After One Year of IRT What Have We Learned and Done?

Charles H. Atwood
and
Kimberly D. Schurmeier
Chemistry Department
University of Georgia
Athens, GA 30602

Outline of Presentation

- Brief description of IRT
- How we used IRT in CHEM 1211/1212
- What major topics have we identified as troublesome areas for students?
- Can we show any improvement?
- Where are we headed?
- Conclusion

Brief description of IRT

- Classical Test Theory (CTT)
  - Mean, median, mode
  - Discrimination Index
    - comparison of top and bottom quartiles
  - CTT is good for small samples
  - CTT is more dependent upon the subject group
    - Same assessment given to 2 groups will give different results

Brief description of IRT

- Item Response Theory (IRT)
  - More modern psychometric analysis tool than CTT
  - Works well for large sample sizes (> 200)
  - Iterative process which fits the students responses to a mathematical formula

$$P(\theta) = c + (1 - c)\frac{1}{1 + e^{-a(\theta - b)}}$$

θ = ability level

a = discrimination parameter

b = difficulty parameter

c = guessing parameter

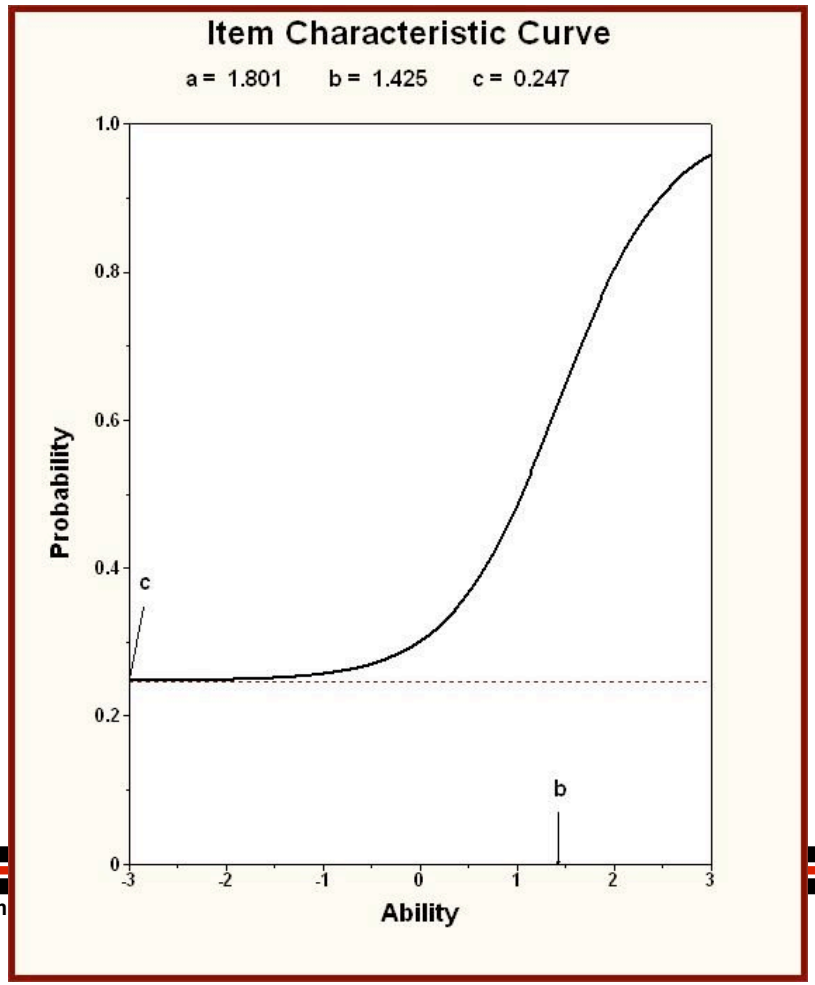
Brief description of IRT

- We use the program Bilog-MG3 to fit our data.
- Bilog-MG3 assigns to every test item values for a, b, and c and displays them on an item characteristic curve
  - Plot of the probability of a student with a given IRT ability vs. probability that the student answered the question

