Investigating Structures of Reading Comprehension Attributes at Different Proficiency Levels: Applying Cognitive Diagnostic Models and Factor Analyses

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Introduction

Levels of Reading Comprehension Based on Cognitive Processes

There are distinct cognitive levels of reading comprehension imposing different cognitive demands on readers, such as literal, inferential, and evaluative comprehension.

Each level reflects the different types of interaction with the text, as well as the various cognitive demands on comprehenders.

Locating the explicitly stated information.

Connecting information pieces in the text and applying their background knowledge or experiences to the text .

Evaluating the information from the text based on the reader's background knowledge or experiences

Introduction

Criticisms of the Theory of Reading Comprehension Levels

(1) The theory oversimplified the complicated process of comprehension by positing the difficulty between the comprehension levels as a linear progression without considering other factors.

(2) Other critics doubt the premise that lower-level skills (i.e., literal comprehension) should be a prerequisite for other higher-level skills (i.e., inferential comprehension) in reading comprehension.

(3) It has been controversial whether the levels or skills associated with the levels can be empirically discriminated.

The theory of reading comprehension levels has less research validation, even though it has been prevalently used in the field of practice.

Introduction

Overview of Cognitive Diagnosis Models (CDMs)

Recently, as assessment frameworks providing cognitive features by modeling items and cognitive skills of students, CDMs have attracted a lot of attention (Gorin & Svetina, 2012).

"probabilistic, confirmatory multidimensional latent-variable models with a simple or complex loading structure, which are suitable for modeling observable categorical response variables and contain unobservable (i.e., latent) categorical predictor variables" (Rupp et al., 2010)

By using CDMs, one can classify examinees into groups of different profiles based on their item responses.

Introduction

Overview of Cognitive Diagnosis Models (CDMs)

(1) CDM is considered as an interdisciplinary approach between cognitive psychology and statistical analysis to diagnostic measurement (Ravand & Robitzsch, 2015).

(2) CDMs are used to classify examinees into some latent classes based on similarity of their responses to the items, so they can be regarded as latent class models (Haagenars & McCutcheon, 2002).

(3) CDMs are confirmatory models in that latent variables in CDMs are determined a priori through a Q-matrix.

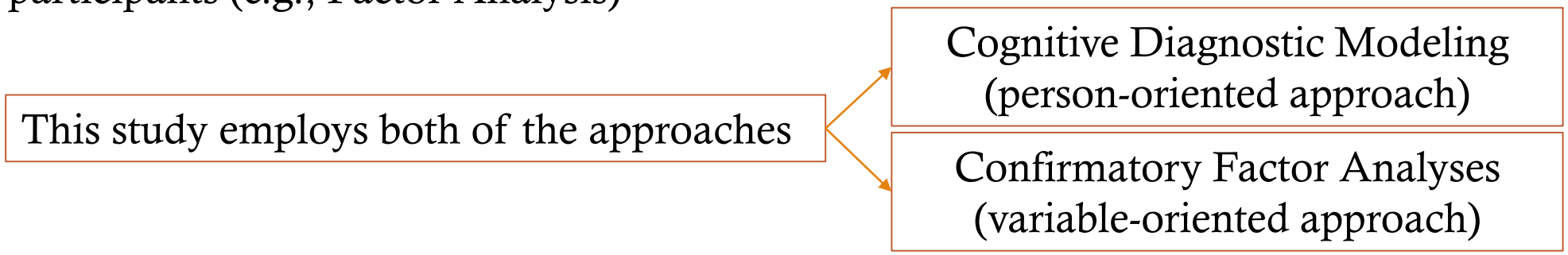
(4) CDMs are multidimensional models (Li, 2011).

Introduction

Person-Oriented and Variable-Oriented Approach to Investigate Structure of Reading Comprehension Attributes

(1) Person-Oriented Approach: The focus is on studying individuals based on their individual patterns of characteristics which need to be considered in a study (e.g., Latent Class Analysis)

(2) Variable-Oriented Approach: The focus is on identification of relationships between variables, assuming these relations can commonly apply all participants or a group of participants (e.g., Factor Analysis)



Introduction

PIRLS: An International Reading Comprehension Assessment for Fourth Graders

PIRLS 2011 framework

	PIRLS
Definition	The ability to understand and use those written language forms required by society and/or valued by the individual. Young readers can construct meaning from a variety of texts. They read to learn, to participate in communities of readers in school and everyday life, and for enjoyment.
Content	Literary and informational texts
Cognitive dimensions	Focus on and retrieve Make straightforward inferences Interpret and integrate Examine and evaluate

