Can Inquiry-Based Learning Augment Computer-Assisted Instruction in Developmental Algebra?

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Where to Get More Information

- http://www.math.uab.edu/GBMP/
- http://gbmp.mspnet.org/index.cfm/

Computer Assisted Instruction

- PROS
    - Actively engaged with material
    - More time spent on task
    - On-demand help in lab
    - High tech and high touch

- CONS
    - Algorithmic learning
    - Emphasis on memorization
    - Computation rather than thought
    - Tenuous connection with Quantitative Literacy

Audience for Basic Algebra (MA 098)

- Developmental Course (Non-Credit)
- General studies students
- Liberal arts students
- Pre-service elementary teachers
  - Take four 3-credit hour courses
  - Sometimes MA 098 first

Comparative Study, Fall 2010 MA 098 Class Formats

- Same computer assisted lab instruction
  - Determines 79% of final grade
- Three different treatment groups
  - *(LL) Lecture:* Traditional lectures on up-coming material twice weekly
  - *(GG) Group:* Inquiry-based group work with no prior instruction twice weekly
  - *(GL) Blended:* One lecture meeting and one inquiry-based meeting weekly
- Quasi-experimental: random assignment of students to class formats

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5.6 Example 7: A truck travels 120 miles on the highway in the same amount of time it takes to travel 40 miles in the city. If the rate that the truck is traveling in the city is 30 miles per hour slower than on the highway, find the rates at which the truck was traveling both on the highway and in the city.

	Distance	Rate
Highway	120	R
City	40	R – 30

Since the times are equal, we can solve this by setting the ratios equal to each other (a proportion.)

$$\frac{120}{R} = \frac{40}{R - 30}$$
$$120(R - 30) = 40R$$
$$120R - 3600 = 40R$$
$$120R - 40R = 3600$$
$$80R = 3600$$
$$R = 45$$

The truck is traveling 45 mph on the highway and 15 miles per hour in the city.

5.6 Example 7: A truck travels 120 miles on the highway in the same amount of time it takes to travel 40 miles in the city. If the rate that the truck is traveling in the city is 30 miles per hour slower than on the highway, find the rates at which the truck was traveling both on the highway and in the city.

Comparative Study Students

- Students register for one of three time slots (Section)
  - 9 AM - MWF, 10 AM - MWF, 12 Noon - MWF
- Section split into 3 subsections
  - Students randomly assigned to subsection
- Each subsection at same time slot receives different treatment

Comparative Study Design

- Three instructor/teaching assistant pairs
- Each pair teaches three time slots
- Each pair implements each treatment

♣	♦	♥
♥	♣	♦
♦	♥	♣

Comparative Study Measurements

- Content pre-test and post-test
  - Part I: Three open-ended questions, rated blind according to rubric on
    - Conceptual understanding 0-1-2
    - Problem-solving 0-1-2
    - Explanation 0-1-2
    - Accuracy 0-1-2
  - Part II: Objective Test (25 questions)
- Course assessments (grades)
  - Sum of first four of five tests
  - Maximum value 520

Comparative Study Hypotheses

- Hypothesis 1: Grades will be similar regardless of treatment (as measured by computerized test sum)

- Hypothesis 2: Group work treatments will have differentially improved problem-solving and communication skills (as measured by Rubric-Graded Part I, Pre/Post-Test)

- Hypothesis 3: Group work treatments will have differentially improved accuracy (as measured by Objective Part II, Pre/Post-Test)

Summary of Results

- Hypothesis 1 supported:
no significant difference in test grades

- Hypotheses 2 supported:
significant differences in favor of group treatments on pre-test to post-test gains