$$P(\theta) = \frac{(1 + c)}{2}$$

Brief description of IRT

- Item Characteristic Curve

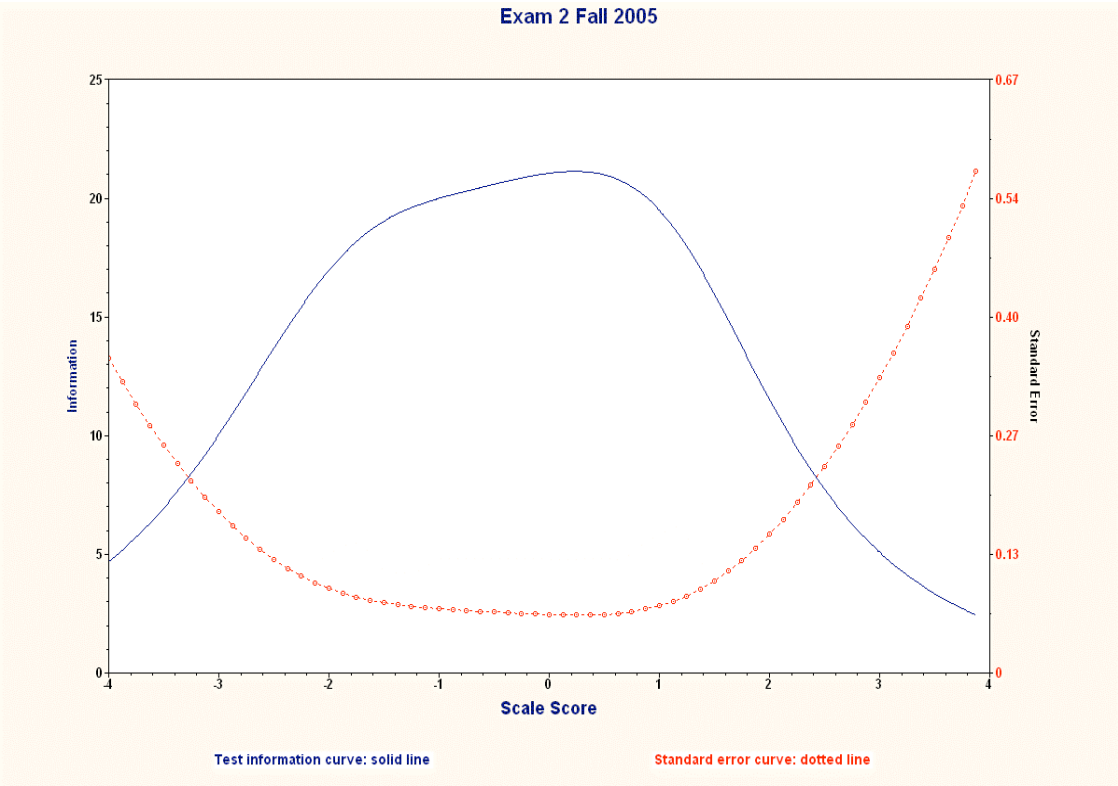


How we used it in CHEM 1211/1212

- Because we give our tests via computer, we have 6 years of data stored on the server.
  - Kim analyzed the old test data
    - Chose the highly discriminating test questions with a variety of abilities
    - Built all of the 2005-2006 tests based upon IRT analysis
      - Ideally the tests have
        - » 2 A-B discriminating questions
        - » 3 B-C discriminating questions
        - » 4 or 5 C-D discriminating questions
        - » Etc.

How we used IRT in CHEM 1211/1212

- We can tell if the tests are doing what we would like by looking at the test information curves