Purposes of reading

(1) Reading for literary experience (narrative text)

(2) Reading for acquisition of information (expository text)

Processes of comprehension

(1) Focusing on and retrieving explicitly stated information

(2) Making straightforward inferences

(3) Interpreting and integrating ideas and information

(4) Examining and evaluating content, language, and textual elements

Introduction

Purpose of Study & Research Questions

The first purpose is to examine patterns of reading comprehension attributes of fourth graders at different proficiency levels, which will be achieved by applying CDMs as a person-oriented approach.

The second purpose is to explore how these attributes affect reading comprehension at different proficiency levels, which will be accomplished by employing confirmatory factor analyses.

Research Question 1: What are the patterns of reading comprehension attributes of individual examinees when applying CDMs for fourth-grade examinees at different proficiency levels as well as the whole group?

Research Question 2: What are the factor structures of reading comprehension attributes for the fourth-grade examinees at different proficiency levels as well as the whole group?

Methods

Participants and Measures

Table 7. Item Information in the booklet 13 of PIRLS 2011

N	Item ID	Type	Passage Name	Passage Sequence	Purposes for Reading	Processes of Comprehension
1	R31P01M	MC	Enemy Pie	P01	NAR	EVA
2	R31P02C	CR	Enemy Pie	P02	NAR	INF
3	R31P03C	CR	Enemy Pie	P03	NAR	RET
4	R31P04M	MC	Enemy Pie	P04	NAR	INT
5	R31P05C	CR	Enemy Pie	P05	NAR	INF
6	R31P06C	CR	Enemy Pie	P06	NAR	RET
7	R31P07C	CR	Enemy Pie	P07	NAR	RET
8	R31P08M	MC	Enemy Pie	P08	NAR	INF
9	R31P09C	CR	Enemy Pie	P09	NAR	INF
10	R31P10M	MC	Enemy Pie	P10	NAR	INF
11	R31P11M	MC	Enemy Pie	P11	NAR	INF
12	R31P12M	MC	Enemy Pie	P12	NAR	INT
13	R31P13M	MC	Enemy Pie	P13	NAR	EVA
14	R31P14C	CR	Enemy Pie	P14	NAR	INT
15	R31P15C	CR	Enemy Pie	P15	NAR	INT
16	R31P16C	CR	Enemy Pie	P16	NAR	EVA
17	R31G01M	MC	The Giant Tooth Mystery	G01	EXP	RET
18	R31G02C	CR	The Giant Tooth Mystery	G02	EXP	INF
19	R31G03M	MC	The Giant Tooth Mystery	G03	EXP	RET
20	R31G04C	CR	The Giant Tooth Mystery	G04	EXP	INT
21	R31G05M	MC	The Giant Tooth Mystery	G05	EXP	INF
22	R31G06M	MC	The Giant Tooth Mystery	G06	EXP	RET
23	R31G07M	MC	The Giant Tooth Mystery	G07	EXP	INF
24	R31G08CA	CR	The Giant Tooth Mystery	G08A	EXP	INT
25	R31G08CB	CR	The Giant Tooth Mystery	G08B	EXP	INT
26	R31G09M	MC	The Giant Tooth Mystery	G09	EXP	INF
27	R31G10C	CR	The Giant Tooth Mystery	G10	EXP	INT
28	R31G11M	MC	The Giant Tooth Mystery	G11	EXP	RET
29	R31G12C	CR	The Giant Tooth Mystery	G12	EXP	EVA
30	R31G13CA	CR	The Giant Tooth Mystery	G13A	EXP	INT
31	R31G13CB	CR	The Giant Tooth Mystery	G13B	EXP	INT
32	R31G13CC	CR	The Giant Tooth Mystery	G13C	EXP	INT
33	R31G14M	MC	The Giant Tooth Mystery	G14	EXP	INF

Note. MC=Multiple choice items; CR=Constructed-response items; NAR=Narrative text; EXP=Expository text; RET=Retrieving; INF=Inferencing; INT=Integrating; EVA=Evaluating

A total of 2,574 examinees took the Booklet 13 test.

