

An Application of Profile Analysis via Multidimensional Scaling (PAMS) to the DSTP Grade 8 Mathematics Test

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Background of the Study

- The NCLB regulation requires states to produce individual student interpretive, descriptive, and diagnostic reports that address the specific academic needs of students. Reporting valid and reliable diagnostic information from statewide assessments, however, has been a challenge given that these assessments are designed for summative purposes.
- There has been a great demand for instructional needs to improve student learning.

Methodology of the Study

- Profile Analysis via Multidimensional Scaling (PAMS) developed by Davison (1996) has been used for achievement test in educational area to interpret dimensions as their patterns, rather than as latent variables.
- The PAMS reduces students' observed scores (or observed score profile) to a set of dimensions:
 - Use multi-dimensional scaling procedure to reduce dimensionality (e.g., from 6 content categories to 2 dimensions);
 - Regress each observed score onto the dimension solution to evaluate the correspondence between observed scores and 'dimension' profile.

Methodology of the Study

- Assessment Instrument:
 - DSTP grade 8 mathematics test
 - The test items measure six content standards:
 1. Number Sense
 2. Algebra
 3. Patterns, Relationships, and Functions
 4. Estimate, Measurement, and Computation
 5. Statistics and Probability
 6. Geometry

Methodology of the Study

Table 1. Descriptive Statistics

Content Standards	Max. Points	Mean	S.D.
Number Sense	10	5.21	2.31
Algebra	13	7.87	4.24
Patterns, Relationships, and Functions	11	6.29	3.01
Estimate, Measurement, and Computation	14	6.97	3.35
Statistics and Probability	15	8.4	3.33
Geometry	12	5.33	2.59

Profile Analysis

- Overall profiles for the two reduced dimensions
- Comparison of the profiles between proficient (P) and non-proficient students (NP) for the two dimensions
- Comparison of the profiles between proficient (P) and non-proficient students (NP) using individual student observed profiles for the two dimensions.