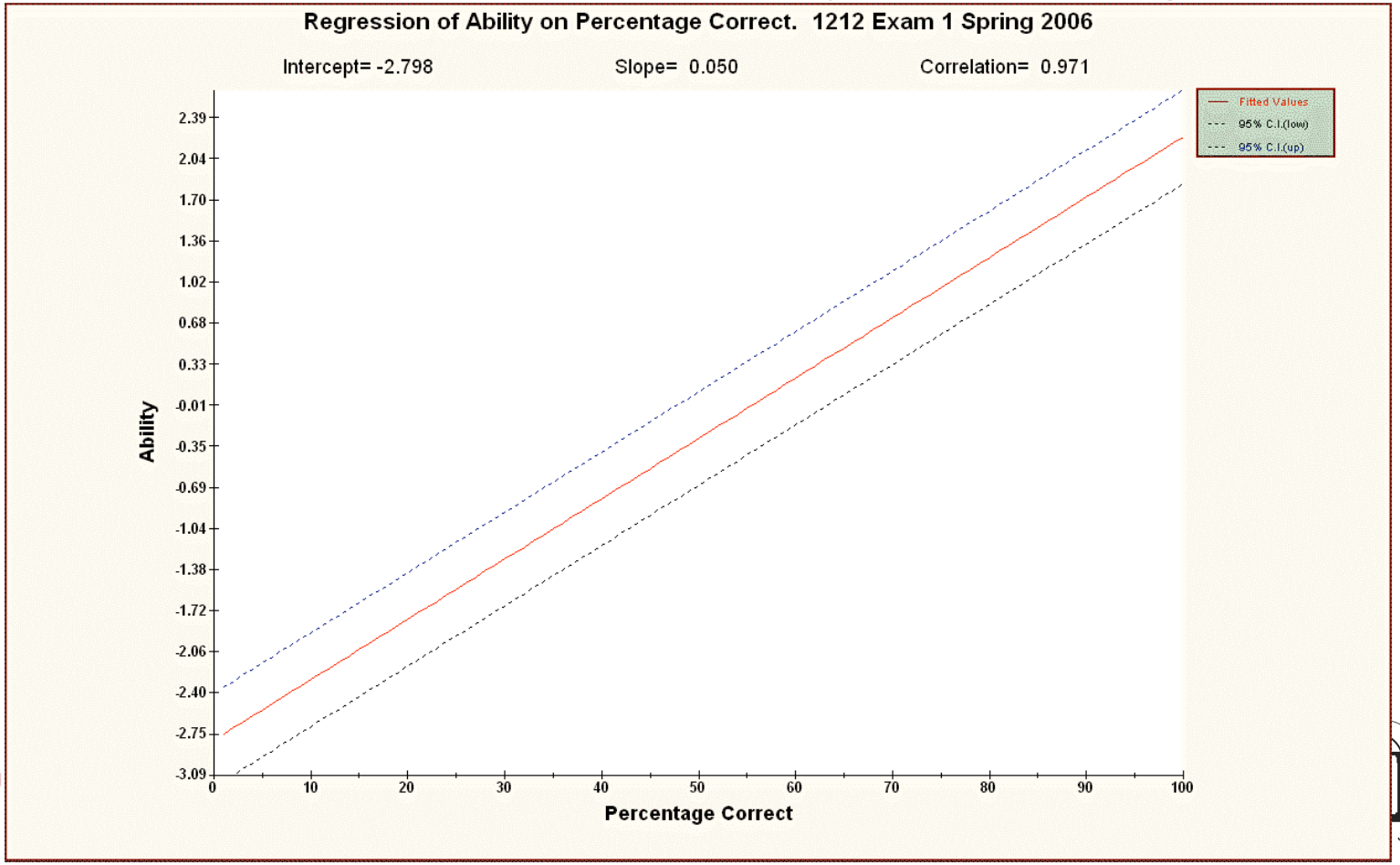


University of Georgi

1785

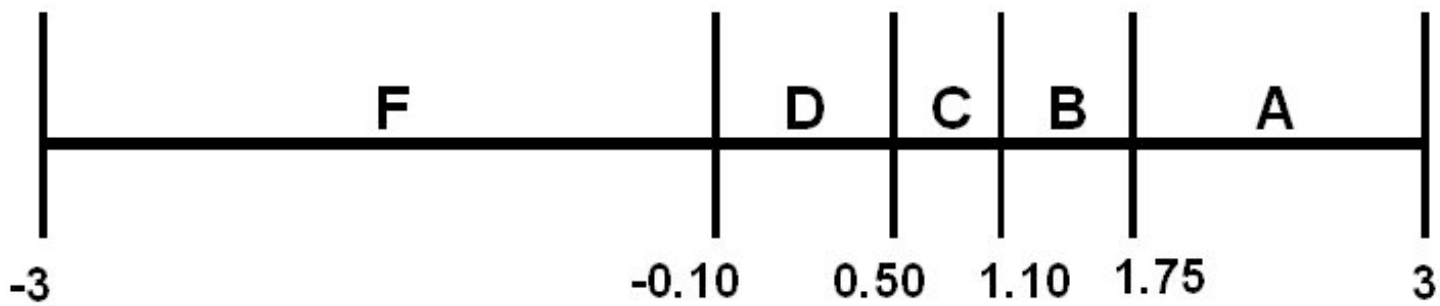
How we used IRT in CHEM 1211/1212

- Comparison of IRT ability vs. test grades



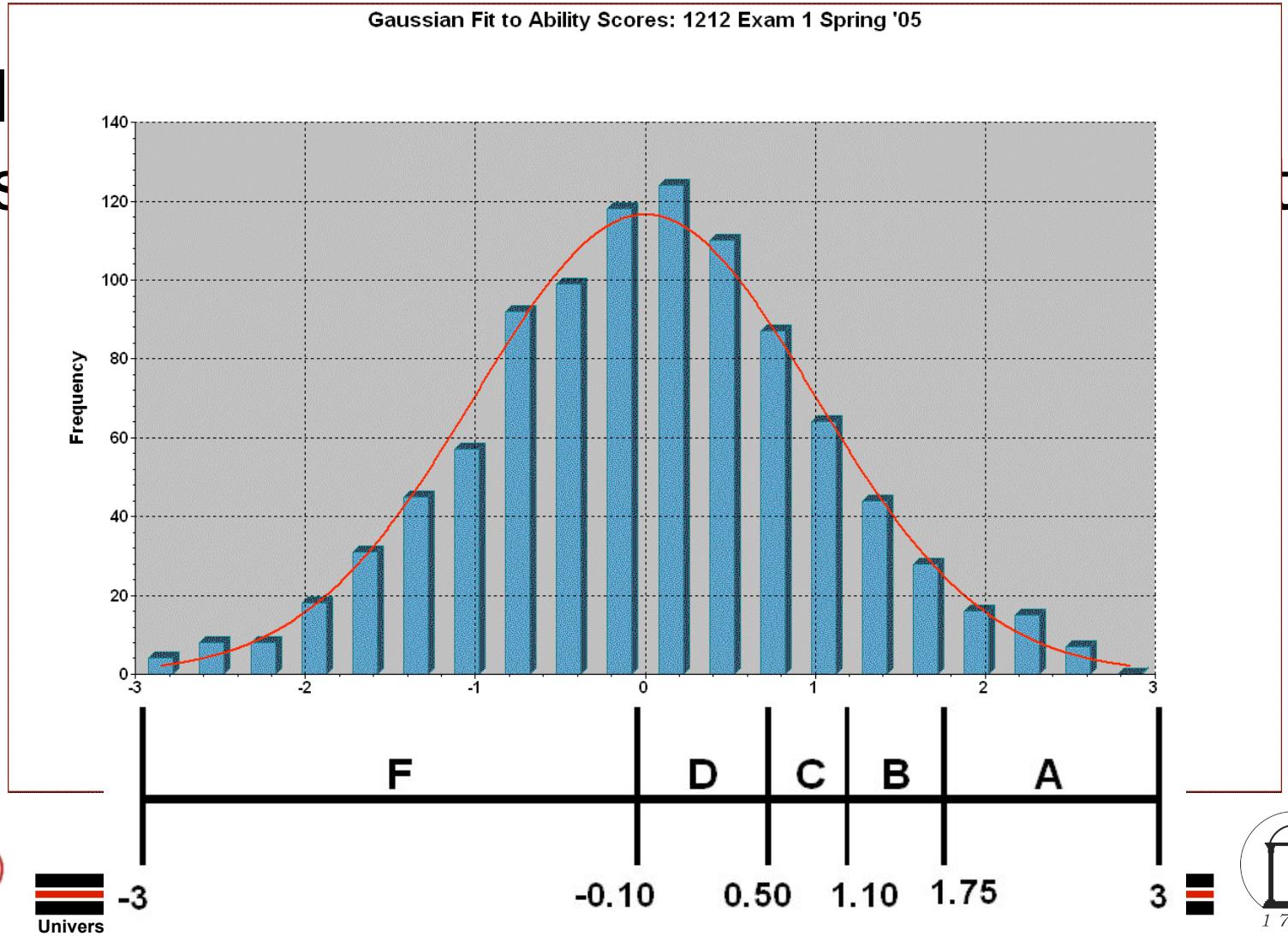
How we used IRT in CHEM 1211/1212

- Kim discovered that for the last 5, now 6, years the IRT ability required to achieve a particular grade in CHEM 1211/1212 has been essentially constant.
  - Unwittingly, we have developed an grading scale that appears to be consistent for the



How we used IRT in CHEM 1211/1212

- I
s



Univers

How we used IRT in CHEM 1211/1212

- After Spring Semester 2006, we went and looked at the test questions which had the highest discrimination and ability levels.
- From this analysis we discovered that there are several topics which cause the students the most difficulty for the entire year.

What major topics have we identified as troublesome areas for students?

1. Understanding the structure of ionic compounds
2. Unit conversion problems
   - Particularly converting from volume to area or height
3. Molecular polarity
4. Intermolecular forces
5. Understanding quantum numbers
6. Distinguishing the terms strong, weak, concentrated and dilute
7. Inorganic nomenclature

What major topics have we identified as troublesome areas for students?

- Understanding the structure of ionic compounds is crucial to student performance in 1211/1212
- This concept is essentially a gatekeeper.

What major topics have we identified as troublesome areas for students?

