Differences in Question Answering style and Motivational Variables Across Conceptual and procedural Understanding of Fractions

Felix Ayesu, Dr. Darcy Hallett, Kyle Morrissey, Aishah Bakhtiar

Memorial University of Newfoundland

Introduction

- Conceptual knowledge is considered as a declarative type of knowledge that must be learned through thoughtful and reflective learning. In contrast, Procedural knowledge can be considered in its broader sense as the ability to apply the necessary rules and symbols pertaining to a particular mathematical domain.
- Previous cluster analyses have found individual differences between conceptual and procedural knowledge, typically in a four-cluster pattern: 1) those with relatively higher conceptual ability; 2) those with relatively higher procedural ability; 3) low on both conceptual and procedural abilities and high on both conceptual and procedural abilities(Hallett et al, 2010 ; 2012).
- This study however is the first of its kind that is controlling for overall fraction ability in the cluster analysis.
- The present study investigated whether the more conceptual and more procedural clusters differ on a set of motivational variables (i.e., Math self concept, Goal orientation, and Attribution of successes and failures), gender differences, and differences between clusters regarding the amount of effort put into answering questions (i.e., reflected by amount of work shown and number of attempted questions)

Hypotheses

- Girls will be more procedural
- Conceptually dominant group will show less work
- Procedurally dominant group will show more work
- Procedural dominant will make external attribution
- Conceptually Dominant group will make internal attributions
- Conceptual group will show performance approach
- Procedural group will show performance avoidance

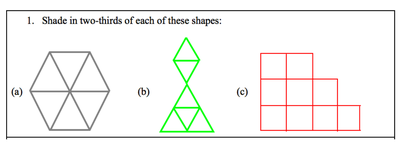
Method

Participants

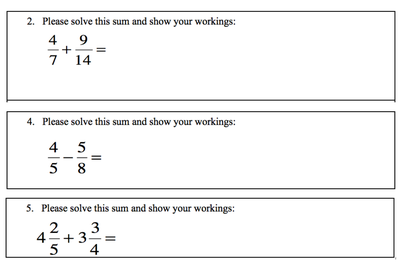
- A total of 264 Grade 8 students (152 boys , 111 girls and 1 unspecified) were recruited from eight schools in a mid-size Canadian city.
- A total of 9 subjects were dropped from the sample because they did not complete all the measures, and 11 more were outliers.
- The final sample included 244 students, with 139 boys (mean age 13,78, SD = 0.33) and 105 females (Mean age = 13.79, SD = 0.32).

Measures

- Conceptual and Procedural Fraction measure (Hallett et al, 2012); Math Self-Concept Subscale; Sydney Attribution Scale; Personal Achievement Goal Orientation Subscale



Sample of conceptual questions



Sample of procedural questions

Results

- The More Procedural cluster is higher than the The More Conceptual cluster on Math Self-Concept, and the More Conceptual Cluster is more likely to attribute their failures to ability than the More Procedural cluster. These differences, however, disappear after controlling for the Overall Fraction score.
- However, there was a gender difference in clusters, with girls being more dominant in the procedural cluster.
- There was also a difference in attempting procedural questions, with girls in the conceptual cluster less likely to do so.

Gender	Cluster				
	High	More conceptual	More procedural	Lower	Total
Boys	45	42	9	43	139
Girls	30	24	29	22	105
Total	75	66	38	65	244

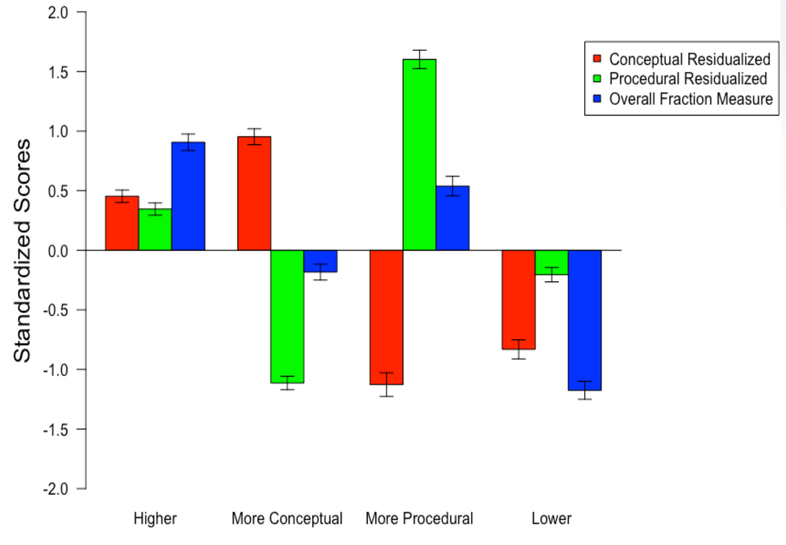
$\chi^2(3, N=244) = 20.89, p = .0001$

	Cluster				
	High	More conceptual	More procedural	Lower	Total
Attempted all pro. questions	63	40	34	34	171
Did not attempt all pro questions	12	26	4	31	73
Total	75	66	38	65	244

$\chi^2(3, N=244) = 26.36, p < .0001$;
When lower cluster excluded: $\chi^2(2, N=179) = 15.19, p = .0005$

		Cluster			
		High	More conceptual	More procedural	Total
Boys	Attempted all pro. questions	36	27	7	70
	Did not attempt all pro. questions	9	15	2	26
	Total	45	42	9	96
Girls	Attempted all pro. questions	27	13	27	67
	Did not attempt all pro. wuestions	3	11	2	16
	Total	30	24	29	83

For boys: $\chi^2(2, N=96) = 2.84, p = .2422$;
For girls: $\chi^2(2, N=83) = 15.39, p = .0005$



Conclusions

- In contrast to previous findings suggesting that conceptual clusters slightly outperform procedural clusters, this study suggests that good procedural ability is grouped with higher overall ability, compared to the conceptual cluster. Still, the greatest overall performance is achieved by students with a combination of both abilities.
- Including overall ability in cluster analysis improves the cluster solution, and leads to profiles in Grade 8 that parallel those in Grade 6.
- The more procedural group consisted of more females than males. This confirms previous findings (Hallett et, 2010; Gallegher, 2000) which suggest females do better on procedural (conventional) questions than males.
- Girls in the conceptual cluster are not attempting procedural questions as much others are
- Other differences between the clusters disappear after controlling for overall ability.

References

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