Methods

Data Analysis:

Four stages of retrofitting CDMs to existing tests (Ravand & Robitzsch, 2015)

1. Specifying attributes

Based on previous studies, (1) four types of reading comprehension processes (e.g., retrieving, inferencing, integrating, and evaluating), (2) text type (e.g., narrative and expository), and (3) item format (e.g., multiple choice and constructed response) were employed as attributes, which were suggested in the official PIRLS 2011 assessment framework (Mullis et al., 2009).

Methods

Data Analysis:

Four stages of retrofitting CDMs to existing tests (Ravand & Robitzsch, 2015)

2. Constructing a Q-matrix

Table 8. Q-matrix based on the PIRLS 2011 assessment framework -continued

Narrative passage							Expository passage						
	α_1	α_2	α_3	α_4	α_5	α_6		α_1	α_2	α_3	α_4	α_5	α_6
1	0	0	0	1	0	0	17	1	0	0	0	0	1
2	0	1	0	0	1	0	18	0	1	0	0	1	1
3	1	0	0	0	1	0	19	1	0	0	0	0	1
4	0	0	1	0	0	0	20	0	0	1	0	1	1
5	0	1	0	0	1	0	21	0	1	0	0	0	1
6	1	0	0	0	1	0	22	1	0	0	0	0	1
7	1	0	0	0	1	0	23	0	1	0	0	0	1
8	0	1	0	0	0	0	24	0	0	1	0	1	1
9	0	1	0	0	1	0	25	0	0	1	0	1	1
10	0	1	0	0	0	0	26	0	1	0	0	0	1
11	0	1	0	0	0	0	27	0	0	1	0	1	1
12	0	0	1	0	0	0	28	1	0	0	0	0	1
13	0	0	0	1	0	0	29	0	0	0	1	1	1
14	0	0	1	0	1	0	30	0	0	1	0	1	1
15	0	0	1	0	1	0	31	0	0	1	0	1	1
16	0	0	0	1	1	0	32	0	0	1	0	1	1
							33	0	1	0	0	0	1
N	3	6	4	3	9	0	E	4	5	7	1	9	17
							T	7	11	11	4	18	17

Note. α_1 = Retrieval; α_2 = Inference; α_3 = Integration; α_4 = Evaluation; α_5 = Constructed responses; α_6 = Expository text; N = Narrative text items; E = Expository text items; T = Total number of test items

Methods

Data Analysis:

Four stages of retrofitting CDMs to existing tests (Ravand & Robitzsch, 2015)

3. Model specification: Selection of an appropriate CDM

Since this study does not predetermine a specific model (It is not clear that RC is a compensatory process or non-compensatory process), an appropriate diagnosis model will be selected by comparing model fit indices after applying several CDMs to the data.

Particularly, one saturated model (G-DINA), two non-compensatory models (DINA, RRUM), and two compensatory models (DINO, ACDM) will be employed and compared for a cognitive diagnosis of this study using the **R-package CDM**, since those models are considered plausible models to compare for cognitive diagnosis of reading comprehension tests in previous studies (e.g., Chen & Chen, 2016; Li et al., 2016; Ravand, 2015).

Methods

Data Analysis:

Four stages of retrofitting CDMs to existing tests (Ravand & Robitzsch, 2015)

4. Estimating the attribute mastery patterns.

In this stage, the attribute mastery patterns of individual examinees are estimated by applying the selected CDM at the whole group level and the different proficiency levels.

Skill Pattern Probabilities

000000	100000	010000	110000	001000	101000	011000	111000	000100	100100	010100	110100	001100	101100	011100	111100
0.0880	0.0016	0.0000	0.0007	0.0011	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0111	0.0045	0.0000	0.0037	0.1937
000010	100010	010010	110010	001010	101010	011010	111010	000110	100110	010110	110110	001110	101110	011110	111110
0.0545	0.0006	0.0000	0.0032	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0052	0.0003	0.0000	0.0029	0.0868
000001	100001	010001	110001	001001	101001	011001	111001	000101	100101	010101	110101	001101	101101	011101	111101
0.0142	0.0059	0.0000	0.0001	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0022	0.0038	0.0000	0.0001	0.1155
000011	100011	010011	110011	001011	101011	011011	111011	000111	100111	010111	110111	001111	101111	011111	111111
0.0542	0.0131	0.0000	0.0023	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0064	0.0015	0.0000	0.0005	0.3196

