Closing Learning Gaps
with Differentiated Math Lessons

Action Research Study by Tiffany Ng
University of Hawaii, Manoa
Learning Design & Technology
Spring 2018
1. Background
World Map
Put a star next to all the places you've lived in.
World Map
Put a star next to all the places you’ve lived in.
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Graduation

San Francisco International High School
Mexico
Honduras
Guatemala
El Salvador
Albania
Learning Culture at SFIHS

San Francisco International High School

Language development through dialogues.

Collaboration and team work.

Experiential and Project-Based Learning

Learning together & peer support.

Background  Project Development  Action Research  Results  Conclusion
Learning Together
Individual Students

Learning gaps are more easily observed.

Steeped in a depth of knowledge but limited in breadth.
Goal & Purpose

Differentiate Content to...

Fill Learning Gaps

Review & Strengthen Math Knowledge

Learn More Topics

Better Prepare Students For Life After Graduation
2. Project Development
## Planning the Lesson Topics

<table>
<thead>
<tr>
<th>Lesson Progression</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Week 1</strong></td>
<td>Arithmetic [1-1]</td>
<td>Order of Operation &amp; Solve for x [1-2]</td>
<td>Complex Numbers [1-3]</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td><strong>Week 2</strong></td>
<td>Combining Like Terms [2-1]</td>
<td>Radical Functions [2-2]</td>
<td>Complex Numbers–Conjugation [2-3]</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>Week 3</strong></td>
<td>Fraction Arithmetic [3-1]</td>
<td>Radical functions - Rationalize denominator [3-2]</td>
<td>Rationalize with Conjugates [3-3]</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td><strong>Week 4</strong></td>
<td>Distribution &amp; Polynomial Expansion [4-1]</td>
<td>Factoring [4-2]</td>
<td>Rational Functions [4-3]</td>
</tr>
</tbody>
</table>
Goal:
The goal of this unit is to focus on strengthening your math skills. You do not need to go through every lesson, instead, you should focus on lesson topics that you are weak on or haven't learned.

Modules:
To see all the lessons, you can click the modules tab on the left.

Self Reflection:
If you finish a lesson or at the end of a class, please complete a self reflection.

Where to Start:
If you are just starting, the only lesson that is available to you is Lesson [1-1].
<table>
<thead>
<tr>
<th>Lesson</th>
<th>Description</th>
<th>Points</th>
<th>Score Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Quiz - Arithmetic</td>
<td></td>
<td>5 pts</td>
<td>Score at least 5.0</td>
</tr>
<tr>
<td>Introduction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using Number Lines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charting Positives and Negatives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Let's Practice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practice Problem Answers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussion: Which method?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Want more practice?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-Quiz - Arithmetic</td>
<td></td>
<td>5 pts</td>
<td>Score at least 5.0</td>
</tr>
<tr>
<td>Self-Reflection</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lesson 1 Complete!
Pre-Quiz - Arithmetic [1-1]

Started: Apr 3 at 6:17pm

Quiz Instructions

Try this pre-quiz to see how well you know this topic. If you pass the quiz, you will be able to move onto another topic without having to go through this lesson. However, if you do not pass the quiz, you will need to go through this lesson to learn this topic well and try to pass the post-quiz.

For the pre-quiz, you can only take it once but you can take the post-quiz as many times as you need to pass.

Question 1

4 - 6 =
Objective: At the end of this lesson, you will be able to add and subtract integers.

Before we get started, let's make sure we know the following definitions.

Adding (+): Joining things together to increase in value. (Example: $3 + 2 = 5$)

Subtracting (-): Taking away from the original value. (Example: $3 - 2 = 1$)

Integers: Positive and negative numbers that are not fractions or decimals. (Examples: ...-3, -2, -1, 0, 1, 2, 3...)
Charting Positives and Negatives [1-1]

Instead of using a number line, you can use a chart to help you add and subtract instead.

You can do this by:

- Putting positive numbers in the right column.
- Putting negative numbers in the left column.

<table>
<thead>
<tr>
<th>Negative Numbers</th>
<th>Positive Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Let's take a look at some examples.

Adding Example:

\[ 2 + 3 = \_\_\_ \]
Factoring [4-2]

In lesson [4-1] we learned about polynomial expansion. Factoring is the opposite process.

