Comparison of Inquiry-Based Class Sessions and Lectures in the Context of Computer Assisted Algebra Instruction

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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/

Active Learning – Computer: All Pre-Calculus Classes at UAB

- 1/3: One class meeting per week
  - What do we do with this class meeting?
- 2/3: Assigned and self-selected time in Mathematics Learning Lab (MLL)
- Assessment
  - Attendance (class & lab) (14-21%)
  - 20-30 homework problems per week (7-10%)
  - Weekly quiz (7-10%)
  - Four tests per semester (and final) (60-70%)
- Variety of assistance on computer and in lab

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 2009 MA 098 Class Formats

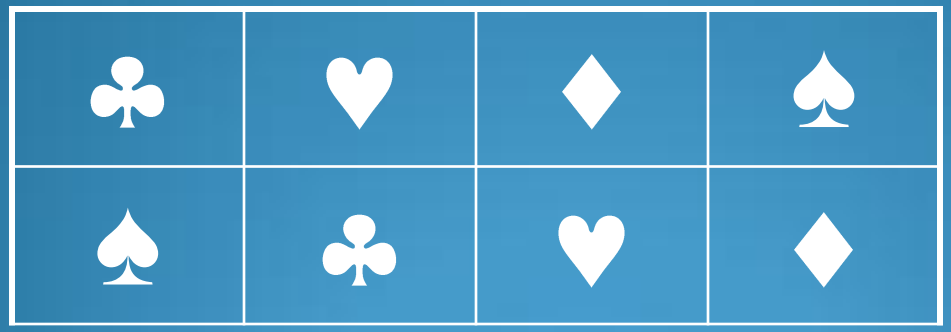
- Same computer assisted lab instruction
  - Determines 79% of final grade
- Two different treatment groups
  - *Lecture:* Traditional lecture on up-coming material
  - *Group:* Inquiry-based group work with no prior instruction
- Quasi-experimental: random assignment of students to class formats

Comparative Study Students

- Students register for one of four time slots (Section)
  - 9 AM - MW, 9 AM - TT,
    10 AM - TT, 12 Noon - MW
- Section split into 2 subsections
  - Students randomly assigned to subsection
- Each subsection at same time slot receives different treatment

Comparative Study Design

- Four instructor/teaching assistant pairs
- Each pair teaches two time slots
- Each pair implements each treatment



Comparative Study Measurements

- Content pre-test and post-test
  - Rated blind according to rubric on
    - Problem identification 0-1
    - Problem-solving 0-1-2
    - Explanation 0-1-2
    - Inter-rater reliability moderate
  - Accuracy 0-10
- Course assessments (grades)
  - Sum of first four of five tests.

Comparative Study Hypotheses

- Hypothesis 1: Grades will be similar regardless of treatment (as measured by computerized test sum)
- Hypothesis 2: Group work treatment will have differentially improved problem-solving and communication skills (as measured by rubric)

Summary of Results for 2009

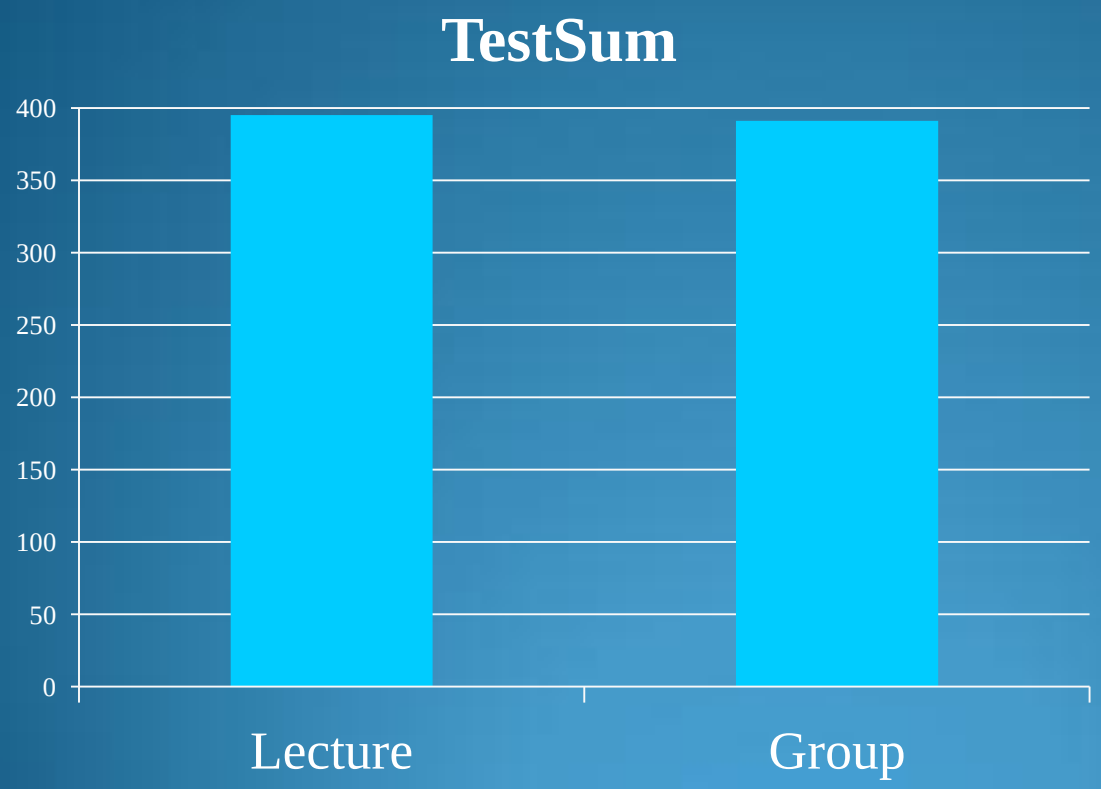
- Hypothesis 1 supported: no significant difference in test grades