Methods

Data Analysis: Confirmatory Factor Analyses

Plausible Factor Structures using unparceled items and parceled items

(1) A one-factor model: One general reading comprehension factor

(2) A bifactor model: One general reading comprehension factor + specific domain factors (four reading comprehension processes in PIRLS 2011: RET, INF, INT, and EVA)

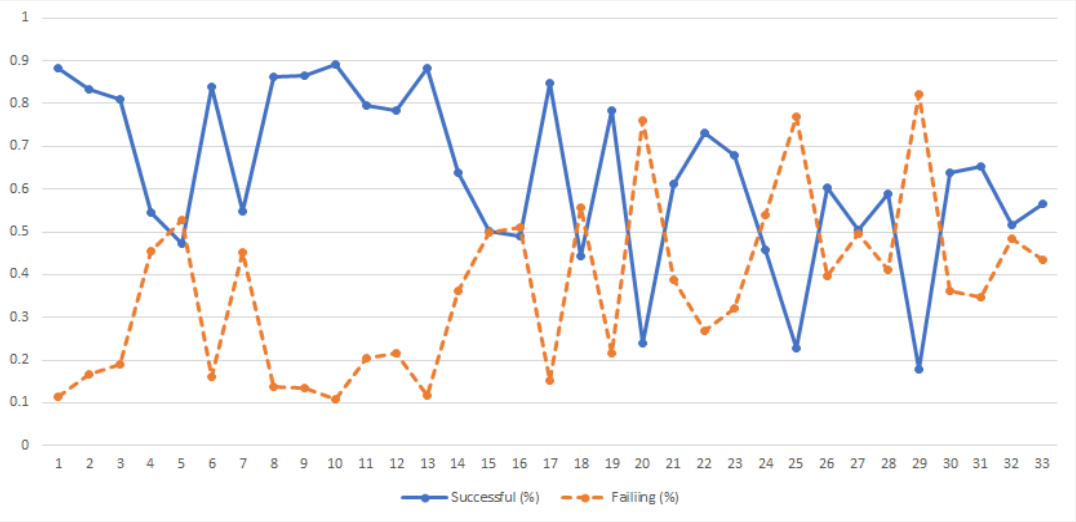
(3) Correlated two-factor models: Item format (MC/CR), Text type (NAR/EXP), Two comprehension processes (Comprehension of explicit information: RET+INF / Comprehension of implicit information: INT+EVA)

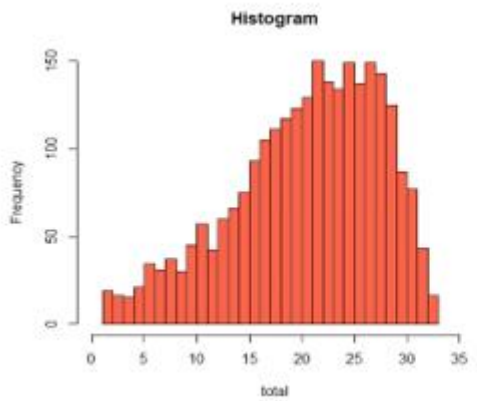
(4) Correlated four-factor models (RET, INF, INT, and EVA)

(5) High-order factor model (Two comprehension processes + four comprehension processes)

Results

Descriptive Statistics





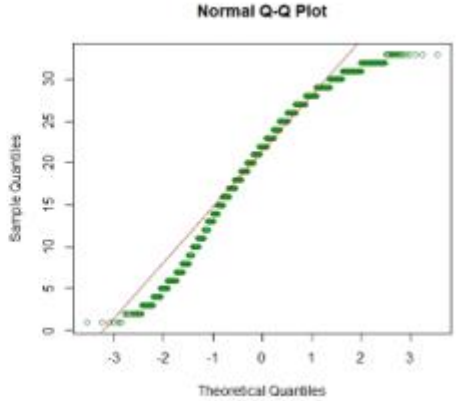


Figure 1. Distribution of the 33 item responses

Table 9. Item statistics based on classical test analysis

No. of items	33	SD	7.012
Mean difficulty	.634	Median	22
Mean discrimination	.485	Min. / Max score	1 / 33
SEM	.138	Reliability (Cronbach α)	.897
No. of examinees	2574	Skewness (SE)	-.596 (.048)
Mean score	20.915	Kurtosis (SE)	-.272 (.096)