Fall 2005 Test 1

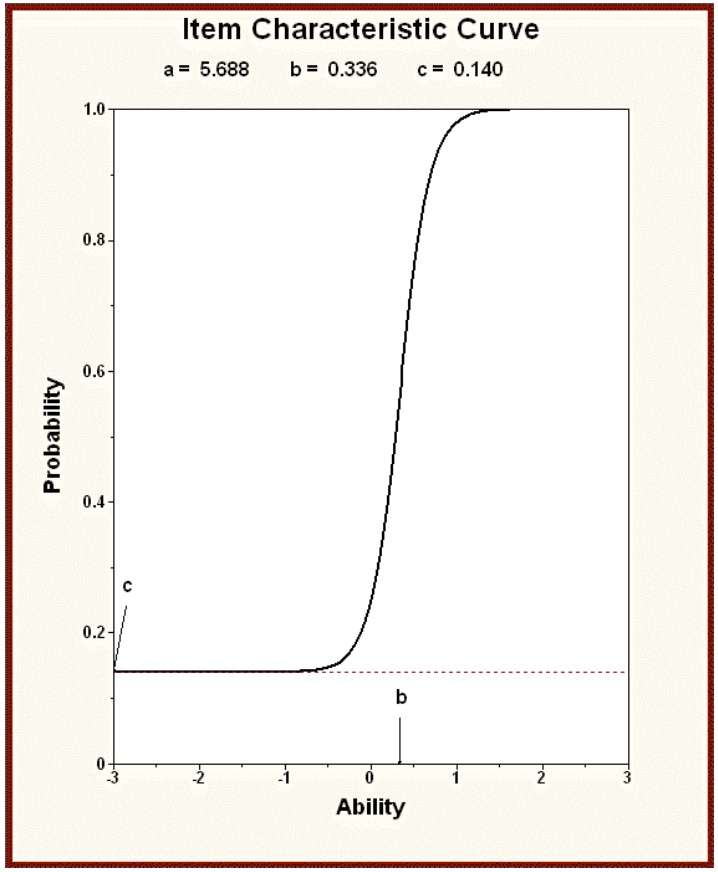
Question:

"What is the correct name of this ionic compound?" $Al(NO_3)_3$

aluminum nitrate

"How many ions are present in one formula unit of the compound shown above?"

4



Ability at 0.336

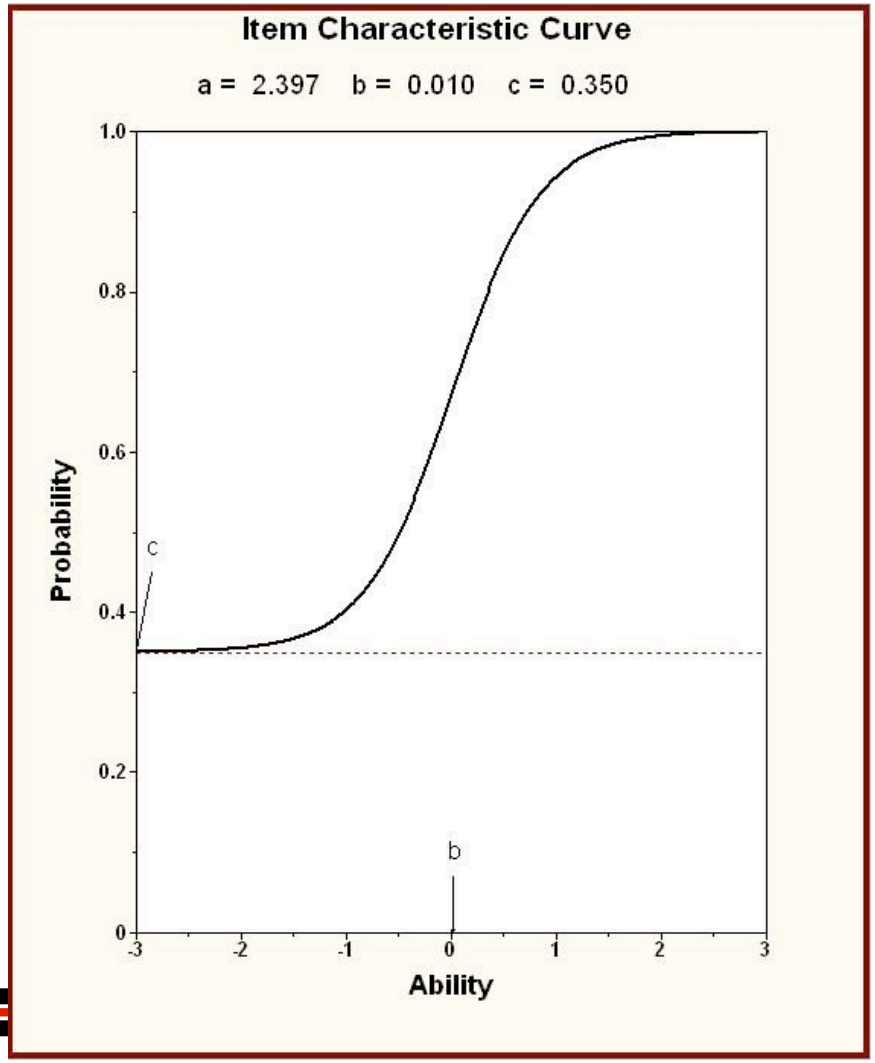
Discriminates between C and D students

What major topics have we identified as troublesome areas for students?