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

Statistical details to follow ---->

Data Supporting Hypothesis 1

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

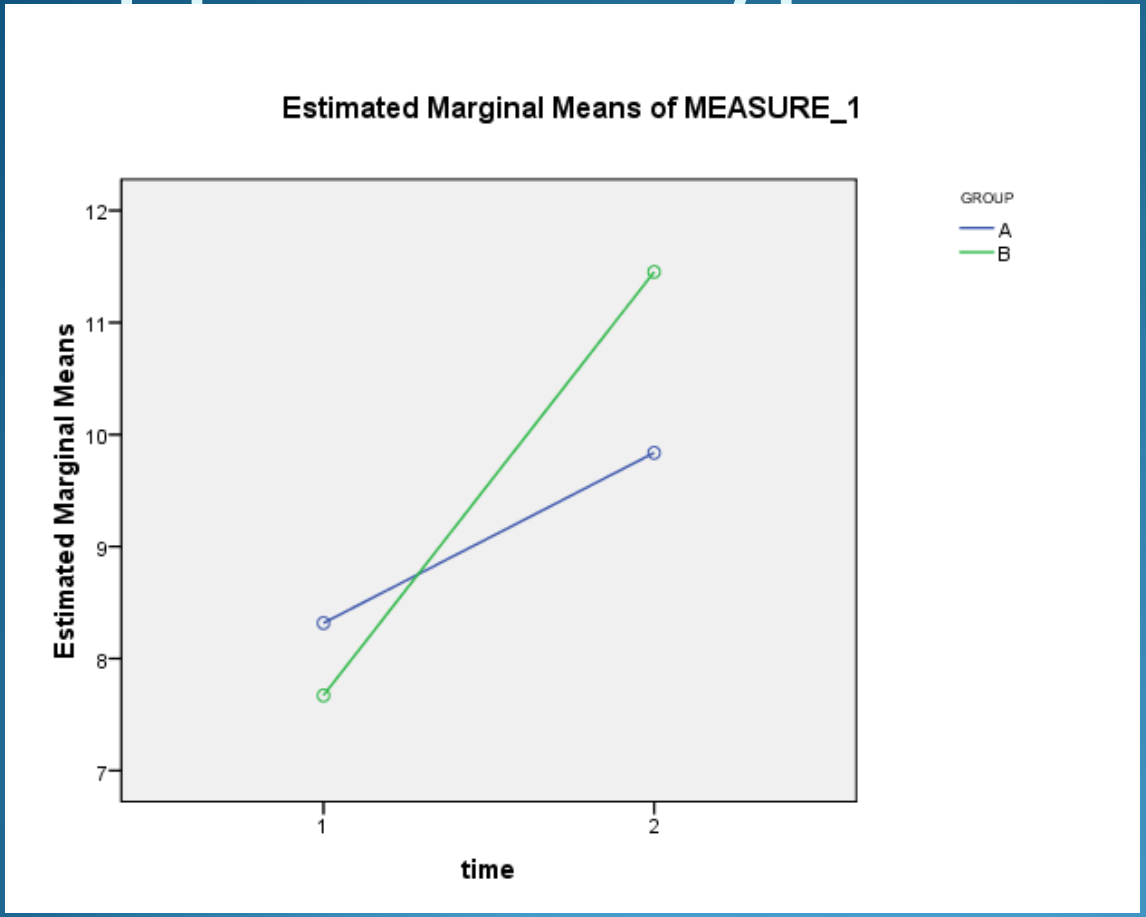


N=300
Lecture=149
Group=151
No significant differences on sum of tests, or any single test.