Overall Profile for Dimension One

Figure 1. Dimension One: Number Sense vs. Geometry

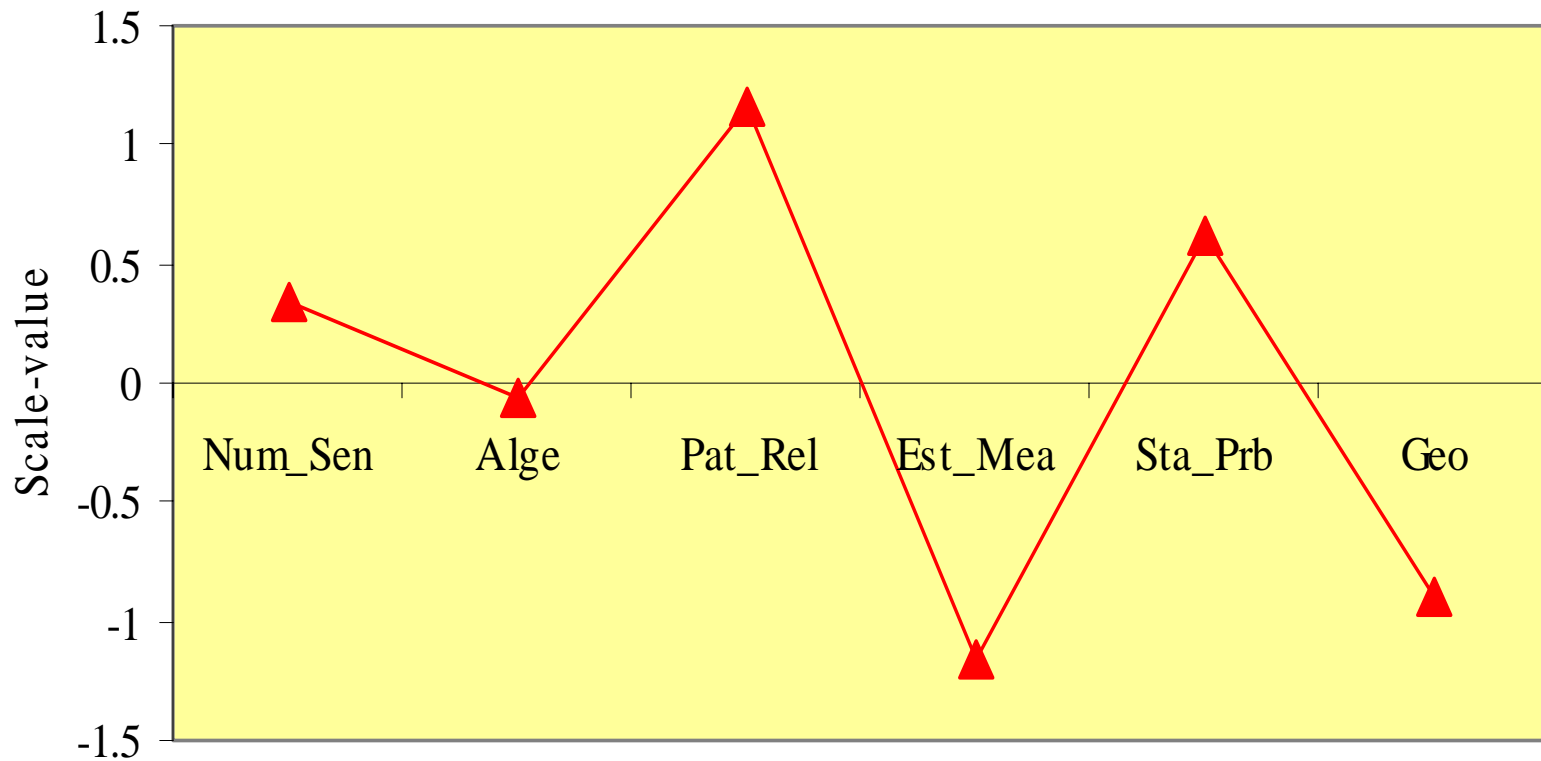


The Overall Profile – Dimension One

- The two-dimension solution was selected because of the model-fit and interpretability
- For Dimension One, Figure 1 shows a significant peak for *Number Sense* with a scale value of +1.9 and a significant valley of *Geometry* with a scale value of -1.9. Given the highest elevation for the observed content domain of *Number Sense*, coupled with the lowest one for *Geometry*, the first dimension is called *Number Sense vs. Geometry*.

Overall Profile for Dimension Two

Figure 2. Dimension Two: Patterns vs. Estimate

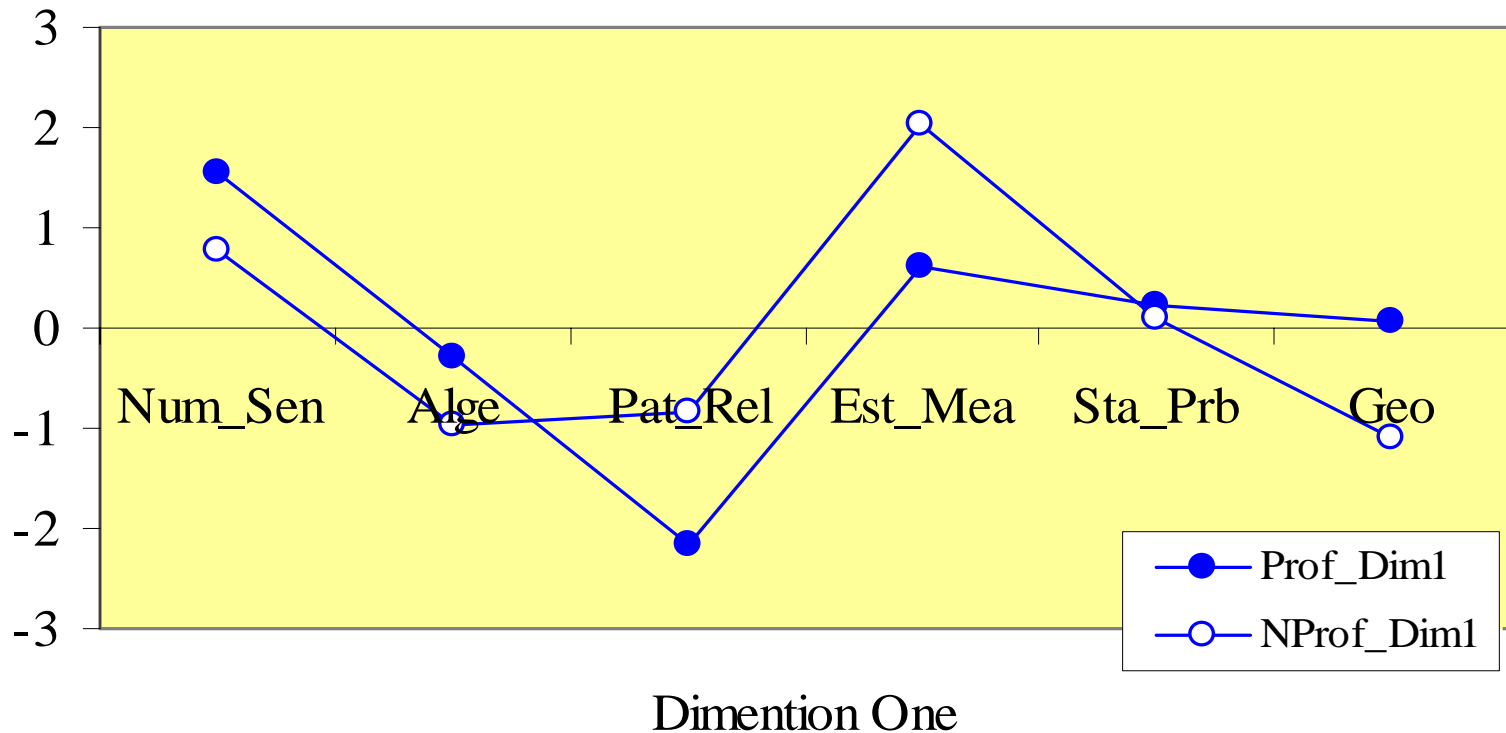


The Overall Profile – Dimension Two

- For Dimension Two, Figure 2 shows a significant peak for *Patterns, Relationships, and Functions* with a scale value of +1.1 and a significant valley of *Measurement, Estimate, and Computation* with a scale value of -1.1. Given the highest elevation for the observed content domain of *Number Sense*, coupled with the lowest one for *Geometry*, the first dimension is called *Patterns, Relationships, and Functions vs. Measurement, Estimate, and Computation*.