- Hypothesis 3 not supported:
no significant difference in accuracy

Statistical details to follow ---->

Data Supporting Hypothesis 1

- All treatments had similar grades for sum of first four (of five) tests

TestSum
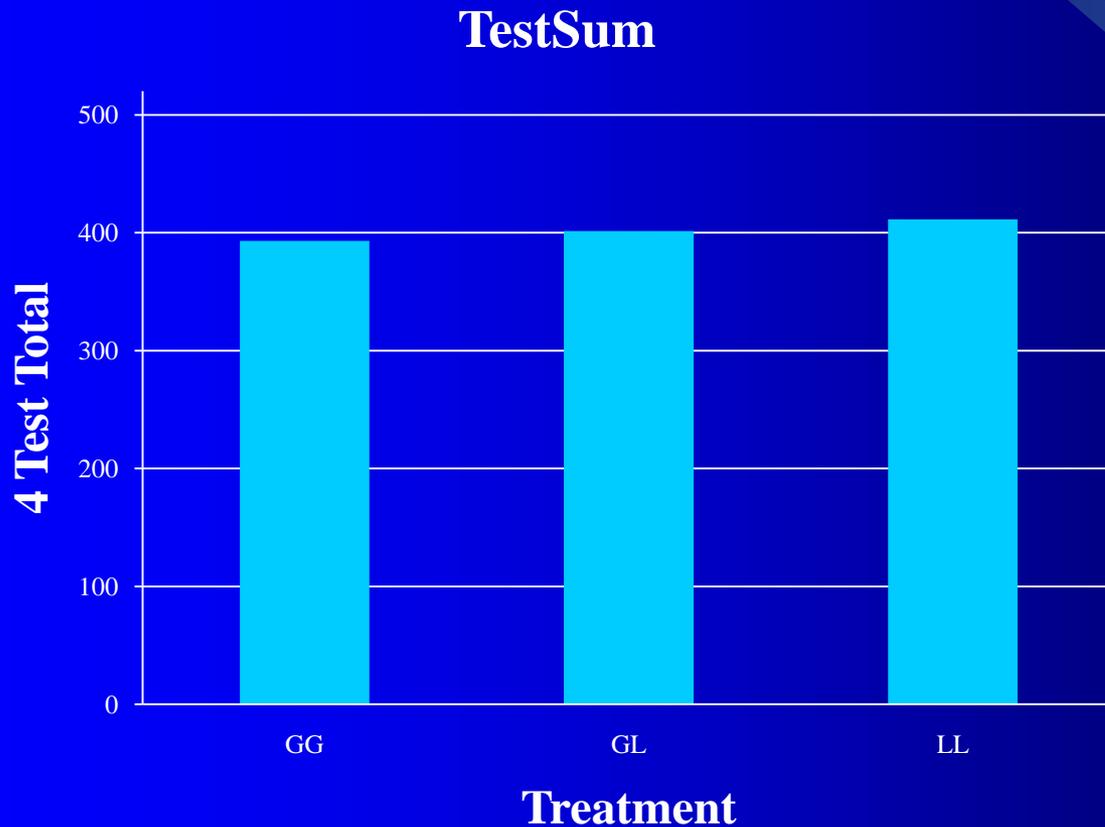
N=315
GG=100
GL=106
LL=109
No significant differences on sum of tests, nor any single test.

Pre-Test and Post-Test

Part I

- Three questions
  - Constructed response
- Scored with same rubric used to score individual reports on group work
  - Conceptual understanding 0-1-2
  - Problem-solving 0-1-2
  - Explanation 0-1-2
  - Accuracy 0-1-2
- Maximum value 24

Part II

- Objective test
- 25 questions
- Multiple choice, yes/no, and always/sometimes/never.
- Maximum value 25
- Expected value 10.38