Pre-Test and Post-Test

- Four questions
  - Constructed response
- Scored with same rubric used to score individual reports on group work
  - Problem identification: 0 - 1
  - Problem-solving: 0 - 1 - 2
  - Explanation: 0 - 1 - 2
- Accuracy: 0 - 10

Support for Hypothesis 2

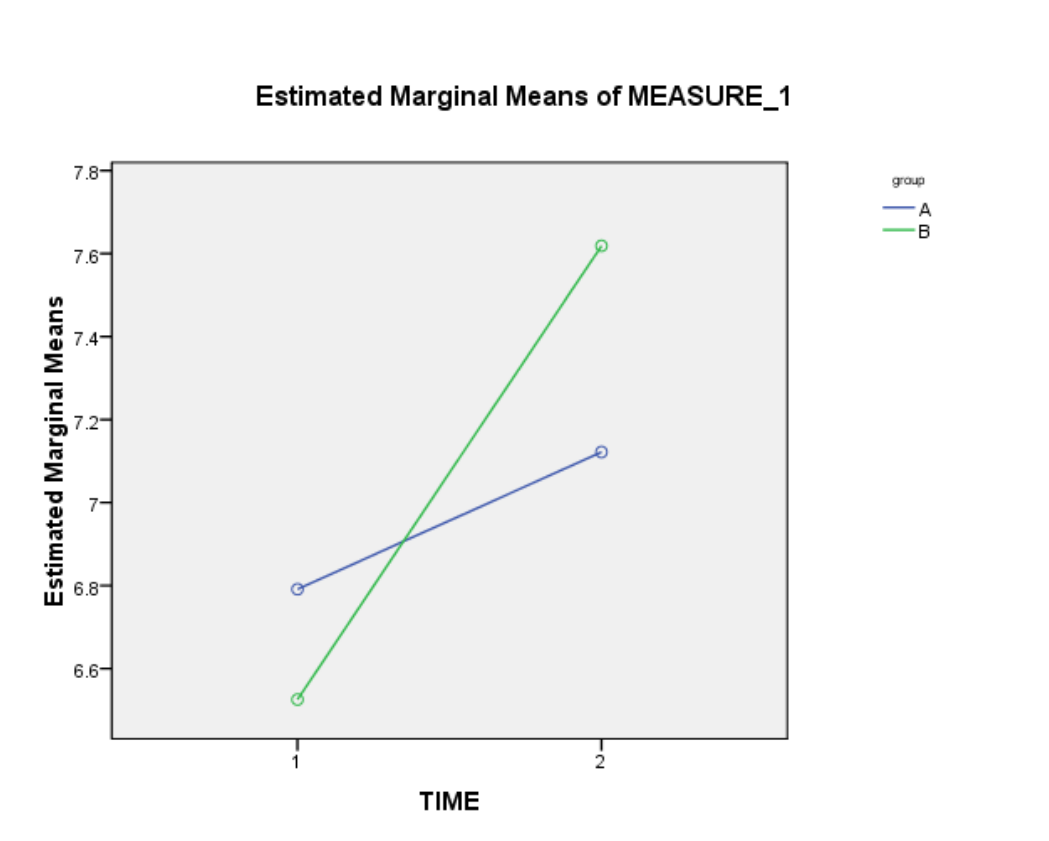


N=234
Lecture(A)=115
Group(B)=119
Significant difference ($p<0.05$) in favor of Group treatment.
Wilks Lambda
Time: $\lambda=0.562$
Time*Treatment: $\lambda=0.876$

Accuracy Analysis

- Pre- and Post-tests evaluated for accuracy of answers
- Scale of 0-10
  (some problems had multiple parts)
- Significant effect pre- to post- for all treatments taken together
- Significant difference in favor of group treatment

Accuracy Analysis 2009



Repeated Measures ANOVA

Significant difference ($p<0.05$) in favor of Group treatment.