- Since understanding ions is so difficult and so crucial to success, we decided to tackle it first.
- Prior to start of Fall semester 2006
  - Teaching faculty meeting
  - Discussed difficult topics
  - Stressed that we must emphasize ions in lecture

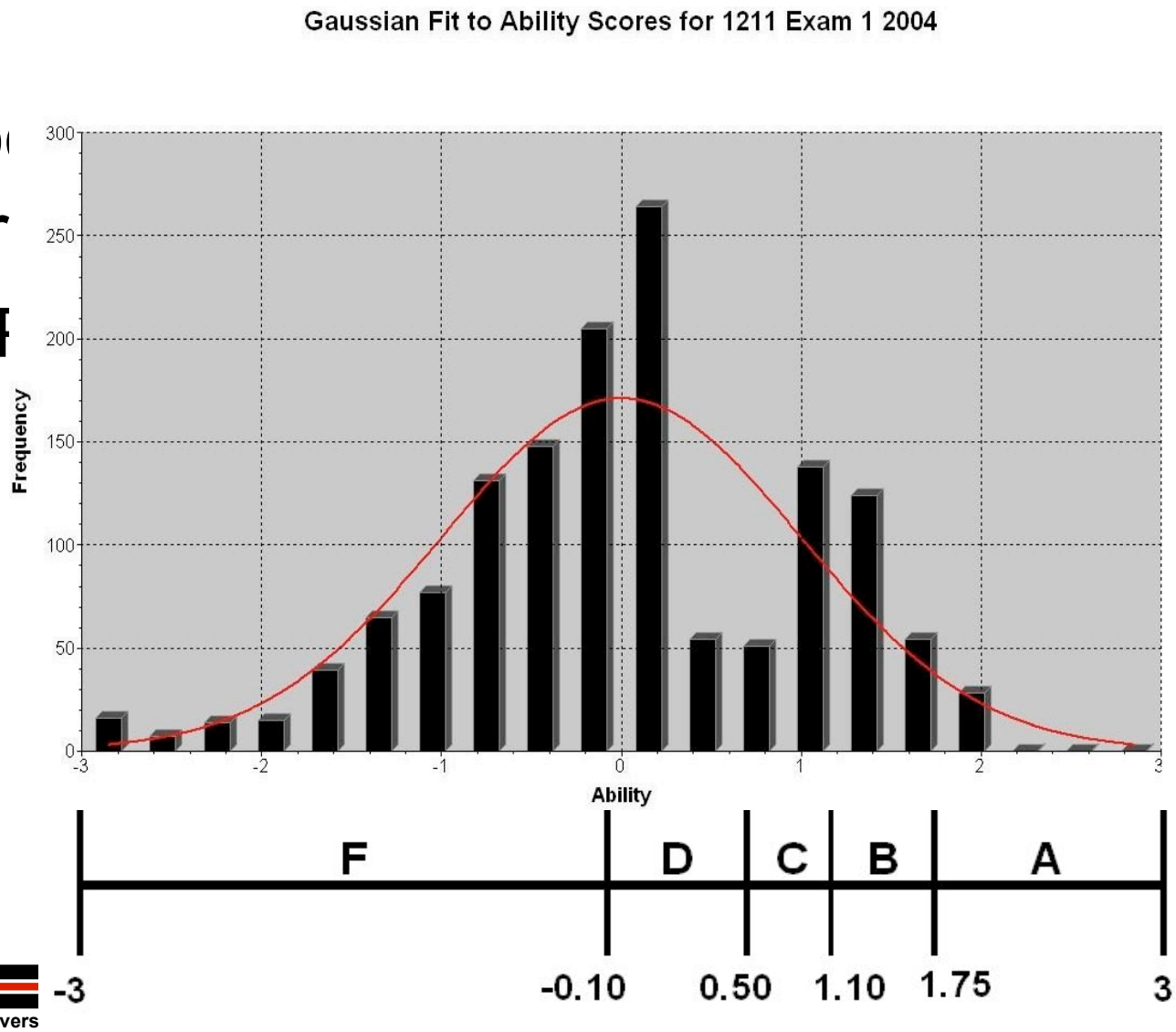
Can we show any improvement?

- Fall 2006 Test 1
- Question:
- "What is the correct name of this ionic compound?" $Al(NO_3)_3$
- **aluminum nitrate**
- "How many ions are present in one formula unit of the compound shown above?"
- **4**



Can we show any improvement?