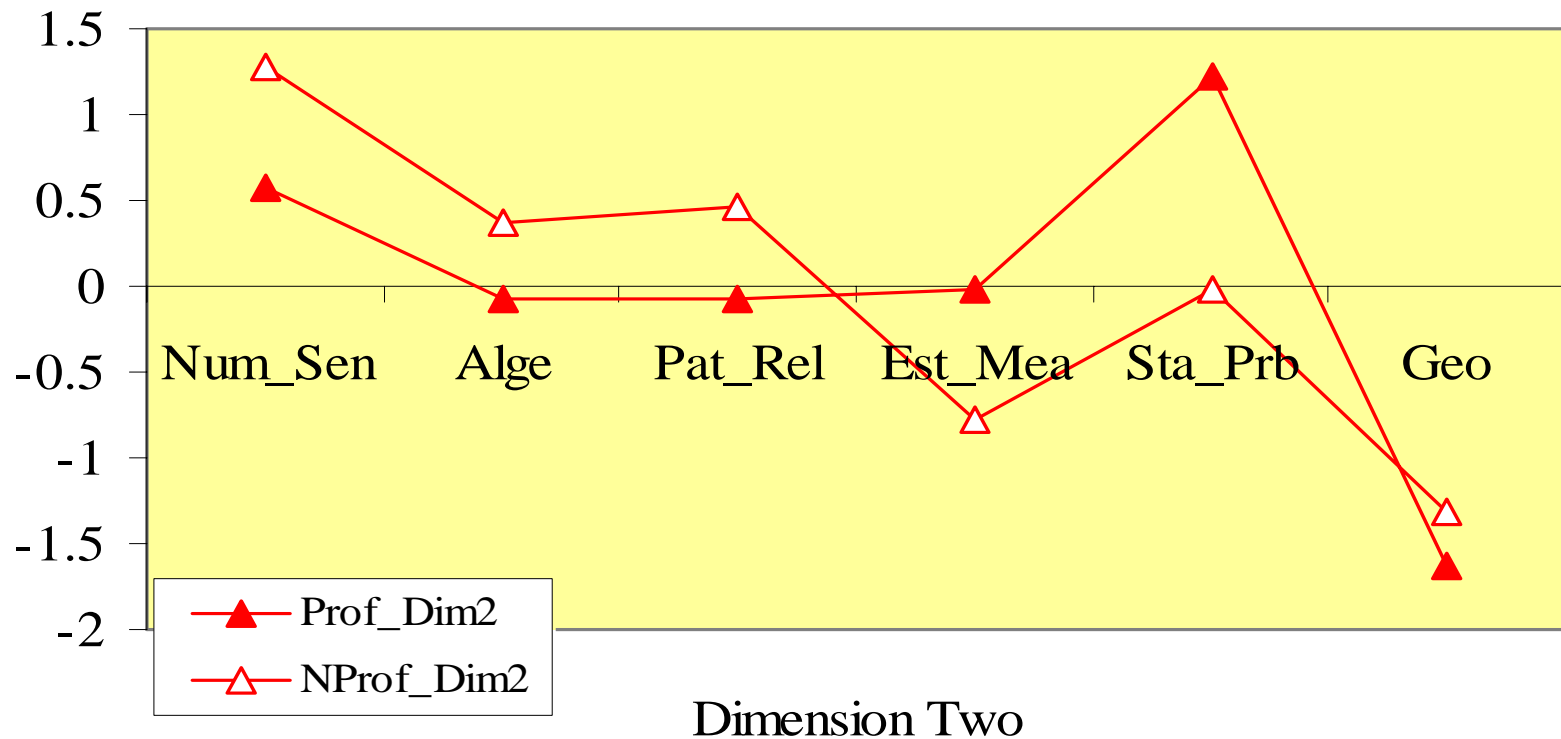
Profiles for Proficient and Non-Proficient Students on Dimension One

Figure 3. P (Number vs. Patterns) & NP (Estimate vs. Geo)



Profiles for Proficient and Non-Proficient Students on Dimension Two

Figure 4. P (Statistics vs. Geo) & NP (Number vs. Geo)