Support for Hypothesis 2
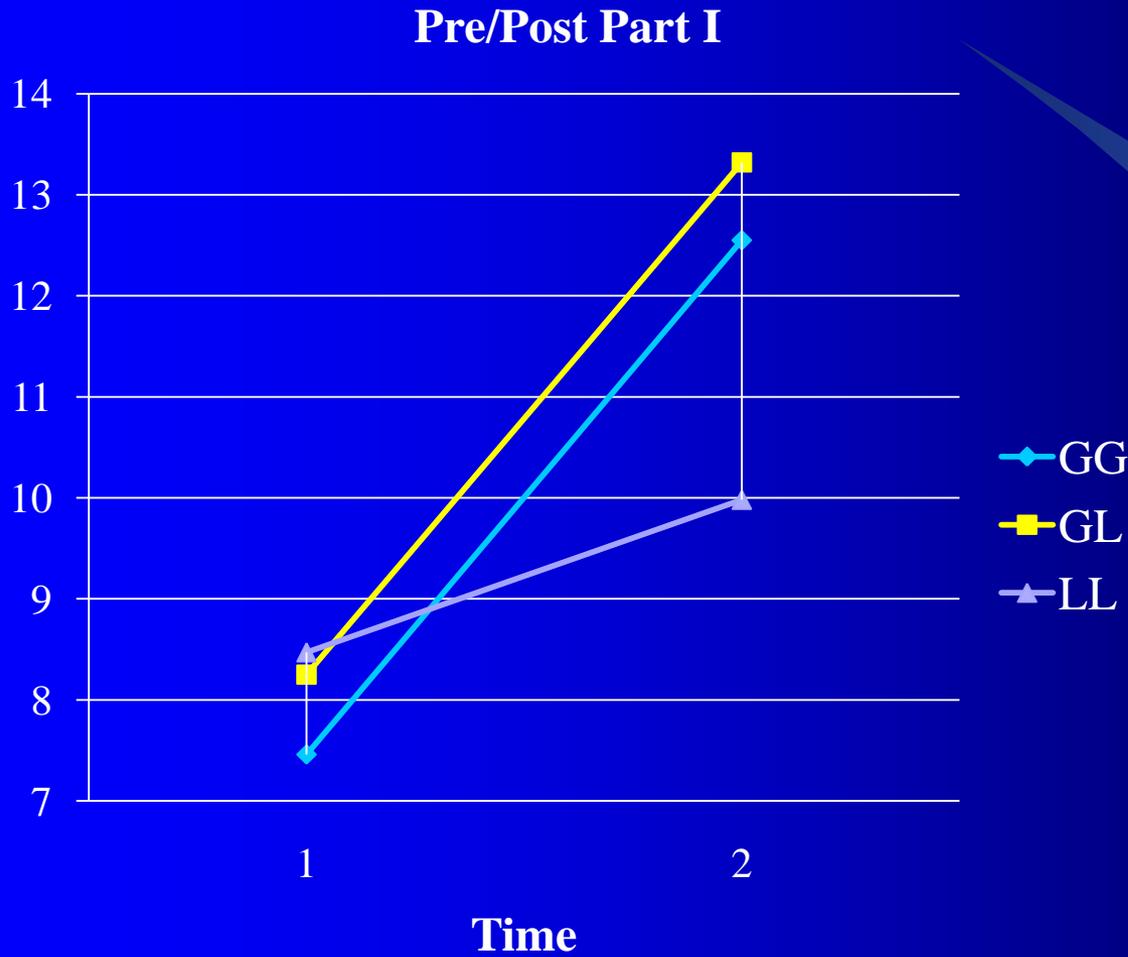
Pre/Post Part I

