement is equivalent to its contrapositive. On the other hand, the truth values of inverse and converse of an if-then statements are also the same, hence, the inverse and converse are equivalent.

To wrap the discussion, the given if-then statement and the corresponding contrapositive are logically equivalent because the corresponding truth values of these statements are the same. Likewise for a given if-then statement, its converse and inverse are logically equivalent because the corresponding truth values of these statements are the same.



What's More

A. Directions: Consider the if-then statement: "If a figure is a square, then it is a quadrilateral"; and its implications. Complete the table of truth values that is shown below.

Implication	**Hypothesis (p)**	**Conclusion (q)**	**Truth Value**
1. If a figure is a square, then it is a quadrilateral			
2. If a figure is not a square, then it is not a quadrilateral.			
3. If a figure is a square, then it is not a quadrilateral.			
4. If a figure is not a square, then it is a quadrilateral.			

Guide Questions:

1. How did you determine the truth values of the hypothesis and conclusion?
2. How did you come up with the truth value of each implication?

B. Directions: Consider the same if-then statement used in Activity A, its converse, and implications. Fill in the table below with the missing truth values.

If-then statement($if\ p, then\ q$): If a figure is a square, then it is a quadrilateral. Converse($if\ q, then\ p$): If a figure is a quadrilateral, then it is a square.

Implications	Hypothesis (p)	Conclusion (q)	Truth Value
1. If a figure is a quadrilateral, then it is a square.			
2. If a figure is not a quadrilateral, then it is not a square.			
3. If a figure is not a quadrilateral, then it is a square.			
4. If a figure is a quadrilateral, then it is not a square.			

Guide Questions:

1. Do you remember any relationship of the truth values of the if-then statement and its converse? State it briefly.
2. How did you determine the truth values of the hypothesis and conclusion?
3. How did you come up with the truth values for the decisions?

C. Directions: Consider the same if-then statement used in Activity A, its inverse, and implications. Fill in the table below with the missing truth values.

If-then statement ($if\ p, then\ q$): If a figure is a square, then it is a quadrilateral.
Inverse ($if\ not\ p, then\ not\ q$): If a figure is not a square, then it is not a quadrilateral.

Implications	Hypothesis (p)	Conclusion (q)	Truth Value
1. If a figure is not a square, then it is not a quadrilateral.			
2. If a figure is a square, then it is a quadrilateral.			
3. If a figure is not a square, then it is a quadrilateral.			
4. If a figure is a square, then it is not a quadrilateral.			

Guide Questions:

1. Do you remember any relationship of the truth values of the if-then statement and its inverse? State it briefly.
2. How did you determine the truth values of the hypothesis and conclusion?
3. How did you come up with the truth values for the decisions?

D. Directions: Consider the same if-then statement used in Activity A, its contrapositive, and implications. Fill in the table below with the missing truth values.

If-then statement ($if\ p, then\ q$): If a figure is a square, then it is a quadrilateral.
Contrapositive ($if\ not\ q, then\ not\ p$): If a figure is a not a quadrilateral, then it is not a square.

Implications	Hypothesis (p)	Conclusion (q)	Truth Value
1. If a figure is a not a quadrilateral, then it is not a square.			
2. If a figure is a quadrilateral, then it is a square.			
3. If a figure is a quadrilateral, then it is not a square.			
4. If a figure is a not a quadrilateral, then it is a square.			

Guide Questions:

1. Do you remember any relationship of the truth values of the if-then statement and its contrapositive? State it briefly.
2. How did you determine the truth values of the hypothesis and conclusion?
3. How did you come up with the truth values for the decisions?

What I Have Learned

Directions: Consider the table and the paragraph below. Fill in the blanks or the missing values with the correct answer which you can choose from the box below. Write you answer on a separate sheet of paper.

Original (If-then) Statement Decision	Converse Decision	Inverse Decision	Contrapositive Decision
T	T		T
T		T	
	T		F
T		F	T

I know that two if-then statements are equivalent _____. I also know that an if-then statement and its _____are equivalent. So to fill in the blank of the first column, I need to look for its _____ truth value in the contrapositive column. From the table, it can be seen that in the contrapositive column the third row has a truth value of _____, therefore the missing truth value of the first column should be _____ also. And then, I also know that the converse and _____ of an if-then statement are equivalent. Thus, to find the missing truth values of the converse and inverse, I just have to _____columns. Following this concept, I finally found out that the missing truth values for the converse column are _____and_____, while on the inverse column the missing truth values are _____andT.

contrapositive	F	corresponding	T	inverse

compare the corresponding truth values of the converse and inverse

if their corresponding truth values are the same

What I Can Do

Situation: You received a call from your two friends who reported that your neighbor had a dry cough. Along the conversation, one of your one friends said that , "If your neighbor had a dry cough, then your neighbor is positive of Corona Virus Disease 2019 (CoVID-19)". That friend of yours even warned you to keep away from your neighbor.

Questions:

1. Will you directly believe in the statement given by your friend?
2. Give real-life reasons to support your belief. You may write your reasons in a paragraph form.

