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Development of an Item Bank of Order and Graph by Applying Multidimensional Item Response Theory

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Abstract

This study aimed to develop an item bank of Order and Graph of Mattayomsuksa 1 level (grade 7). The samples were 4,800 lower secondary students from 34 schools in northeastern area of Thailand, academic year 2011 chosen through multi-stage random sampling. The research tool used in the study was a multiple choicetest of an Order and Graph lesson by applying multidimensional item response theory. Parameter were analyzed by confirmatory factor analysis by applying multidimensional normal-ogive model with guessing of the program normal-ogive harmonic analysis robust method (NOHARM). Discrimination power and Easiness intercept were equated through non–orthogonal procrustes method. The study results indicated that there were 59 items out of 140 passed the test standard.

Key words: Item bank; Cognitive process; Multidimensional item response theory (MIRT)

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INTRODUCTION

The three methods for managing an effective learning achievement are having clear educational goals and objectives, having effective learning procedures for students to get cognitive, affective and psychomotor domains, and having an appropriate effective evaluation (Kanjanawasri, 2009, p.2-6).

The well-known learning process that was widely used was the cognitive domain of Bloom *et al.* (1956) who divided 6 learning processes of the brain including, knowledge, understanding, applying, analyzing, synthesizing and evaluation. In 2001, Anderson *et al.* (2001, p.27-31) had developed this learning process, changing the keywords and rearranging the processes with two dimensions; cognitive process and knowledge. The cognitive dimension included of 6 processes: remembering, understanding, applying, analyzing, evaluation and creating respectively. The knowledge dimension consisted of 4 parts: factual knowledge, conceptual knowledge, procedural knowledge and meta knowledge.

The educational evaluators believe that the inspecting model of the cognitive dimension is based on item response process. Therefore, psychological theory is considered as the base of inspecting the cognitive dimension (Rupp & Templin, 2008a, p.225). According to this, the cognitive dimension inspecting model is undoubtedly associated with psychology and measurement theories which consist of 3 types including classical test theory (CTT), unidimensional item response theory (IRT) and multidimensional item response theory (MIRT). Multidimensional Item Response Theory Models (MIRTM) are the most effective model and consists of latent variables. Each of them indicates its latent trait for the inspection (Haberman, 2008, p. 204-205; Rupp & Templim, 2008b, p.78-80; Sinhary *et al.*, 2007, p.22).

The model is from factor analysis of Structural Equation Modeling (SEM) and it is the implement of IRT (Reckase, 2009, p.63). MIRTM can effectively explain a tester's answers from the test since it can analyze lots of one's factors at the same time, (Embretson & Reise, 2000, p.82).

In conclusion, the development of the item bank by applying MIRT will decrease the number of the test items since it can explain many factors of learners at the same time while the effectiveness is better than CTT and IRT (Frey & Seitz, 2009, p.89).

PURPOSES OF THE STUDY

This study aimed to develop Mattayomsuksa one's item bank of Order and Graph by applying multidimensional item response theory with its specific objectives as follows;

1. To create the test on Order and Graph of Mattayomsuksa 1 level.
2. To find the quality of the test that its parameter value was analyzed through multidimensional normal ogive model with guessing.
3. To arrange an item bank of Order and Graph, Mattayomsuksa 1 level.

PROCEDURES

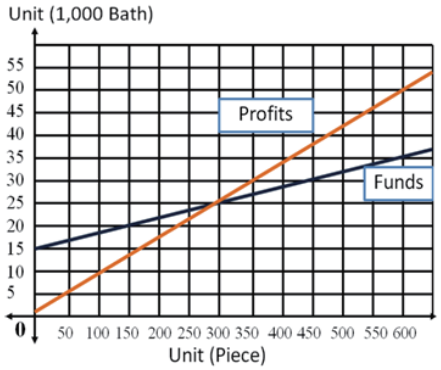
Samples

The samples of this study were 4,800 lower secondary students from 34 schools in northeastern area of Thailand. 3,046 students were from large schools, 1,415 of them were from medium schools and the rests were from small schools. They were chosen through multi-stage random sampling.