Results

Descriptive Statistics

Table 11. Text properties of PIRLS 2011

	Narrative text "Enemy Pie"	Expository test "The Giant Tooth Mystery"
Lexile Measure	500L-600L	800L-900L
Mean Sentence Length	8.55	11.72
Mean Log Word Frequency	3.82	3.52
Number of Words	761	844
Narrativity	96%	55%
Syntactic simplicity	95%	86%
Word concreteness	67%	70%
Referential cohesion	46%	55%
Deep cohesion	87%	50%

Table 12. Descriptive statistics of correct answer rates of items on the four comprehension attributes

	RET (N=8)	INF (N=11)	INT (N=11)	EVA (N=4)	Total
Mean	.736	.694	.519	.609	.634
SD	.240	.223	.232	.257	.213

Note. RET=retrieving; INF=inferencing; INT=integrating; EVA=evaluating

Table 13. Results from One-way ANOVA for correct answer rates of items on the four comprehension attributes

	Sum of squares	*df*	Mean square	F	Sig.
Between groups	71.267	3	23.756	400.533	<.001
Within groups	610.420	10292	.059		
Total	681.687				

Results

Descriptive Statistics

Table 14. Results from Games-Howell post hoc test for correct answer rates of items on the four comprehension attributes

	Mean difference	SE	Sig.
RET-INF	.041	.006	<.001
RET-EVA	.127	.007	<.001
RET-INT	.216	.007	<.001
INF-EVA	.086	.006	<.001
INF-INT	.175	.007	<.001
EVA-INT	.089	.007	<.001

Note. RET=retrieving; INF=inferencing; INT=integrating; EVA=evaluating

Easiness:
RET>INF>EVA>INT

Table 15. Results from paired-samples *t* test in comparison for correct answer rates of items on the text type.

	Narrative (N=16)	Expository (N=17)
Mean	.728	.545
SD	.219	.243
t	49.729	
Sig.	<.001	

Easiness:
NAR>EXP

Table 16. Results from paired-samples *t* test in comparison for correct answer rates of items on the item format.

	Multiple-choice (N=15)	Constructed-response (N=18)
Mean	.738	.548
SD	.234	.213
t	65.121	
Sig.	<.001	

Easiness:
MC>CR

Results

Research Question 1: What are the Patterns of Reading Comprehension Attributes in Fourth Grade at Different Proficiency Levels as well as the whole group?

1. Specifying Attributes and Constructing Q-matrix

Table 17. Results of model-data fit for Q1 to Q4

Q-matrix	Q1	Q2	Q3	Q4
Attribute	$\alpha_1, \alpha_2, \alpha_3, \alpha_4$	Q1 + α_5	Q1 + α_6	Q1 + α_5 + α_6
No. of item parameters	77	118	116	176
-2LL	85233.76	83856.32	83241.32	82285.75
AIC	85387.76	84092.32	83473.32	82637.75
BIC	85838.45	84783.00	84152.30	83667.92
MADcor	0.061	.048	.043	.032
MADres	1.135	.892	.805	.588
MX2	155.871	111.260	102.118	60.682
P (max (χ^2))	<.001	<.001	<.001	<.001
SRMSR	0.075	.062	.054	.042

The best model fit

Table 18. Jaccard coefficients between the attributes of the selected Q-matrix

Attribute	α_1	α_2	α_3	α_4	α_5	α_6
α_1						
α_2	.084					
α_3	.000	.126				
α_4	.030	.000	.000			
α_5	.000	.000	.450	.000		
α_6	.000	.000	.340	.000	.000	

No coefficients are bigger than .5
=not similar each other

Results

Research Question 1: What are the Patterns of Reading Comprehension Attributes in Fourth Grade at Different Proficiency Levels as well as the whole group?

2. Model Specification: Selecting an Appropriate CDM

The best model fit

Table 19. Model fit indices for the CDMs

	G-DINA	DINA	RRUM	DINO	ACDM
No. of item parameters	176	88	123	88	123
-2LL	82285.75	84200.38	82745.32	84937.94	82688.42
AIC	82637.75	84376.38	82991.32	85113.94	82934.42
BIC	83667.92	84891.46	83711.27	85629.02	83654.36
MADcor	.032	.058	.039	.060	.034
MADres	.588	1.089	.723	1.124	.641
MX2	60.682	122.765	73.722	147.572	59.874
P (max (χ^2))	<.001	<.001	<.001	<.001	<.001
SRMSR	.042	.067	.049	.073	.044

Table 20. Model comparison between G-DINA, RRUM, and ACDM

	Model 1	Model 2	χ^2	*df*	P-value
1	G-DINA	ACDM	402.670	53	<.001
2	G-DINA	RRUM	459.572	53	<.001
3	ACDM	RRUM	56.902	0	<.001

Results

Research Question 1: What are the Patterns of Reading Comprehension Attributes in Fourth Grade at Different Proficiency Levels as well as the whole group?