Assessment

Post-Assessment

Directions: Choose the letter of the correct answer. Write your answer on a separate sheet of paper.

1. Which of the following pairs of statements are equivalent?
   A. conditional and inverse C. converse and contrapositive
   B. conditional and converse D. conditional and contrapositive

2. Which of the following is equivalent to a converse?
   A. conclusion B. contrapositive C. inverse D. hypothesis

3. Which of the following best describes equivalent statements?
   A. If one statement is false and the other is true.
   B. If one statement is true and the other is false.
   C. If both statements have undefined truth values.
   D. If statements have the same corresponding truth values.

4. Which of the following statement is NOT true?
   A. Letters T and F , respectively are assigned for truth values True and False.
   B. Letters T and F , respectively are assigned for truth values False and True.
   C. The if-then statement and the corresponding contrapositive are logically equivalent.
   D. The converse and inverse of an if-then statement are logically equivalent.

For items 5-10, use the table below to answer the questions that follow.

If-then Statement: If you study, then your score will improve.
Converse ($If\ q, then\ p$): If your score does improve, then you did study.

Implications	Hypothesis (q)	Conclusion (p)	Decision
1. Your score improved, so you did study.	T	T	T
2. Your score did not improve, that is why you study.	F	T	T
3. Your score improved, hence you did not study.	T	F	F
4. Your score did not improve,hence you did not study.	F	F	T

5. Which of the following best describes the truth table?
   A. The conclusions of implications 1, 2, 3, and 4 are validated as False, True, False, and True respectively.
   B. The conclusion of implications 1, 2, 3 and 4 are validated as True, False, True, and False respectively.
   C. The hypotheses of implications 1,2,3 and 4 are validated as True, True, False, and False respectively.
   D. The hypotheses of implications 1,2,3 and 4 are validated as True, False, True, and False respectively.

6. What decision can you make to an implication of a converse if both hypothesis and conclusion are false?
   A. true B. false C. undefined D. necessarily true

7. What decision can you make to an implication of a converse if the hypothesis is true and the conclusion is false?
   A. true B. false C. undefined D. necessarily true

8. What are the truth values can be validated to a converse given an implication *"Your score did not improve, that is why you study"* ?
   A. Hypothesis (p): T
      Conclusion (q): T
   B. Hypothesis (p): T
      Conclusion (q): F
   C. Hypothesis (p): F
      Conclusion (q): T
   D. Hypothesis (p): F
      Conclusion (q): F

9. What is the implication of the converse if the hypothesis is true and the conclusion is false?
   A. Your score improved, so you did study.
   B. Your score improved, hence you did not study.
   C. Your score did not improve, that is why you study.
   D. Your score did not improve,because you did not study.

10. What is the implication of the converse if both hypothesis and conclusion are true?
   A. Your score improved, so you did study.
   B. Your score improved, but you did not study.
   C. Your score did not improve, that is why you study.
   D. Your score did not improve,because you did not study.

For items 11-14, use the table below to answer the questions that follow.

If-then Statement: If you live in Manila, then you live in the Philippines.

Implications	**Hypothesis (p)**	**Conclusion (q)**	**Decision**
1. You live in Manila, so you live in the Philippines.	T	T	T

2. You live in Manila, that is why you did not live in the Philippines.	T	F	F
3. You did not live in Manila, hence you lived in the Philippines.	F	T	T
4. You did not live in Manila, hence you did not live in the Phippines.	F	F	T

11. Which of the following best describes the truth table?
    A. The conclusions of implications 1, 2, 3, and 4 are validated as False, True, False, and True respectively.
    B. The conclusions of implications 1, 2, 3 and 4 are validated as True, False, True, and False respectively.
    C. The hypotheses of implications 1,2,3 and 4 are validated as False, True, False, and True respectively.
    D. The hypotheses of implications 1,2,3 and 4 are validated as True, False, True, and False respectively.

12. What are the truth values of the hypothesis and conclusion of the implication of the conditional statement *"You did not live in Manila, hence you did not live in the Phippines"*
    A. Hypothesis (p): T
       Conclusion (q): T
    B. Hypothesis (p): T
       Conclusion (q): F
    C. Hypothesis (p): F
       Conclusion (q): T
    D. Hypothesis (p): F
       Conclusion (q): F

13. What are the truth values of the hypothesis and conclusion of the implication of the conditional statement *"You did not live in Manila, hence you lived in the Philippines"?*
    A. Hypothesis (p): T
       Conclusion (q): T
    B. Hypothesis (p): T
       Conclusion (q): F
    C. Hypothesis (p): F
       Conclusion (q): T
    D. Hypothesis (p): F
       Conclusion (q): F

14. What is the implication of the conditional statement if the hypothesis is true and conclusion is false?
    A. You live in Manila, so you live in the Philippines.
    B. You did not live in Manila, hence you lived in the Philippines.
    C. You live in Manila, that is why you did not live in the Philippines.
    D. You did not live in Manila, hence you did not live in the Phippines.