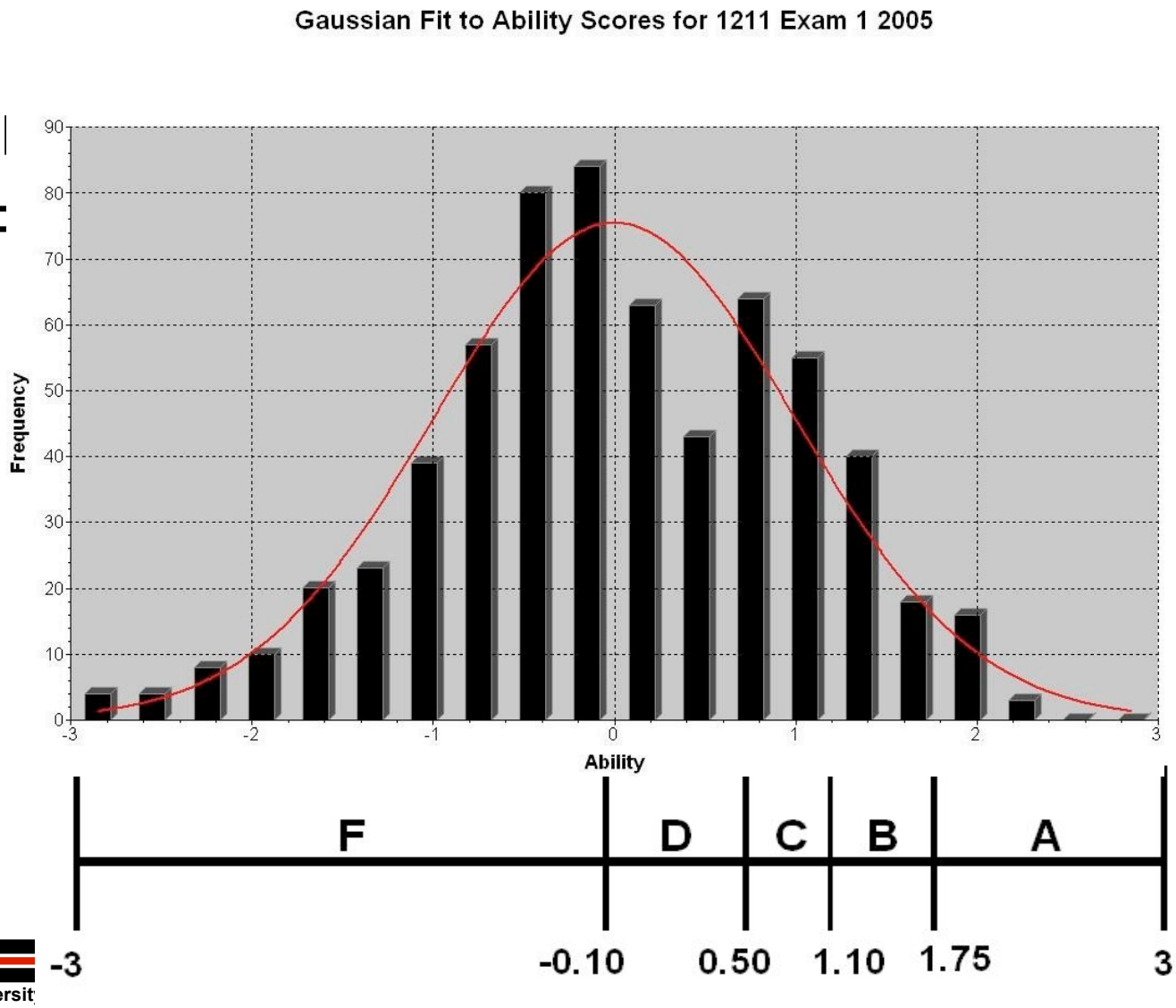
- Lo cores for
  - F



Univers

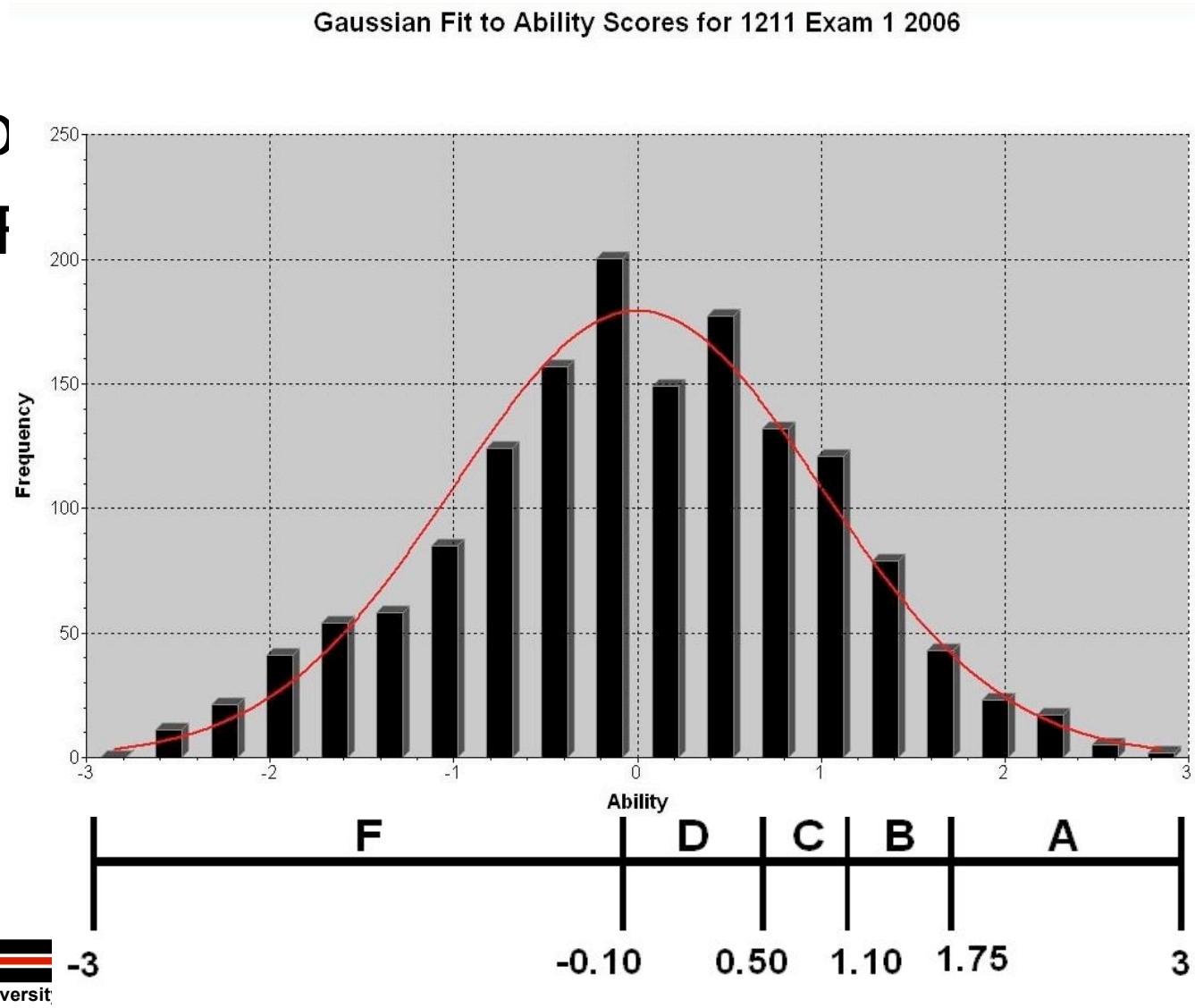
Can we show any improvement?