Profiles for Proficient Students

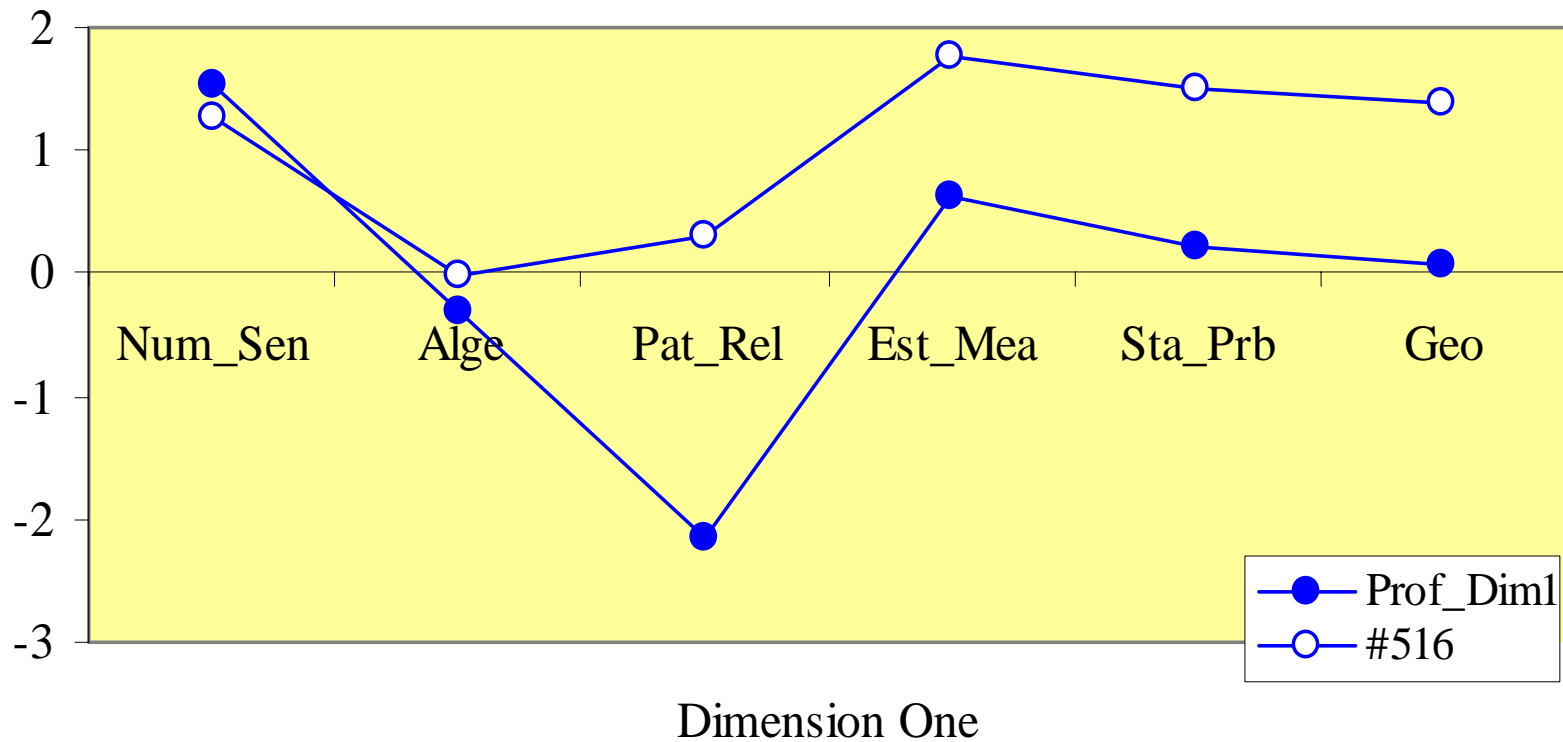
- On Dimension One, the latent profile is called a *Number Sense vs. Patterns, Relationships, and Functions* profile, where mean = 53, stress = .06, and RSQ = .97 (Figure 3).
- On Dimension Two, the latent profile is called a *Statistics and Probability vs. Geometry* profile (Figure 4).

Profiles for Non-Proficient Students

- On Dimension One, the latent profile is called a *Measurement, Estimate, and Computation vs. Geometry* profile, where mean = 26, stress = .08, and RSQ = .96 (Figure 3)
- For Non-Proficient students, the latent profile on Dimension Two is called a *Number Sense vs. Geometry* profile (Figure 4).

Individual Student Profile – Sample 1

Figure 5. Proficient Profile vs. #516
(w1=1.23; w2=-.12; level=1.47; RSQRD=.42)