15. Given the if-then statement, "If an animal barks, then it is a dog", your friend claim that the statements, "If an animal is a dog, then it barks"; and "If an animal does not bark, then it is not a dog" are equivalent. What would support his claim?
    A. If-the statements and its converse are equivalent.
    B. If-the statements and its contrapositive are equivalent.
    C. Converse and inverse of an if-then statement are equivalent.
    D. Converse and contrapositive of an if-then statement are equivalent.

Additional Activities

Directions:Write a free-verse poem related to if-then statements, truth values, and equivalence. You may also include in the poem details of your experiences in going through this module. Your work will be judged according to the rubric below.

Categories and Criteria	**Beginning (2)**	**Developing (3)**	**Accomplished (4)**	**Exemplary (5)**
Content	Demonstrate 0 – 5 correct ideas about the lesson.	Demonstrate 6 -7 correct ideas about the lesson.	Demonstrate 8 -9 correct ideas about the lesson.	Demonstrate 10 or more correct ideas about the lesson.
Conventions	The poem has 5 or more errors in spelling and grammar.	The poem has 3 to 4 errors in spelling and grammar.	The poem has 1 to 2 errors in spelling and grammar.	No errors in spelling and grammar.
Originality	The poem is 51% - 100 % copied from another source.	The poem 26% - 50% copied from another source.	The poem is 1% -25% copied from another source.	The poem is 0% copied.

Answer Key

What I Have Learned

Original (If-then) Statement Truth Value	Converse Truth Value	Inverse Truth Value	Contrapositive Truth Value
T	T	**T**	T
T	**T**	T	**T**
F	T	**T**	F
T	**F**	F	T

I know that two if-then statements are equivalent **if their corresponding truth values are the same**. I also know that an if-then statement and its **contrapositive** are equivalent. So to fill in the blank of the first column, I need to look for its **corresponding** truth value in the contrapositive column. From the table, it can be seen that in the contrapositive column the third row has a truth value of **F**, therefore the missing truth value of the first column should be **F** also. And then, I also know that the converse and **inverse** of an if-then statement are equivalent. Thus, to find the missing truth values of the converse and inverse, I just have to **compare the corresponding truth values of the converse and inverse** columns. Following this concept, I finally found out that the missing truth values for the converse column are **T** and **F**, while on the inverse column the missing truth values are **T** and T.

What I Can Do

Answers may vary.

Assessment

1. D
2. C
3. D
4. B
5. D
6. A
7. B
8. C
9. B
10. A
11. B
12. D
13. C
14. C
15. C

What I Know

1. C
2. A
3. C
4. A
5. A
6. C
7. B
8. C
9. A
10. A
11. C
12. A
13. D
14. D
15. A

What's In

1. Statement:	***If a polygon is a rectangle, then it has four sides.***
Converse:	If a polygon has four sides, then it is a rectangle.
Inverse:	If a polygon is not a rectangle, then it does not have four sides.
Contrapositive:	If a polygon does not have four sides, then it is not a rectangle.
2. Statement:	***If you are a human, then you are a vertebrate.***
Converse:	If you are a vertebrate, then you are a human.
Inverse:	If you are not a human, then you are not a vertebrate.
Contrapositive:	If you are not a vertebrate, then you are not a human.

Guide Questions:

a. Interchange the hypothesis and conclusion of the given statement.
b. Negate both the hypothesis and conclusion of the given statement.
c. Negate and then interchange the hypothesis and conclusion of the given statement.

What's New

1. TRUE
2. FALSE
3. FALSE
4. TRUE

Guide Questions:

A. Implications 1 and 4 are true; and 2 and 3 are false
B. Truth table
C. Refer to the implications in validating the conditional statement.

What's More

B.
1. T, T, T
2. F, F, T
3. T, F, F
4. F, T, T

Guide Questions:

1. I compared both the hypothesis and conclusion of each implication to the original if-then statement's p and q.
2. I referred on the rules which states that all truth value combinations are true except when the hypothesis is true, and the conclusion is false.

C.
1. T, T, T
2. F, F, T
3. F, T, T
4. T, F, F

Guide Questions:

1. Yes, the truth values for p and q for the original statement are only interchanged.
2. I compared both the hypothesis and conclusion of each implication to the original if-then statement's q and p.
3. I referred on the rules which states that all truth value combinations are true except when the hypothesis is true, and the conclusion is false.

C.
1. F, F, T
2. T, T, T
3. F, T, T
4. T, F, F

Guide Questions:

1. Yes, the truth values for p and q of the inverse statement are the opposite truth values of both the hypothesis and conclusion of the original If-then Statement.
2. I compared both the hypothesis and conclusion of each implication to the original if-then statement's p and q.
3. I referred on the rules which states that all truth value combinations are true except when the hypothesis is true, and the conclusion is false.

D.
1. F, F, T
2. T, T, T
3. T, F, F
4. F, T, T

Guide Questions:

1. Yes, the truth values for q and p of contrapositive statement are based on the opposite and interchanged truth values of both the hypothesis and conclusion of the original If-then Statement.
2. I compared both the hypothesis and conclusion of each implication to the original if-then statement's q and p.
3. I referred on the rules which states that all truth value combinations are true except when the hypothesis is true, and the conclusion is false.

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