Wilks' Lambda

Time: $\lambda=0.872$

Time*Treatment: $\lambda=0.960$

Comparative Study, Fall 2010 MA 098 Class Formats

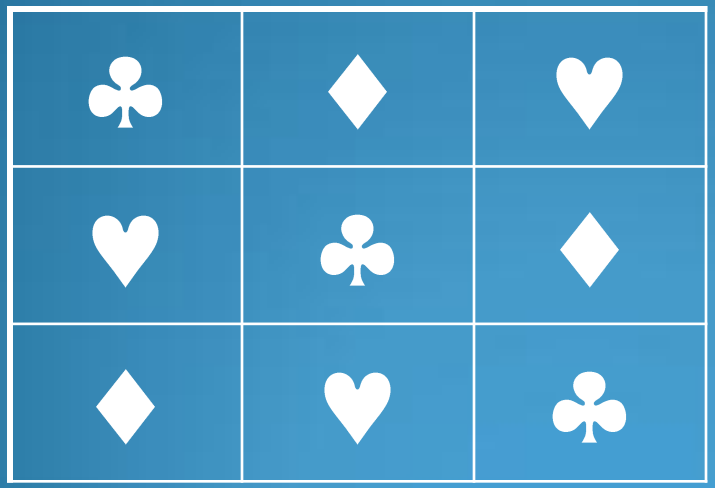
- Same computer assisted lab instruction
  - Determines 79% of final grade
- Three different treatment groups
  - *(LL) Lecture:* Traditional lectures on up-coming material twice weekly
  - *(GG) Group:* Inquiry-based group work with no prior instruction twice weekly
  - *(GL) Blended:* One lecture meeting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

