Blending Inquiry-Based Learning and Computer Assisted Instruction in Algebra

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Greater Birmingham Mathematics Partnership
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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

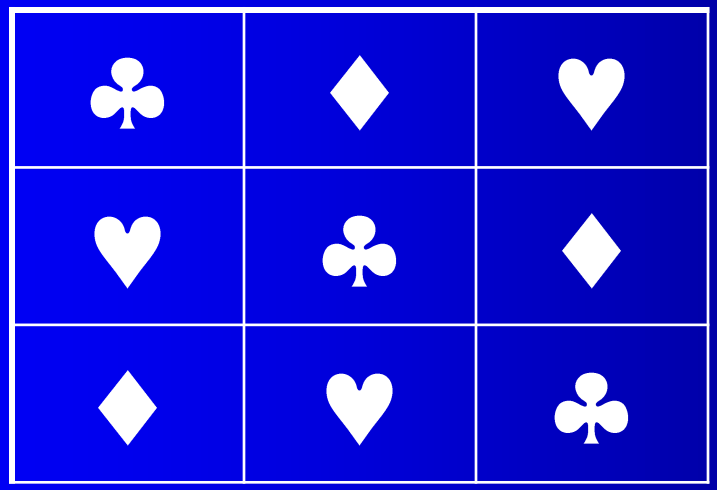
- Same computer assisted lab instruction
  - Determines 79% of final grade
- Three different treatment groups
  - *(LL) Lecture:* Traditional lectures on up-coming material twice weekly
  - *(GG) Group:* Inquiry-based group work with no prior instruction twice weekly
  - *(GL) Blended:* One lecture meeting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

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

UAB - Math Scoring Guide

	Conceptual Understanding: *Interpreting the concepts of the task and translating them into mathematics*	**Evidence Of Problem Solving:** *Choosing strategies that can work, and then carrying out the strategies chosen.*
2	The translation of the task into adequate mathematical concepts using relevant information is completed	Pictures, models, diagrams, symbols, and/or words used to solve the task are complete
1	The translation of the major concepts of the task is partially completed and/or partially displayed	Pictures, models, diagrams, symbols, and/or words used to solve the task may be only partially useful and/or partially recorded.
0	Does not achieve minimal requirements for 1 point	Does not achieve minimal requirements for 1 point

UAB - Math Scoring Guide

	Explanation: *Using pictures, symbols, and/or vocabulary to convey the path to the identified solution*	**Accuracy:** *Providing a complete and accurate solution appropriate for the given problem*
2	Explanation is clear and complete	Solution is correct and complete with no errors
1	The explanation is partially complete and/or partially developed with gaps that have to be inferred	Solution is appropriate and demonstrates understanding, but is either not quite complete or contains minor errors
0	Does not achieve minimal requirements for 1 point	Does not achieve minimal requirements for 1 point

Adapted from the Oregon Department of Education's 1995-2003 statewide assessments

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)