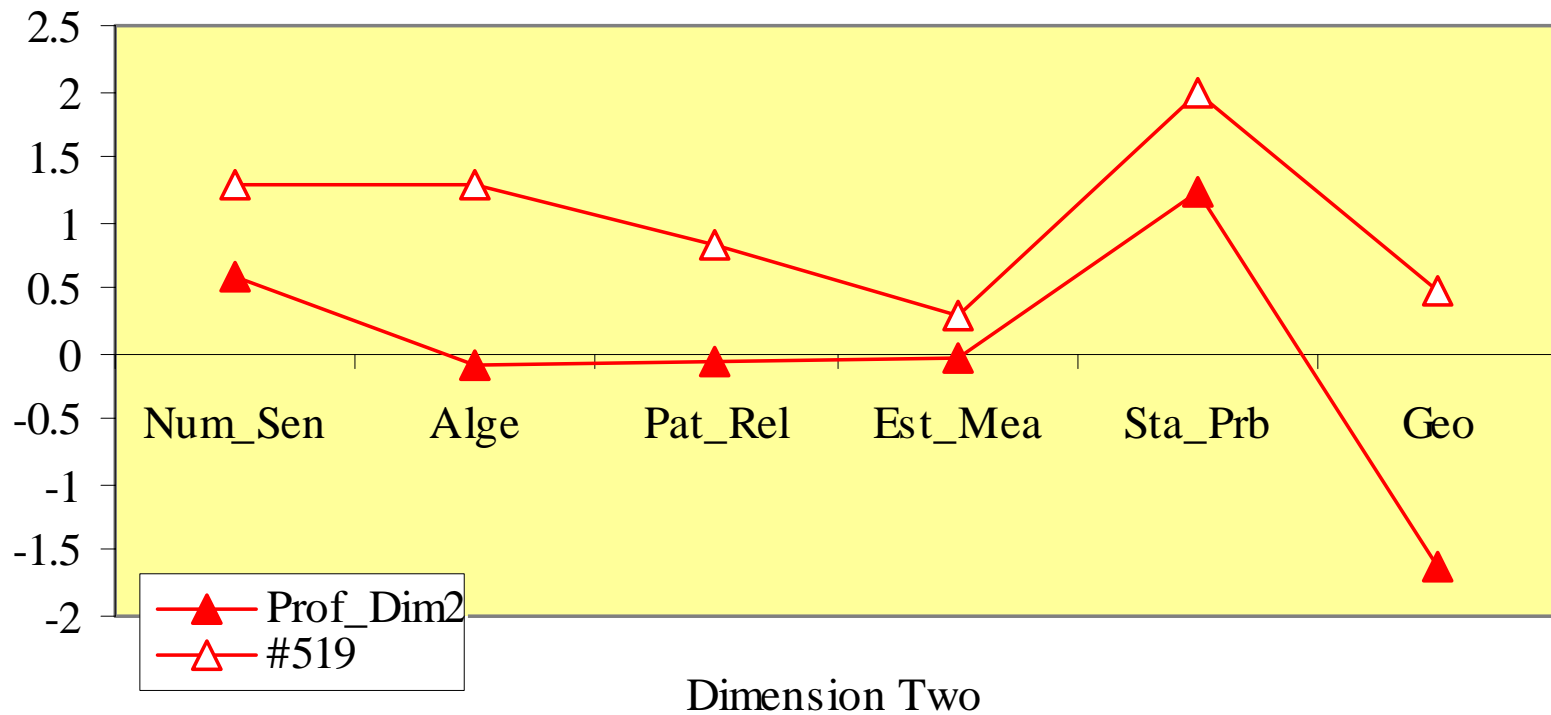


Sample 1 – Student #516

- Dimension One scale value: $w_1=1.23$
- Dimension Two scale value: $w_2=-.12$
- Height of the profile or standardized average sub-scores: level=1.47
- The proportion of variance of both dimensions to the total variance: $RSQRD=.42$
- Student #516 has a high positive weight on D-1, but a trivial weight on D-2. The individual profile shows a similar pattern to the *Number Sense vs. Patterns, Relationships, and Functions* profile.

Individual Student Profile – Sample 2

Figure 6. Proficient Profile vs. #519
($w1=-.07$; $w2=1.29$; level=1.46; RSQRD=.57)