3. Estimating the Attribute Mastery Patterns

Table 21. Reading comprehension attribute mastery of reading proficiency groups

Levels	N	α_1	α_2	α_3	α_4	α_5	α_6	Score
All	2574	.768	.754	.737	.758	.553	.541	20.915
High	491	.999	.999	.999	.999	.980	.992	29.593
Intermediate	540	.942	.929	.909	.929	.378	.409	21.561
Low	548	.162	.139	.125	.152	.355	.183	10.296

Note. N = sample size; α_1 = Retrieval; α_2 = Inference; α_3 = Integration; α_4 = Evaluation; α_5 = Constructed responses; α_6 = Expository text; Score = A total of test score

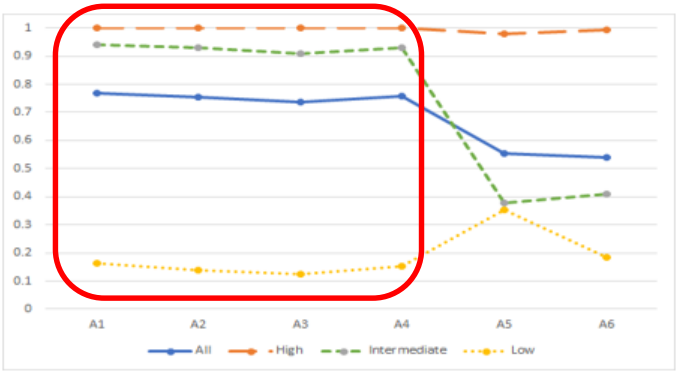


Figure 3. Attribute mastery probabilities of groups at different reading proficiency

Insignificant Differences in the comprehension attributes

Results

Research Question 1: What are the Patterns of Reading Comprehension Attributes in Fourth Grade at Different Proficiency Levels as well as the whole group?

3. Estimating the Attribute Mastery Patterns

Table 22. Correlations among the attribute mastery probabilities for the whole group

Attributes	RET	INF	INT	EVA	CON	EXP
RET						
INF	.968*					
INT	.894*	.936*				
EVA	.945*	.983*	.965*			
CON	.201*	.177*	.183*	.163*		
EXP	.352*	.295*	.329*	.302*	.607*	

Note. RET=Retrieving; INF=Inferencing; INT=Integrating; EVA=Evaluating; CON=Constructed-response items; EXP=Expository text

Figure 4. Scatterplots for the correlation of attribute mastery probabilities for the whole group
Note. N = sample size; A_1 = Retrieval; A_2 = Inference; A_3 = Integration; A_4 = Evaluation; A_5 = Constructed responses; A_6 = Expository text

Highly correlated comprehension attributes

Results

Research Question 1: What are the Patterns of Reading Comprehension Attributes in Fourth Grade at Different Proficiency Levels as well as the whole group?

3. Estimating the Attribute Mastery Patterns

Table 24. The 10 most frequent attribute mastery profiles

	Patterns (Latent class)	%	Remarks
1	111111	31.96	Master all attributes
2	111100	19.37	Master the four reading comprehension process attributes (RET, INF, INT, and EVA), but not CON and INF
3	111101	11.55	Master all attributes except for CON
4	000000	8.80	Master none of the attributes
5	111110	8.68	Master all attributes except for INF
6	000010	5.45	Master CON only
7	000011	5.42	Master CON and INF, not the four reading comprehension process attributes (RET, INF, INT, and EVA)
8	000001	1.42	Master INF only
9	100011	1.31	Master only RET, CON, and INF
10	110100	1.11	Master RET, INF, and EVA, but not INT, CON, and INF

Master all four comprehension attributes = 71.56%
Master none of the four attributes = 21.09%
* In terms of the mastery rate, the four comprehension attributes were not divisible for about 93% of examinees.