In polynomial expansion, we multiply polynomials together.

\[(a+b)(c+d) = ac + ad + bc + bd\]

In factoring, we will look at the first and last term to try and determine what they are a product of.

\[ac + ad + bc + bd\]

\[(a+b)(c+d)\]
Let's Practice [1-1]

Try these problems!
You might want to use a number line or chart to help you.

-10 -9 -8 -7 -6 -5 -4 -3 -2 -1  0  1  2  3  4  5  6  7  8  9  10

<table>
<thead>
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<th>Positive Numbers</th>
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</table>

1) 3 + 2 =
2) 9 - 3 =
3) 5 + 2 =
4) 8 - 1 =
5) 6 + 4 =
Practice Problem Answers [1-1]

Try these problems!

1) $3 + 2 = 5$

2) $9 - 3 = 6$
Want more practice? [1-1]

Would you like more practice?
Try this game to practice more on adding and subtracting integers.

Ready for the post-quiz?
If you've practiced enough, feel free to take the post-quiz by clicking the next button below.
30

Project Development

Results

Action Research

Background

Conclusion
Post-Quiz - Arithmetic [1-1]

Due: No due date  Points: 5  Questions: 5  Time Limit: None
Allowed Attempts: Unlimited

Instructions

Now that you've learned about adding and subtracting integers. Try this post-quiz. If you pass the quiz, you will be able to move onto other lessons. However, if you do not pass the quiz, you will need to review this lesson and retake the quiz until you pass.

Take the Quiz
# Course Question Banks

## Add & Subtract Fractions with Different Denominators
- 4 Questions
- Last Updated: Mar 3 at 6:42pm

## Add & Subtract Fractions with Same Denominators
- 7 Questions
- Last Updated: Mar 3 at 6:42pm

## Arithmetic - Neg/Pos Questions
- 10 Questions
- Last Updated: Mar 3 at 6:42pm

## Asymptotes and Holes
- 23 Questions
- Last Updated: Mar 3 at 6:42pm

## Asymptotes and Holes 2
- 12 Questions
- Last Updated: Mar 3 at 6:42pm
Arithmetic - Neg/Pos Questions

Remember, changes to question templates won’t automatically update quizzes that are already using those questions.
Self-Reflection

Now that you've finished a lesson. Reflect on your learning.

* Required

Name: *

Your answer

Which lesson did you complete? *

- Lesson [1-1] - Arithmetic
- Lesson [1-2] - Order of Operations & Solving for x
- Lesson [1-3] - Complex Numbers
3. Action Research
Research Purpose & Questions

Online Differentiated Mathematics Lessons

Student’s Needs
- Engagement
- Confidence
- Math Knowledge

Background
Project Development
Action Research
Results
Conclusion
Data Collection Tools

- Observation Tool
- Teacher Journal
- Canvas Quiz Scores
- Student Self-Reflections
<table>
<thead>
<tr>
<th></th>
<th>Student Initials</th>
<th>First 5 mins of class</th>
<th>At 30 mins</th>
<th>Last 5 mins of class</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td></td>
<td>D1</td>
<td>D2</td>
<td>D4</td>
</tr>
<tr>
<td>D2</td>
<td></td>
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<td></td>
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**Engagement Level Observation Tool**

**Class Period:** ______ to ______

**Lesson Group/Date:** ______

**Time of Observation:** ______

**Time of Sweep (Suggested/Actual Time):**

**Data-Collection Tools**
<table>
<thead>
<tr>
<th>Engagement Behaviors:</th>
<th>Disengagement Behaviors:</th>
<th>Confident Behaviors:</th>
<th>Unconfident Behaviors:</th>
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<tbody>
<tr>
<td>E1 - able to focus and be on task</td>
<td>D1 - sleeping</td>
<td>C1 - positive facial expression (i.e. smiling or laughing)</td>
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<td>E2 - taking notes</td>
<td>D2 - playing on cell phones</td>
<td>C2 - relaxed body language (i.e. leaning in and engaging themselves with the class)</td>
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<td>E4 - other signs of engagement</td>
<td>D4 - other signs of disengagement</td>
<td>C4 - other confident</td>
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Research Journal

Class Period: ____________  Lesson Group/Date: ___________________________________________________________________

Which students stood out today?

What captured my attention?

What worked well in class today?

Conclusion
What did not work or could work better?