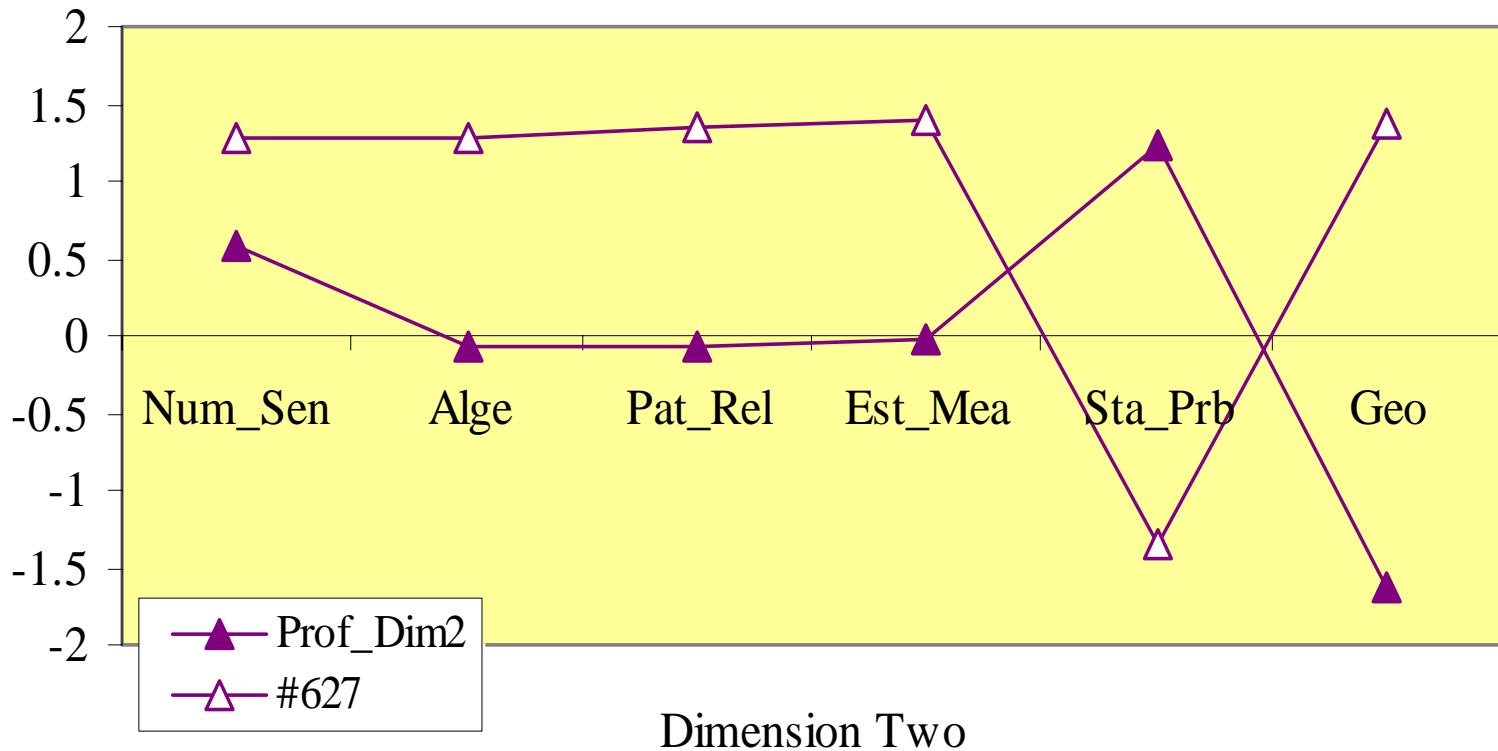


Sample 2 – Student #519

- Dimension One scale value: $w_1 = -.07$
- Dimension Two scale value: $w_2 = 1.29$
- Height of the profile or standardized average sub-scores: $level = 1.46$
- The proportion of variance of both dimensions to the total variance: $RSQRD = .57$
- Student #516 has a high positive weight on D-2, but a trivial weight on D-1. The individual profile shows a similar pattern to the *Statistics and Probability vs. Geometry*.

Individual Student Profile – Sample 3

Figure 7. Proficient Profile vs. #627 (Mirror Image)
(w1=.09; w2=-1.97; level=1.27)