Table 25. Distribution of Attribute mastery patterns in each proficiency level

Level	Pattern	Frequency	Percent
High	111111	491	100
Intermediate	111100	209	38.7
	111101	131	24.3
	111110	114	21.1
	111111	45	8.3
	110111	14	2.6
	000011	12	2.2
	100011	9	1.7
	001011	2	.4
	001111	1	.2
	110011	1	.2
	110101	1	.2
	110110	1	.2
Low	000000	240	43.8
	000010	131	23.9
	000011	47	8.6
	111100	45	8.2
	000001	36	6.6
	110100	16	2.9
	001100	9	1.6
	110010	5	.9
	011100	3	.5
	100000	3	.5
	100001	3	.5
	110110	3	.5
	001000	2	.4
	100010	2	.4
	001011	1	.2
	100011	1	.2
	111101	1	.2

Results

Research Question 2: How do the Attributes Affect the Achievement of Reading Comprehension?

Table 23. Model fit statistics for the whole group using unparceled items

Name	χ^2	*df*	*p*	RMSEA	WRMR	CFI	TLI
O1G	2396.22	495	<.001	.039	1.875	.954	.954
C2I	2369.89	494	<.001	.038	1.861	.954	.951
C2C	2354.38	494	<.001	.038	1.857	.955	.952
C2T	1465.42	494	<.001	.028	1.446	.976	.975

Note. RMSEA = root mean square error of approximation; WRMR = weighted root-mean-square residual; CFI = comparative fit index; TLI = Tucker–Lewis index; O1G = one factor model using 1 general reading comprehension factor; C2I = Correlated two factor model using 2 item format factors; C2C= Correlated two factor model using 2 comprehension process attribute factors; C2T= Correlated two factor model using 2 text type factors

Table 24. Model fit statistics for the low-level group using unparceled items

Name	χ^2	*df*	*p*	RMSEA	WRMR	CFI	TLI
O1G	869.06*	495	<.001	.037	1.376	.656	.633
C2I	866.02*	494	<.001	.037	1.372	.658	.634
C2T	756.06*	494	<.001	.031	1.262	.759	.742

Note. RMSEA = root mean square error of approximation; WRMR = weighted root-mean-square residual; CFI = comparative fit index; TLI = Tucker–Lewis index; O1G= one factor model using 1 general reading comprehension factor; C2I= Correlated two factor model using 2 item format factors; C2T= Correlated two factor model using 2 text type factors

Figure 5. The structure of C2T model

Results

Research Question 2: How do the Attributes Affect the Achievement of Reading Comprehension?

Table 25. Model fit statistics for the whole group using parceled items

Name	AIC	BIC	χ^2	*df*	*p*	RMSEA	SRMR	CFI	TLI
S1G2C	36678.3	36760.2	.107	0	<.001	0	.001	1.000	1.000
C2C	36676.3	36752.4	.107	1	.744	0	.001	1.000	1.001
O1G	36674.7	36744.9	.580	2	.748	0	.001	1.000	1.001

Note. AIC = Akaike's information criterion; BIC = Bayesian information criterion; RMSEA = root mean square error of approximation; SRMS = standardized root mean square residual; CFI = comparative fit index; TLI = Tucker–Lewis index; S1G2C = second-order model + 1 general reading comprehension factor + 2 reading comprehension process attribute factors; C2C= Correlated two factor model using 2 reading comprehension process attribute factor; O1G = One factor model using 1 general reading comprehension factor

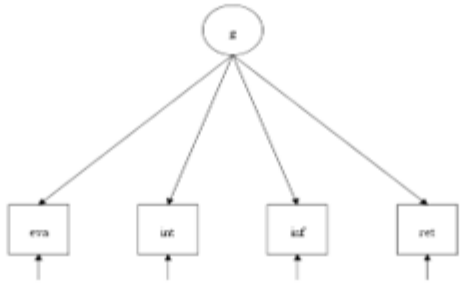


Figure 6. The structure of O1G model

Results

Research Question 2: How do the Attributes Affect the Achievement of Reading Comprehension?