N=272
GG =85
GL =93
LL =94
Significant difference (p<0.05) in favor of both Group treatments.
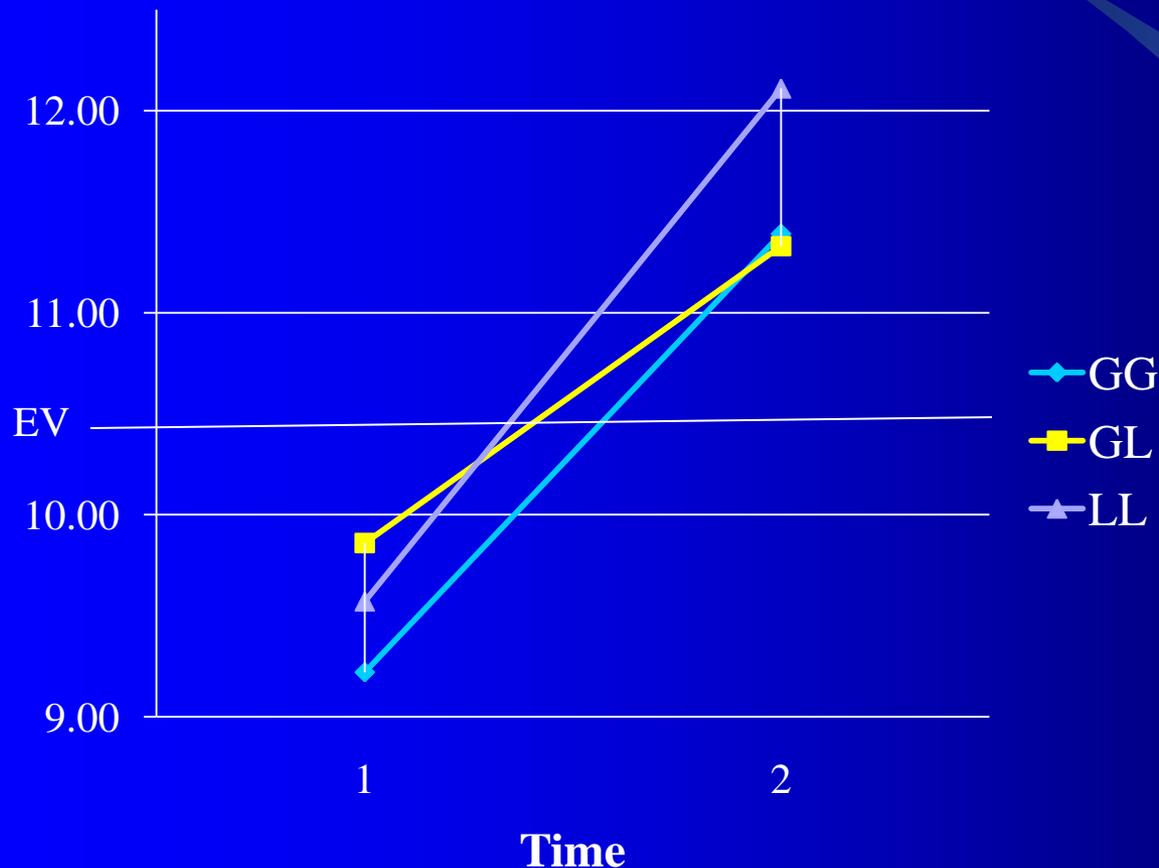Wilks Lambda
Time: λ=0.690
Time*Treatment: λ=0.921

Objective Accuracy Analysis

- Part II of Pre/Post-test
  - Objective test
  - Maximum value 25
  - Expected value 10.38
- Significant effect pre- to post- for all treatments taken together and for each treatment individually
- No significant difference among treatments

Objective Accuracy Analysis

Pre/Post Part II

N=273
GG =88
GL =91
LL =94
Significant Time effect (p<0.05) for all treatments: Wilks Lambda λ=0.690.
No significant Time*Treatment effect.

Objective Accuracy Analysis

Treatment	Mean		Standard Deviation		Effect Size
	Pre	Post	Pre	Post	
GG	9.22	11.39	3.02	2.98	0.72
GL	9.86	11.33	3.44	3.38	0.43
LL	9.57	12.11	3.00	3.32	0.84

Limitations

- Rater training on rubric
  - Only moderate --- 8 raters working in pairs
- Accuracy gain on post-test low
  - Less than one standard deviation from expected value
- Unit of significance
  - Student versus class
  - Correlation of variance because of a common experience
  - Theory versus practice --- suppression of differences

Conclusions

- The inclusion of group work class meetings in lieu of lecture does not appear to affect adversely student success as measured by grades

- Inquiry-based group work does have a positive effect on problem-solving and communications abilities

- Inquiry-based group work does not appear to affect accuracy

- Two group work sessions do not appear to be significantly better than one per week

Questions

- Is it cost effective to use the group treatment as opposed to the blended treatment?

- How did the students feel about the treatment they received?

- How well did students in different treatments involve themselves during class?

Where to Get More Information about GBMP

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