Tools and Collecting Data

The tools used in the study was multiple choice test of Order and Graph, 140 items, created by MIRT and cognitive theory including the cognitive processes and the knowledge dimensions. For example, Figure 1. The test validity and Q-matrix were approved by the experts to choose the items that had IOC at 0.50 or higher for learners' further test. 136 items were chosen and the researcher divided the items into 4 copies, then tested the students by Anchor – test design and anchor – test random group. Each copy of the test had common or anchor items called "Anchor test" (Kanjanawasri, 2007, p.164). The purpose of an anchor test was to get a test result to calibration parameters compare with parameter. There were 8 out of 136 items guessed to be an anchor test while the rests were divided into 4 copies, 32 items per each. Thus, each copy consisted of 40 items. Then, the researcher tested the students who had learned lesson. Each pupil got only one test copy.

Item: The graph presented funds and profits of a Company's manufactures



The Knowledge Dimension	The Cognitive Process Dimension			
	1. Remember	2. Understand	3. Apply	4. Analyze
A.Factual knowledge	✓A1			
B.Conceptual Knowledge		✓B2		✓B4
C.Procedural Knowledge			✓C3	

A1 refers to remembering factual knowledge
B2 refers to understanding conceptual knowledge
C3 refers to applying procedural knowledge
B4 refers to analyzing conceptual knowledge

Remark The test could measured 4 dimensions of cognitive process including A1, B2, C3 and B4

Figure 1
A Sample of Multidimensional Items

DATA ANALYSIS

1. Bring the students' test results for having confirmatory factor analysis by multi- dimensional item response model of multidimensional normal ogive model with NOHARM (Normal ogive by harmonic analysis robust method). Then, set the c value of each item at 0.20 while parameter, a value, discrimination power (a) and essiness intercept (b) were estimated from the possibility of the students' test ability in multidimensional normal ogive model (Bock & Schilling, 2003, p.585; McDonald, 1999, p.317; Reckase, 2009, p.95; Samejima, 1974, p.114) as shown in Equation 1.

$$P(\mu_{ij} = 1 \mid \ _j, \mathbf{a}_j, c_i, d_i) = c_i + (1+c_i)\frac{1}{\sqrt{2\pi}} \int_{-z_i(\ _j)}^{\infty} e^{\frac{-t^2}{2}} dt$$

Where $z_i(\boldsymbol{\theta}_j) = \mathbf{a}_j\boldsymbol{\theta}'_j + d_i$ (1)

Where $P(\mu_{ij} = 1\theta_j, \mathbf{a}_j, c_i, d_i)$ is the probability of a correct response for examinee j on test item i an in m dimensional space, u_{ij} is the item response for person j on item i (1 correct; 0 wrong), $\mathbf{a}_j$ is a vector of parameters that specifies the discrimination power of the item i on each of the n-dimensions in the space, c_i is a parameter that specifies the probability of correct response for persons who are low on all of the dimensions, d_i is a parameter

related to the difficulty of item i, (Essiness intercept), $\mathbf{q}_j$ is a vector of parameters that describe the location of person j in an n-dimensional space, and e is the mathematical constant 2.7182818.

2. Multidimensional discrimination (MDISC) and Multidimensional difficulty (MDIFF) were inspected to meet the test quality as presented in equation 2 and 3 respectively (Reckase & McKinley, 1991, p.367; Reckase, 2009, p.117).

$$MDISC = \sqrt{\sum_{k=1}^{m} a_{ik}^2} \quad (2)$$

$$MDIFF = \frac{-d_i}{\sqrt{\sum_{k=1}^{m} a_{ik}^2}} \quad (3)$$

3. NOP (Non – othogonal procrustes method) of Scilab5.1 was applied to equating of the discrimination power and essiness intercept parameters as shown in equation 4 and 5 (Reckase & Martineau, 2004, p.22)

$$\mathbf{a}^*_i = \mathbf{a}'_i\mathbf{T} \quad (4)$$

$$d^*_i = \mathbf{d}_i + \mathbf{a}^*_i\mathbf{Tm} \quad (5)$$

Where $\mathbf{a}^*_i$ and d^*_i are the values of parameters from the comparison form transformed to match the metric of the base form, $\mathbf{a}_i$ is a vector of discrimination parameters; item i of the comparison form, d_i is a parameter related to item difficulty; item i of the comparison form, **m** is a translation vector for location and **T** is an orthogonal procrustes rotation matrix for positioning calculated from $\mathbf{T} = (\mathbf{A'A})^{-1}\mathbf{A'B}$ while **A** is the matrix of the discrimination power of the comparison form, **B** was a parameter matrix of the base test discrimination of the base form.