- Co
  - F



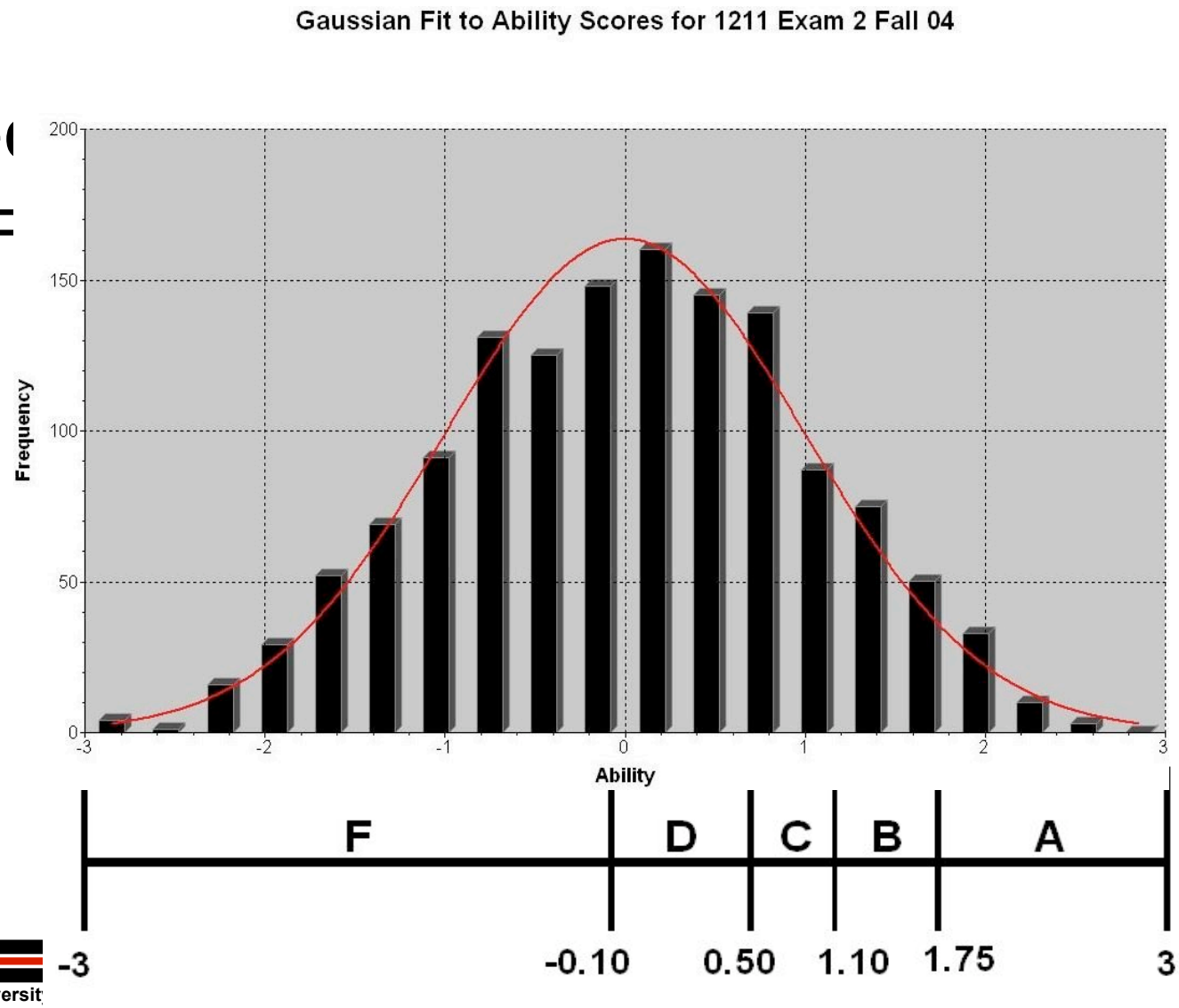
Can we show any improvement?

- Co
  - F



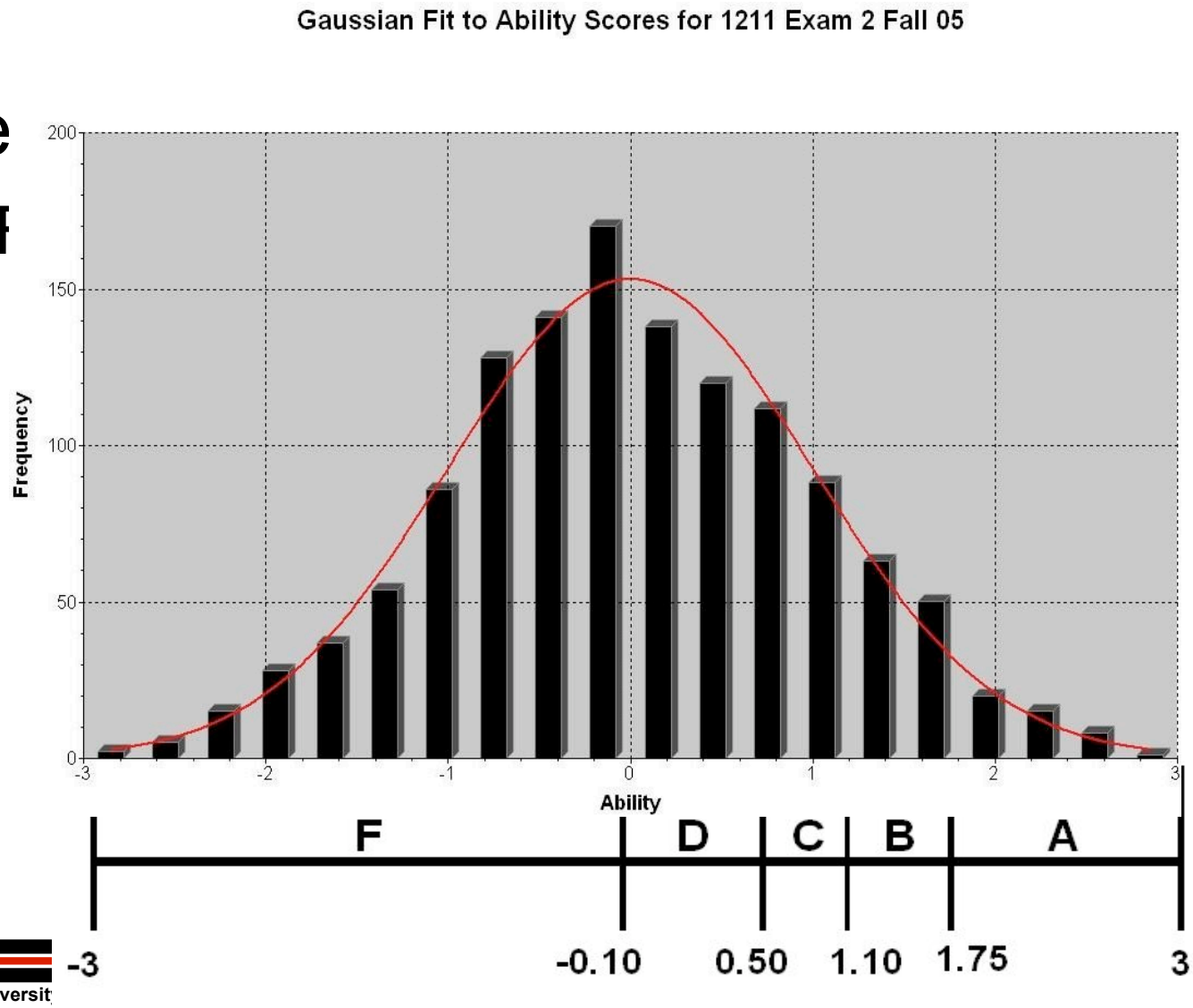
Can we show any improvement?