What can be revised or added?

Other thoughts:
Four Week Iterative Process

01 Implement Lesson
02 Observations & Data Collection
03 Informal Analysis of Data
04 Revise for Following Week
### Action Research Weekly Revisions

**Week 1**
- Observed: Quick lesson completion
- Revision: Created additional lesson for subsequent weeks

**Week 2**
- Observed: Seating & increased distractions
- Revision: Assigned Seating

**Week 3**
- Observed: Placement test time crunch
- Revision: Earlier lesson in the week

**Week 4**
- Observed: Students were overwhelmed with placement test approaching & incomplete lessons

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### Results
4. Results
Engagement Data: Teacher Observation

- 75% Engaged
- 16% Both
- 9% Disengaged
Engagement Data: Teacher Observation

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- **Engaged**: 75%
- **Both**: 16%
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- **Engaged**: 75%
- **Both**: 16%
- **Disengaged**: 9%
Engagement Data:
Student Reflection

- 91% Engaged
- 7% Neutral
- 2% Disengaged
Engagement Data:
Student Reflection

How engaged were you during this lesson?

- 91% Engaged
- 7% Neutral
- 2% Disengaged

Number of Students

Level of Engagement

- 1 (Not Engaged)
- 2
- 3
- 4
- 5 (Very Engaged)
Confidence Level Data: Teacher Observation

59% Confident
33% Both
8% Unconfident
Confidence Level Data: Teacher Observation

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<td>C4 - other confident signs</td>
<td>U4 - other unconfident signs</td>
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- **59%** Confident
- **33%** Both
- **8%** Unconfident
Confidence Level Data:
Student Reflection

94% Confident
6% Neutral
0% Unconfident
Confidence Level Data: Student Reflection

How confident do you feel about how well you learned?

- 94% Confident
- 6% Neutral
- 0% Unconfident

<table>
<thead>
<tr>
<th>Student Confidence Level</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Not Confident)</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>5 (Very Confident)</td>
<td>32</td>
</tr>
</tbody>
</table>
Math Knowledge Data: Pre-Quiz Scores & Post-Quiz Scores

Average Pre-Quiz Score and Average All Post-Quiz Scores

- **Background**
- **Project Development**
- **Action Research**
- **Results**
- **Conclusion**
Math Knowledge Data: Traditional vs Differentiated Learning

Traditional Lessons
- Week 1
- Week 2
- Week 3
- Week 4

Online Differentiated Lessons
- Week 1
- Week 2
- Week 3
- Week 4
Math Knowledge Data: Range of Students

Student A

- Week 1
- Week 2
- Week 3
- Week 4

Student B

- Week 1
- Week 2
- Week 3
- Week 4
Math Knowledge Data: Different Students, Different Needs

Lower Skilled Students

• Had difficulty completing lessons
• Some students only completed 1 to 2 lessons
• Lesson level was too high for some students.

Average & Higher Skilled Students

• Successful self-regulated learners
• Able to individually learn new content
• Had enough lesson to learn
Two students needed **SEVEN** attempts to pass the lowest level lesson.
5. Conclusion
Conclusion

Student’s Needs

Engagement

Confidence

Math Knowledge

Background

Project Development

Action Research

Results

Conclusion
Impact of Online Differentiated Lessons

Learning More Lessons
Impact of Online Differentiated Lessons

Learning More Lessons

Background
Project Development
Action Research
Results
Conclusion
Impact of Online Differentiated Lessons

Fill Learning Gaps

Learning More Lessons
Impact of Online Differentiated Lessons

Fill Learning Gaps

Learning More Lessons
Ideas to Improve Differentiation Process

1. Lower Starting Point
2. Options for struggling students
3. Differentiate Teaching Strategies

Further differentiate
Ideas to Improve Differentiation Process

1. Lower Starting Point
2. Options for struggling students
3. Differentiate Teaching Strategies

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Ideas to Improve Differentiation Process

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Further differentiate
Ideas to Improve Differentiation Process

1. Lower Starting Point
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Further **differentiate**
“Rather than focusing on how students need to change and improve, I learned to focus on how to improve lessons for students.”

Impact on My Teaching Practice
Thanks!

Dr. Grace, Critical Friends, all LTEC faculty and classmates, & SFUSD colleagues and students.

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Any Questions or Comments?