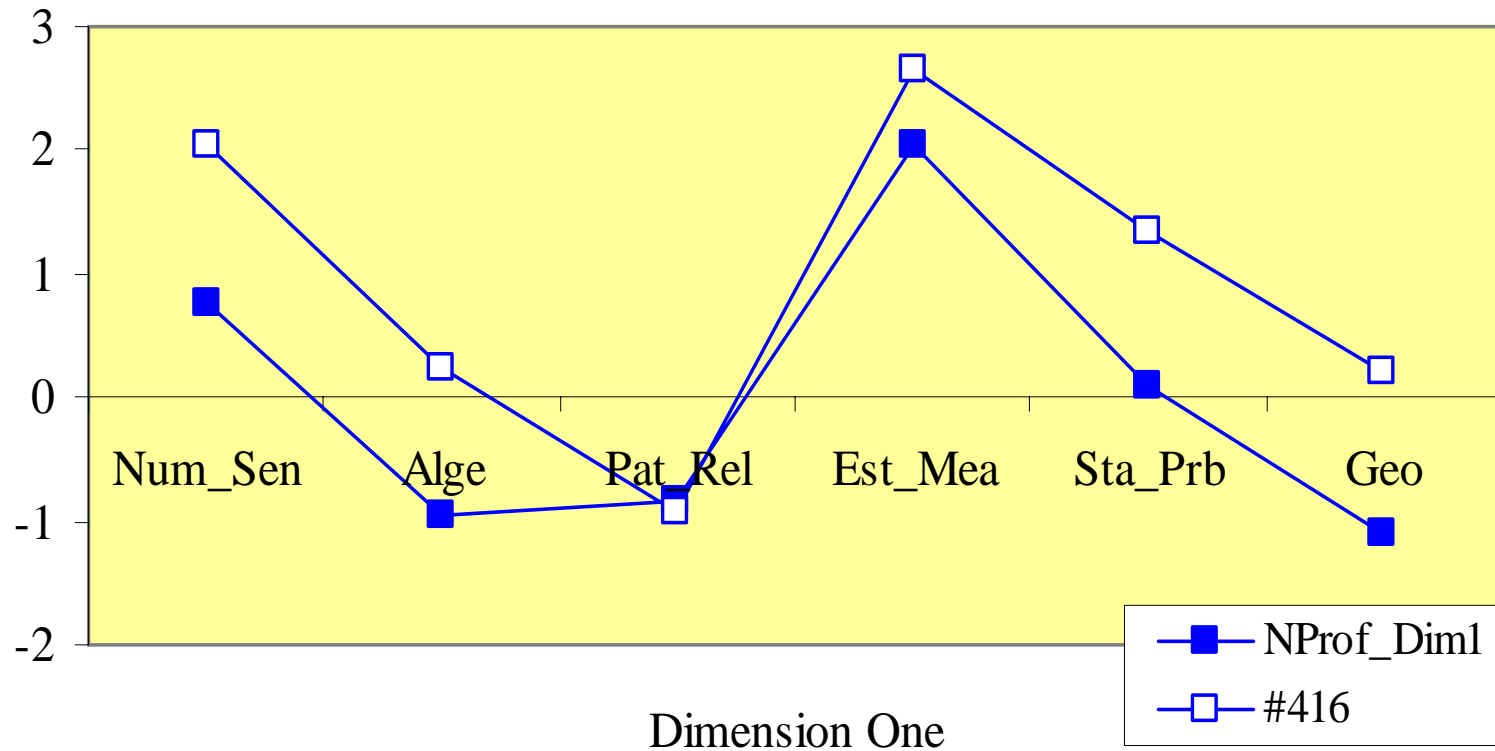


Sample 3 – Student #627

- Dimension One scale value: $w_1=.07$
- Dimension Two scale value: $w_2=-1.97$
- Height of the profile or standardized average sub-scores: $level=1.27$
- The proportion of variance of both dimensions to the total variance: $RSQRD=??$
- The individual profile for Student #627 displays a ‘mirror image’ with the highest, negative weight to the D-2 profile *Statistics and Probability vs. Geometry*.

Individual Student Profile – Sample 4

Figure 8. Not Proficient Profile vs. #416
($w_1=2.93$; $w_2=-.20$; level=1.39; RSQRD=.85)

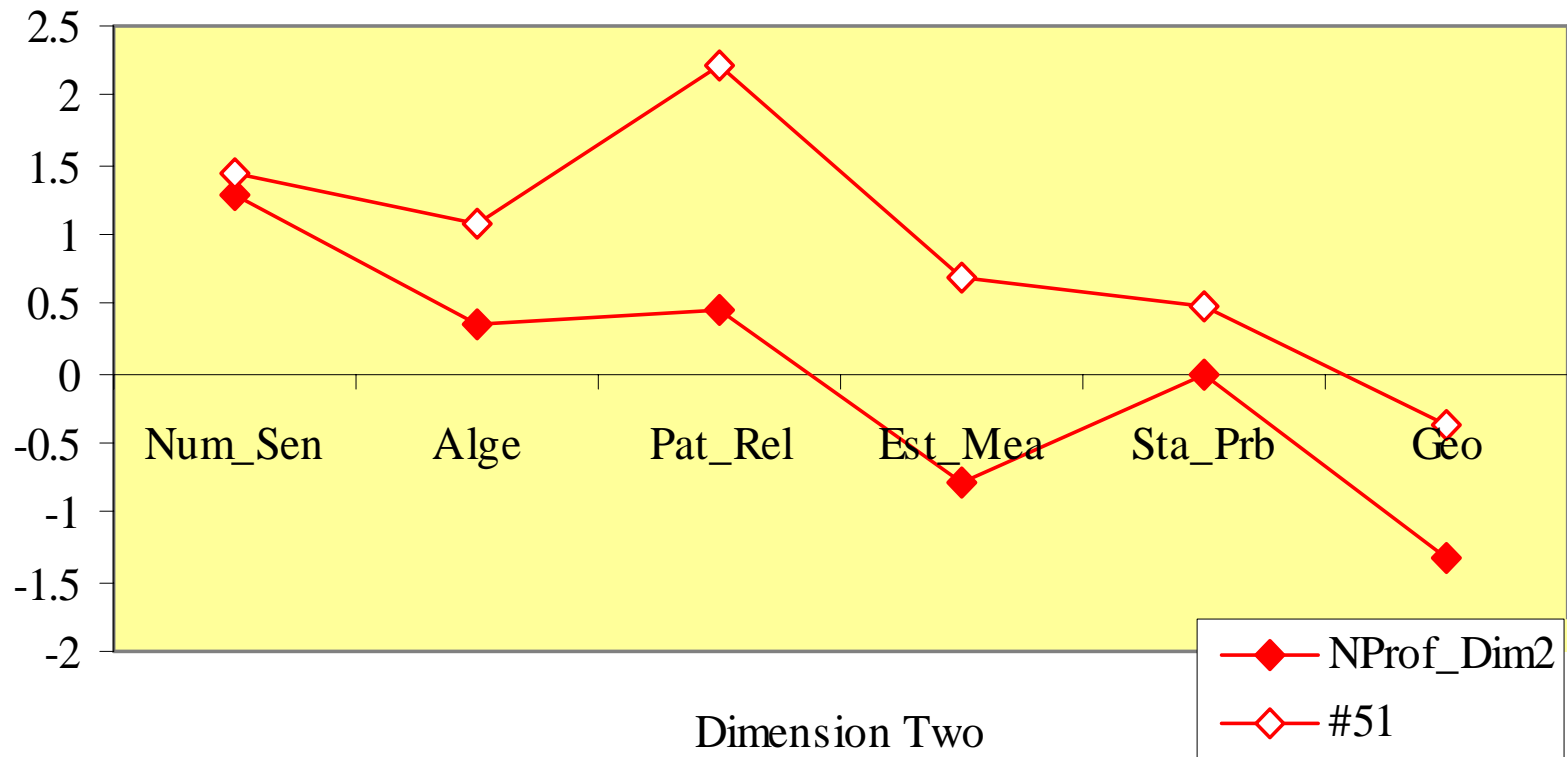


Sample 4 – Student #416

- Dimension One scale value: $w_1=2.93$
- Dimension Two scale value: $w_2=-.20$
- Height of the profile or standardized average sub-scores: $level=1.39$
- The proportion of variance of both dimensions to the total variance: $RSQRD=.85$
- Student #416 has a high positive weight on D-1, but a trivial weight on D-2. The individual profile shows a similar pattern to the *Measurement, Estimate, and Computation vs. Geometry* profile. The proportion of variance on D-1 and D-2 to the total variance is about 85%.

