

Learning Principle

Presentation by Chris Harvey

Introduction

- A student named Rachel experiences cognitive disequilibrium.

Research Question

- “How much more comfortable are students explaining material they have learned conceptually compared to material they have learned procedurally?”

Literature Review

NCTM, 2000

- “Learning of mathematics with understanding” (p. 20).
 - factual knowledge
 - procedural proficiency
 - conceptual understanding
 - especially when judgements change about facts and procedures that are essential

NCTM, 2000

- Autonomous learners
 - define their own goals
 - monitor their own progress
 - reflect on their own thinking
 - learn from their own mistakes

Philipp & Vincent, 2003

- Students were found to have remembered and applied conceptual understanding better than procedural understanding
- Two lessons on the same material five weeks apart.
 - First lesson: procedure based.
 - Algorithm for converting mixed fractions to improper fractions.
 - Second lesson: concept based.
 - Pattern blocks.

Philipp & Vincent, 2003

- Post and Delayed Assessments
 - Post: immediately after each lesson
 - Delayed: three weeks after each lesson
 - Exact same assessment all four times
- The difference in average scores between post-procedural and delayed-procedural was far greater than the difference in average scores between post-conceptual and delayed-conceptual.

Philipp & Vincent, 2003

- Students will forever remember the procedures and algorithms they create for themselves
- Rachel says, “It stays there ‘cause I was the one who brought it there” (Video Clip 2).

Niess, Lee, & Kajder, 2008

- Psychological Theories of Learning
 - Behaviorist
 - Cognitive
 - Constructivism — most popular
 - personal or social constructivism
 - learning is an active role in the learner
 - building understanding
 - making sense

Niess, Lee, & Kajder, 2008

- Acronyms (e.g. PEMDAS) and procedures *without* connections focuses the learner on the algorithms involved rather than making sense.
- Many times, students will retrieve erroneous procedures, such as flipping the wrong fraction in “flip-and-multiply.”
- Learners may develop a fear or dislike for the subject, or the notion that it need not make sense.

Methods

Data Collection

- 16 student participants in Algebra II.
- Writing prompt. Students are to choose 2 topics they learned about this year and explain them to a sixth-grader.
- I can gain an understanding of how one learns by understanding how one teaches.

Data Analysis

- Grading Rubric
- Conceptual vs. Procedural
 - Conceptual: the student shows he / she knows the material and provides an informal proof of why or how it works
 - Procedural: the student explains a procedure or method of how to calculate or use the material
- Level of comfort: students chose #1 to be the concept they are very familiar with, while #2 is one they are not as familiar with.

Findings

“Very Comfortable” Topics

- order of operations ×6
- binomial multiplication (FOIL), factoring integers, factoring quadratic trinomials
- polynomial parent functions, definition of function, graphing linear equations, slope of a line, graphing ellipses
- absolute value

“Not so Comfortable” Topics

- graphing circles $\times 3$, conic sections
- slope $\times 2$
- factoring quadratic trinomials $\times 3$, difference of squares
- adding rational expressions $\times 2$
- synthetic division
- exponential growth & decay
- calculating square roots
- the number i

Procedure vs. Concept

- 16 participants
- 15 demonstrated either “procedural understanding” or “conceptual understanding” in the first topic
 - 7 were “procedural” and 8 were “conceptual”
- 15 demonstrated either “procedural understanding” or “conceptual understanding” in the second topic
 - 8 were “procedural” and 7 were “conceptual”
- Results were about half and half.

Conclusions

Conclusions

- The way students understand a topic does not seem to affect their comfort level of explaining it.

References

- The National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.
- Niess, M. L., Lee, J. K., & Kajder, S. B. (2008). *Guiding learning with technology* (pp. 34–50). Hoboken, NJ: John Wiley & Sons, Inc.
- Philipp, R. A., & Vincent, C. (2003). Reflecting on learning fractions without understanding. *On Math*, 2(2). Retrieved from http://www.nctm.org/eresources/view_article.asp?article_id=6430.

Endnotes

- The study by Philipp and Vincent (2003) is an online article and can be found at http://www.nctm.org/eresources/view_article.asp?article_id=6430. The hyperlinks to the video clips on this web page are broken. The video clips can be accessed at the following URLs:
 1. Video Clip 1: http://www.nctm.org/eresources/view_article.asp?article_id=6430&page=11&add=Y
 2. Video Clip 2: http://www.nctm.org/eresources/view_article.asp?article_id=6430&page=12&add=Y
 3. Video Clip 3: http://www.nctm.org/eresources/view_article.asp?article_id=6430&page=13&add=Y
 4. Video Clip 4: http://www.nctm.org/eresources/view_article.asp?article_id=6430&page=14&add=Y
 5. Video Clip 5: http://www.nctm.org/eresources/view_article.asp?article_id=6430&page=15&add=Y
 6. Video Clip 6: http://www.nctm.org/eresources/view_article.asp?article_id=6430&page=16&add=Y
 7. Video Clip 7: http://www.nctm.org/eresources/view_article.asp?article_id=6430&page=17&add=Y