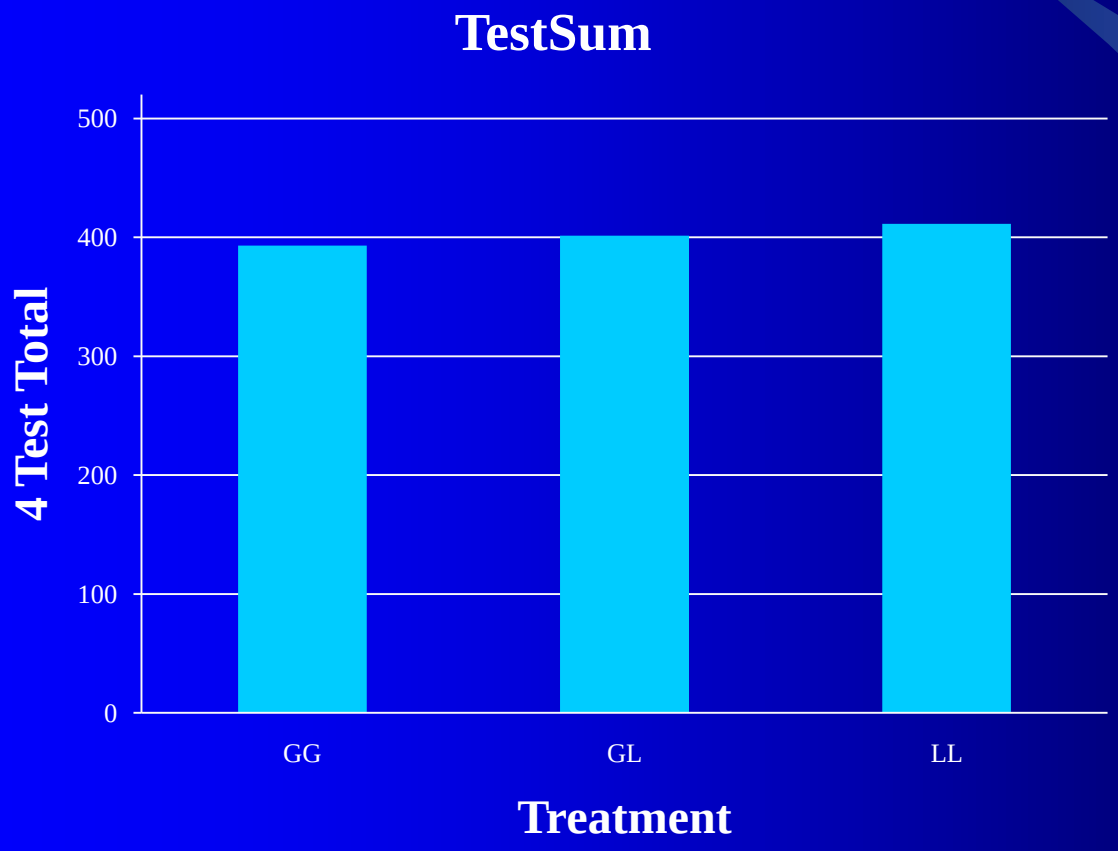
Summary of Results

- 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



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

Pre-Test and Post-Test

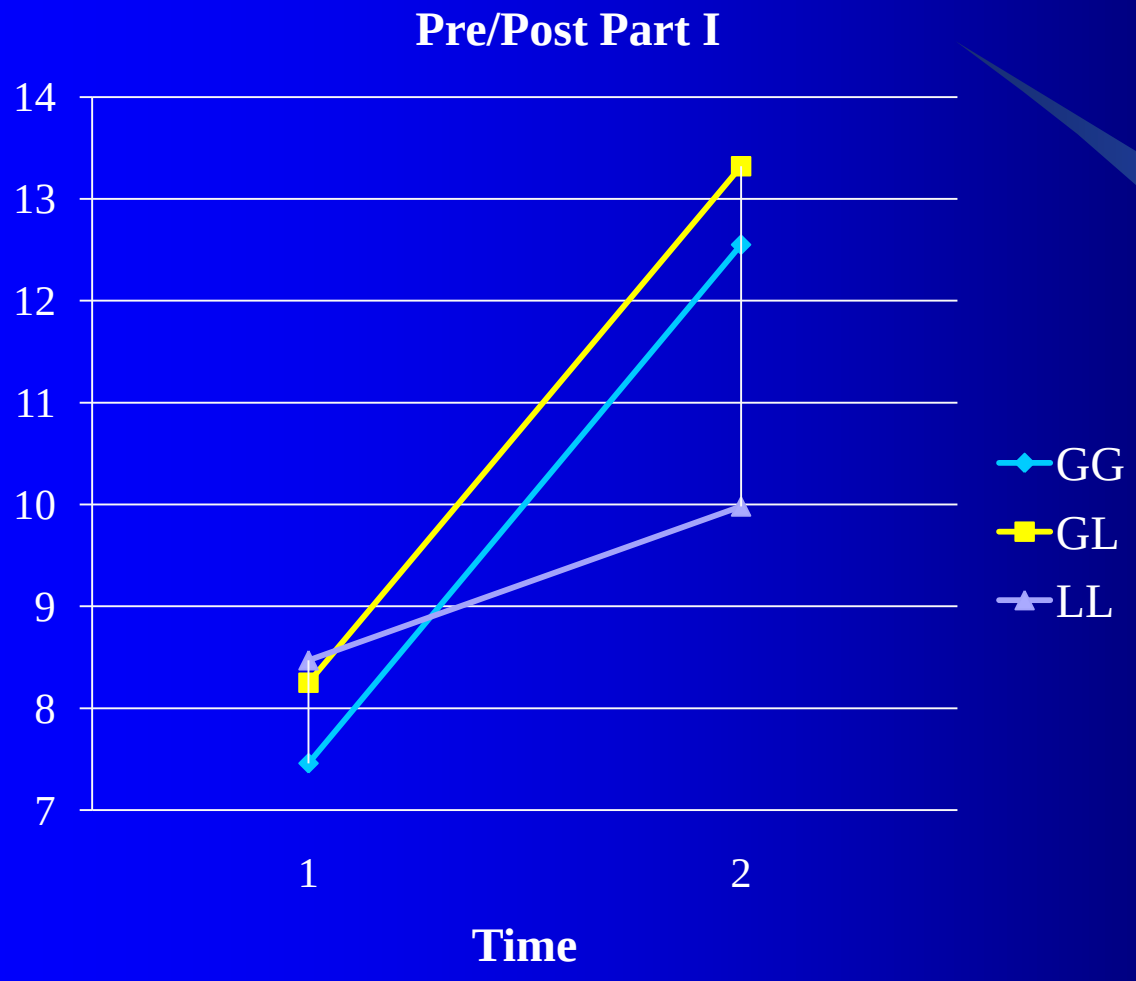
Part I

- 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

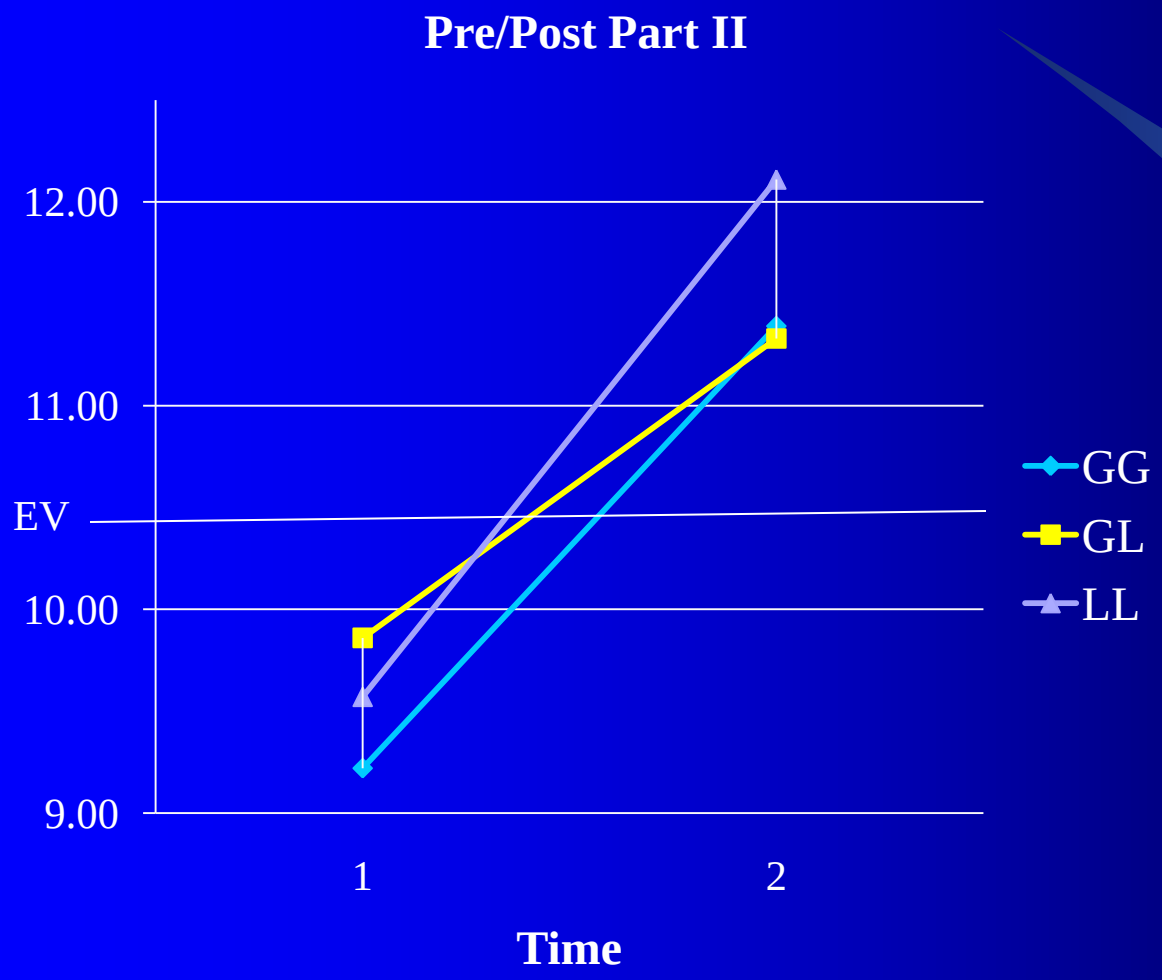


N=272
GG =85
GL =93
LL =94
Significant difference ($p<0.05$) in favor of both Group treatments.
Wilks Lambda
Time: $\lambda=0.690$
Time*Treatment: $\lambda=0.921$

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



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

Objective Accuracy Analysis

	Mean		Standard Deviation		Effect Size
Treatment	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

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