Individual Student Profile – Sample 5

Figure 9. Not Proficient Profile vs. #51
($w1=-.01$; $w2=1.69$; $level=1.52$; $RSQRD=.61$)

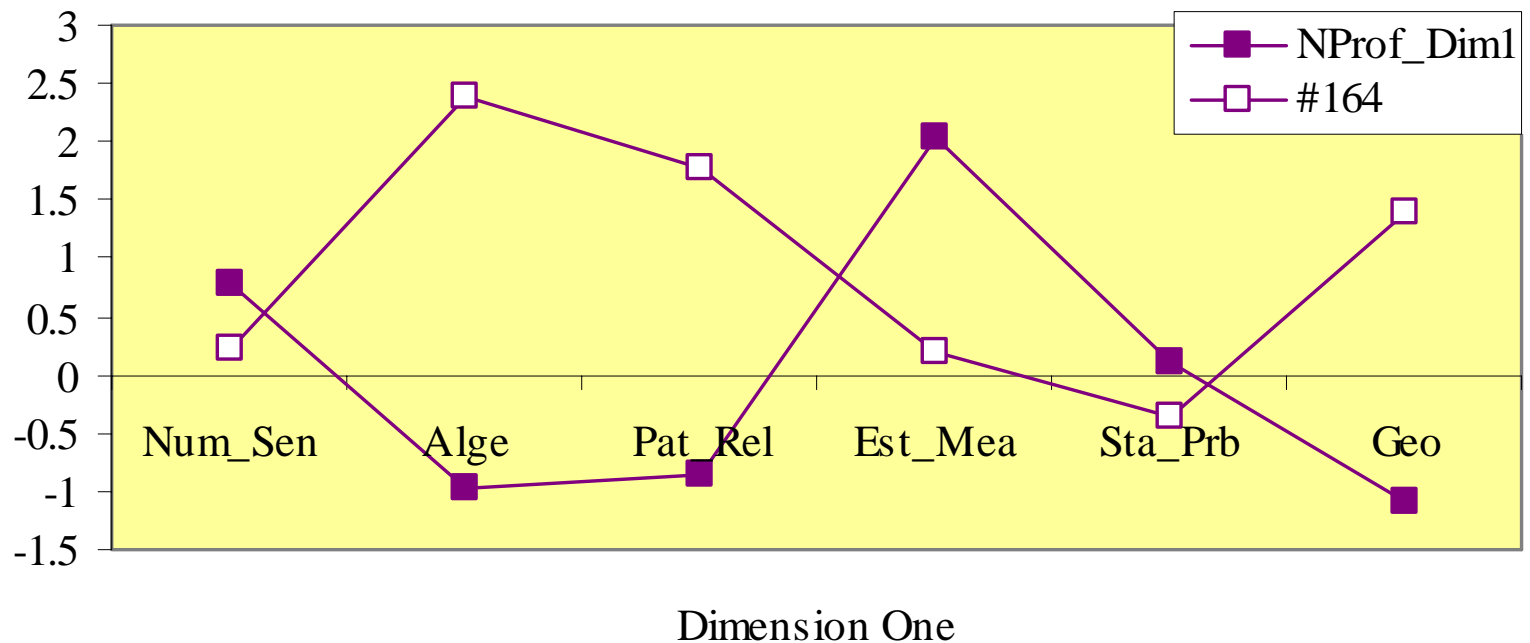


Sample 5 – Student #51

- Dimension One scale value: $w_1 = -.01$
- Dimension Two scale value: $w_2 = 1.69$
- Height of the profile or standardized average sub-scores: $level = 1.52$
- The proportion of variance of both dimensions to the total variance: $RSQRD = .61$
- Student #51 has a high positive weight on D-1, but a trivial weight on D-2. The individual profile shows a similar pattern to the *Number Sense vs. Geometry* profile. The proportion of variance on D-1 and D-2 to the total variance is about 61%.

Individual Student Profile – Sample 6

Figure 10. Not Proficient Profile vs. #164: Mirror Image
($w1=-1.77$; $w2=.02$; level=1.53; RSQRD=.42)



Sample 6 – Student #164

- Dimension One scale value: $w1 = -1.77$
- Dimension Two scale value: $w2 = .02$
- Height of the profile or standardized average sub-scores: level = 1.53
- The proportion of variance of both dimensions to the total variance: $RSQRD = .42$
- This is a non-proficient student. The individual profile for displays a ‘mirror image’ with the highest, negative weight to the D-2 profile *Number Sense vs. Geometry*.

Educational Importance

- NCLB requires descriptive instructional needs for individual from statewide assessment;
- Great demand for the information of instructional needs to improve student learning;
- The visualized profile is easy to understand and interpret; and
- The PAMS could be conducted for different cohort of students based on test scores and for longitudinal comparison to track the pattern of student learning.