- Se
  - F



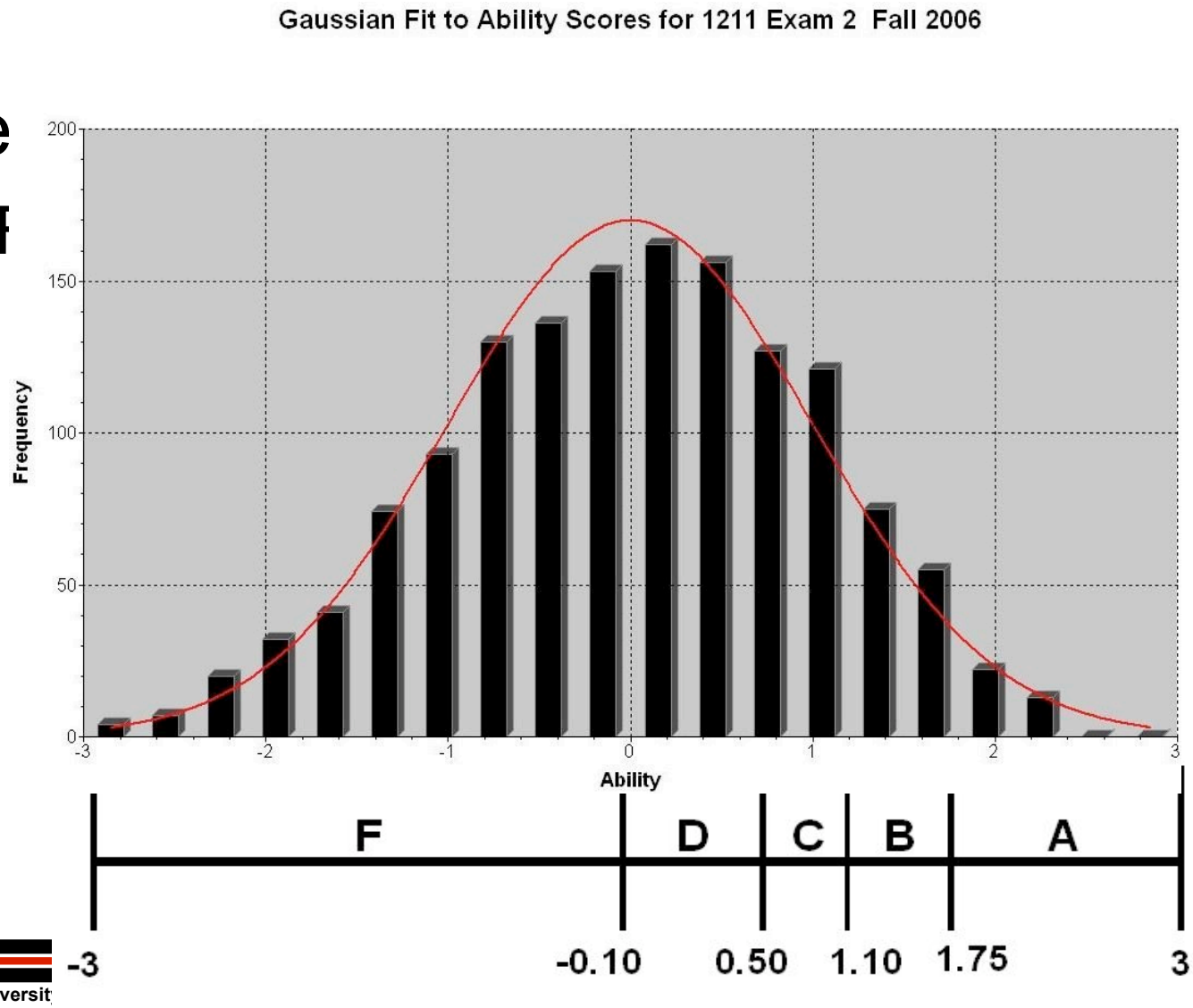
Can we show any improvement?

- Se
  - F



Can we show any improvement?

- Se
  - F



Universit

1785

Where are we headed?

- Continue IRT analysis of test items at UGA
- IRT analysis of a national homework system
- Interview students post-test and determine what thought characteristics distinguish student ability levels
- Develop novel interventions for specific topics
- Develop elicitation questions

Conclusion

- Item Response Theory is a more effective method of assessing student ability.
- We can design and implement test questions that discriminate student abilities at all levels.
- Beginning to assess those characteristics that differentiate student abilities.
- Interventions can improve overall student abilities.

Acknowledgements

- Bob Scott and John Stickney
  - Department Chairs
- Gary Lautenschlager
  - Professor of Psychology and IRT expert
- UGA's PRISM project.
  - This material is based on work supported by the National Science Foundation under Grant No. EHR-0314953.