Table 26. Model fit statistics for the different proficiency groups using parceled items

Level	Name	AIC	BIC	χ^2	*df*	*p*	RMSEA	SRMR	CFI	TLI
Low	O1G	7282.3	7333.9	4.680	2	.096	.049	.019	.988	.963
	C2C	2861.9	2917.9	1.212	1	.271	.02	.011	.995	.973
Inter-mediate	O1G	5762.9	5814.5	.340	2	.844	0	.008	1.000	1.014

Note. AIC = Akaike's information criterion; BIC = Bayesian information criterion; RMSEA = root mean square error of approximation; SRMS = standardized root mean square residual; CFI = comparative fit index; TLI = Tucker–Lewis index; O1G = One factor model using 1 general reading comprehension factor; C2C= Correlated two-factor model using 2 reading comprehension process attribute factor

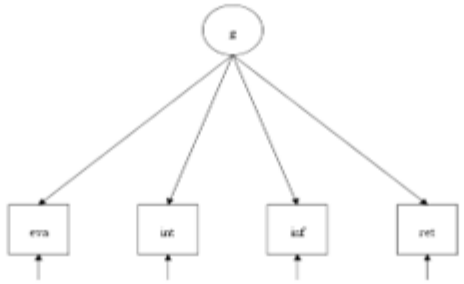


Figure 6. The structure of O1G model

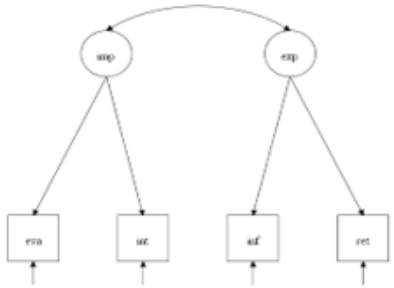


Figure 7. The structure of C2C model

Discussion

Indivisibility of the Four Reading Comprehension Process Attributes

1) There were no significant differences among the mastery probabilities of the four attributes within each different proficiency group as well as the whole group.

2) The high correlations (.894 to .945) between the attribute mastery probabilities (Table 22) support the indivisibility of the four attributes.

3) For about a total of About 93% of examinees, reading comprehension attributes are likely to be indivisible in that they mastered all four process attributes or failed to master all of them showing the mastery patterns of “1111XX” or “0000XX”

4) The results of the factor analyses also supported that the reading comprehension processes tended to be indistinguishable.

Considering the indivisibility of the reading attributes, the examination of readers’ component skills may provide more reliable and abundant information for diagnosis at different proficiency levels.

Discussion

The Role of Item Format in Reading Achievement

1) In order to account for the significant differences in mastery probability between CON and the other attributes, the characteristics of answering constructed-response should be considered. While attending elementary school, mean sentence length in words largely corresponds to their age up to about the fourth grade (or age 10) and, around the time, children's writing should start to include sentences with formal syntactic structures which may sound formal if they are spoken (Scott & Balthazar, 2010). In order to receive the full credits from the items having 2 or 3 credits in PIRLS 2011, examinees should often provide relatively long sentences using more than 10 words, which can be cognitively demanding for examinees.

2) In addition, the coding method used in this study may have significantly affected the low mastery rate of CON. In this study, four constructed-response items with full-credit (2), partial credit (1), and no credit (9) were changed to dichotomous items by assigning full credit (2) to 1 (correct) and remaining scores (1, 0) to 0 (incorrect).

Discussion

The Role of Text Type in Reading Achievement

1) Expository texts are generally more challenging for children to comprehend than narrative texts (e.g., Best et al., 2006), which was also suggested in this study.

2) However, in PIRLS 2011, it should be noted that the expository text is different from the narrative text in the text features based on the results of Lexile text analysis and Coh-Metrix text analysis. Specifically, several text features (i.e., Lexile measure, mean sentence length, number of words, narrativity, and syntactic complexity) indicated that the narrative text is easier than expository text in PIRLS 2011, so it cannot be concluded that text type itself determines the low mastery rate of EXP in this study.

Discussion

Instructional Implications

(1) Indivisibility of reading comprehension attributes: It can be more critical for teachers to provide instruction according to the diagnoses of reading component skills and reading processes based on highly evidence-based frameworks such as SVR or Perfetti's framework for comprehension.

(2) Low mastery rate of answering constructed-response items: It may be critical to write sentences grammatically and understandably for constructed-response items. In addition, when a student failed to correctly answer a constructed-response item, the teacher needs to recognize whether the wrong answer was due to the deficit reading comprehension or deficit writing ability. Lastly, according to Collins (2015), oral language skills have a significant impact on the response accuracy of this item format. Providing appropriate instruction to enhance readers' oral language may contribute to improving the readers' skills to answer constructed-response items.

(3) Low mastery rate of expository text comprehension: Comprehension strategies (i.e., making connections and predictions, self-monitoring, and questioning), Graphic organizer, and text structure and before-reading interventions have been suggested as effective methods for expository text comprehension for elementary school students.

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Thank you!