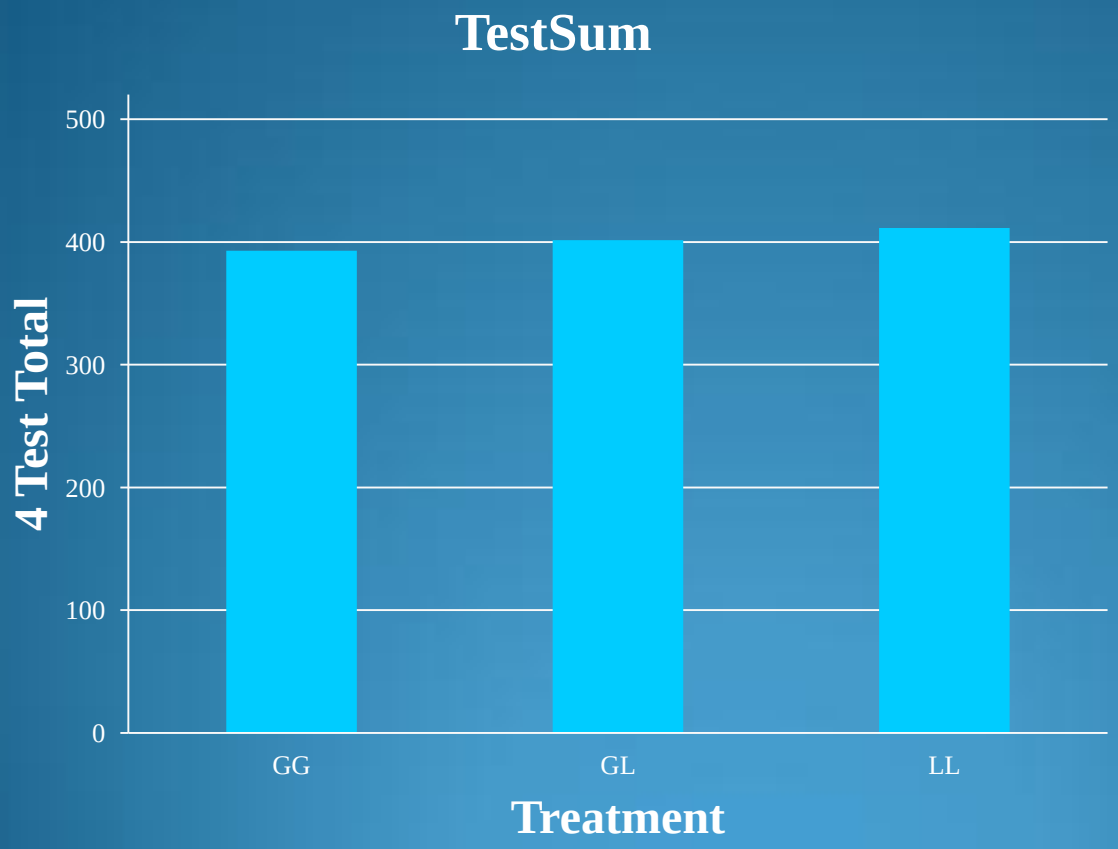
Summary of Results

- 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 2010

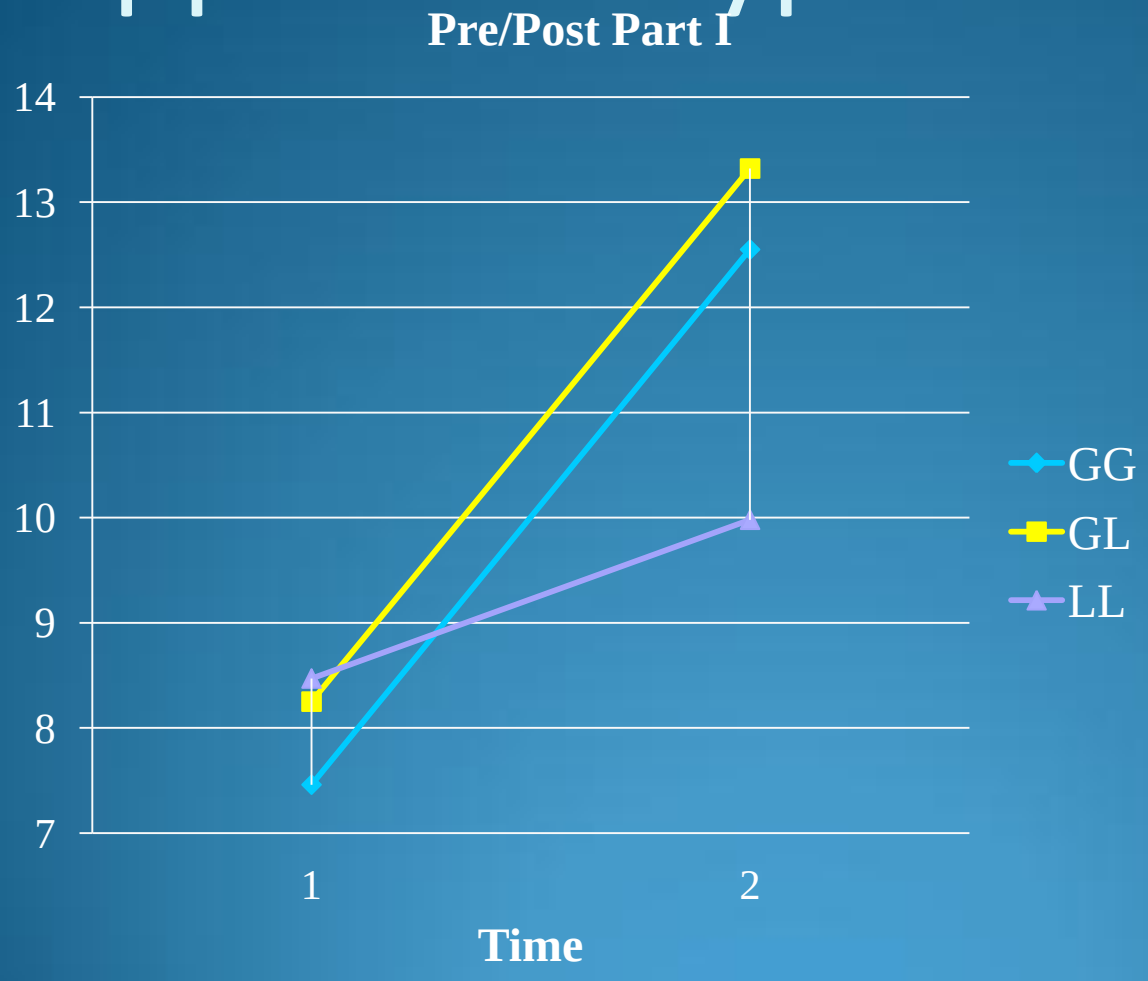
Part I

- 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

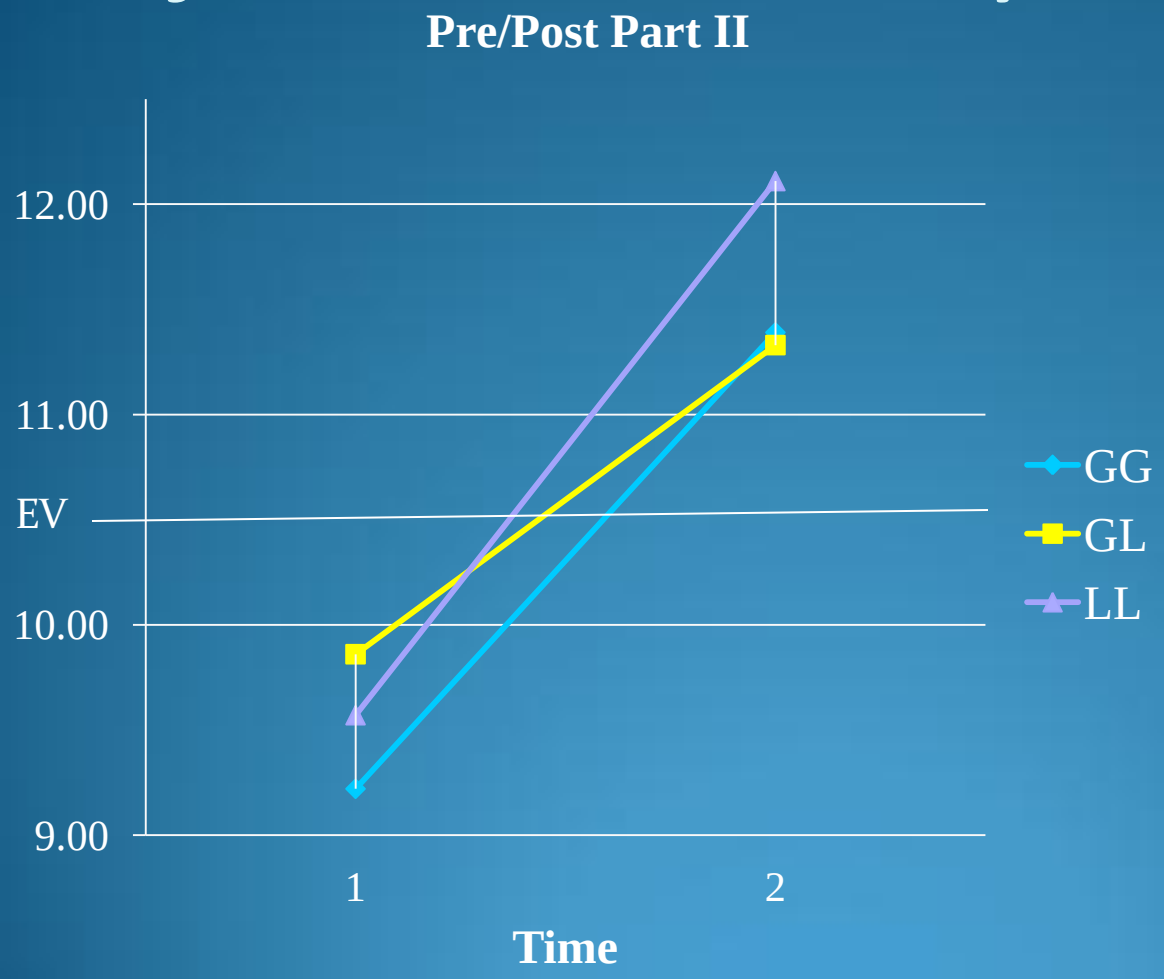


N=272
GG =85
GL =93
LL =94
Significant difference ($p<0.05$) in favor of both Group treatments.
Wilks Lambda
Time: $\lambda=0.690$
Time*Treatment: $\lambda=0.921$

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

Student success in subsequent courses for both cohorts

- Analysis of 2009 cohort and 2010 cohort were run separately
- Based on Student t test there were no significant differences between treatment groups for either cohort regarding student success in future courses (as measured by grade in the next course)

Further analysis on Success in subsequent courses for 2009 cohort

- After passing MA098 students have a choice of taking MA102 (pre-calculus algebra) taught with a lecture class meeting or MA110 (finite mathematics) taught with group work class meeting
- No significant differences were noted for the treatment groups of 2009 cohort even when separated by next course taken

Future Work

- Look at the differences between 2010 cohort by what course was taken next
- Add data from summer and fall 2011
- Track students over time depending on exposure to inquiry based classes

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 communication abilities

Current teaching approach at UAB to MA098

- Course is now taught with 3 contact hours
- 1 lab session
- 1 inquiry session (since evidence supported that it help improve communication skills)
- 1 lecture (since students were much more receptive to the course as a whole when it involved at least some lecture component)

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