RESULTS

1. The Test on Order and Graph, Mattayousuksa 1

The results indicated that all of the 140 items were accordant with the content and appropriate for the cognitive process dimension. 136 items were chosen to make the test in order to find the parameter is presented in Table 1. Most of the items (70 items) measured students' remembering factual knowledge and understanding conceptual knowledge (2 dimensions). The test items measuring remembering factual knowledge, understanding conceptual knowledge, applying procedural knowledge and analyzing conceptual knowledge, (4 dimensions) were 29 items. 27 items was the 3 a dimension test which measured three factors, remembering factual knowledge, understanding conceptual knowledge and applying procedural knowledge, and the rest was the 1 dimension test measuring only remembering factual knowledge.

Table 1
Results of Accordance Among the Test on, Contents and the Appropriation of Cognitive Process Dimension

Cognitive Process	Numbers of item		
	Provided	Passed the standard	Chosen
A1	10	10	10
A1 and B2	73	73	70
A1, B2 and C3	28	28	27
A1, B2, C3 and B4	29	29	29
Total	140	140	136

Remark: A1 refers to remembering the factual knowledge, B2 refers to understanding conceptual knowledge, C3 refers to applying procedural knowledge and B4 refers to analyzing conceptual knowledge.

2. Finding the Quality of the Test by Multidimensional Normal Ogive Model with Guessing

From analyzing the students' test results by confirmatory factor analysis with multidimensional normal ogive model with guessing of NOHARM (Normal ogive by harmonic analysis robust method), and equating the item parameter by non–orthogonal procrustes method (NOP Method) of Reckase and Martineau (2004), the researcher found out that the ranking from the highest to the lowest discrimination were the first, the second, the fourth and the third, -4.650 - 7.793, -2.372 - 5.409, -1.909 - 2.809 and -0.342 - 2.224 respectively. Each has its average value at 1.002, 0.751, 0.401 and 0.339 respectively with the standard deviations at 1.715, 1.307, 1.016 and 0.728 respectively. Moreover, d value was between -8.799 -10.584; average -0.739 and the standard deviation at 2.509. MDISC was between 0.095 - 8.769; average, 1.963 with 1.686 of a standard deviation. MDIFF was between -5.041 -12.916, average 0.693 and 2.251 of the standard deviation as presented in Table 2.

Table 2
Results of Estimating Parameter of Item Bank of by NOHARM and Applying NOP to Normalize the Parameter of 136 Items

Item	a_1	a_2	a_3	a_4	d	MDISC	MDIFF
1	0.652	-	-	-	0.147	0.652	-0.225
2	1.111	-	-	-	-0.762	1.111	0.686
3	0.712	-	-	-	-0.151	0.712	0.212
4	-0.095	-	-	-	-1.227	0.095	12.920
5	1.285	-	-	-	-0.800	1.285	0.623
6	1.115	-	-	-	0.319	1.115	-0.286
7	-0.173	-	-	-	0.095	0.173	-0.549
8	0.825	-	-	-	0.475	0.825	-0.576
9	0.367	-	-	-	-0.705	0.367	1.921
10	0.350	-	-	-	0.213	0.350	-0.609
11	1.646	-0.196	-	-	-0.944	1.658	0.569
12	0.201	1.020	-	-	-0.428	1.040	0.412
13	-0.089	1.757	-	-	1.340	1.759	-0.762
14	2.934	-0.794	-	-	-1.828	3.040	0.601
15	-0.336	1.004	-	-	-1.424	1.059	1.345
16	0.685	0.342	-	-	-0.291	0.766	0.380
17	0.164	1.738	-	-	0.635	1.746	-0.364

To be continued

Continued

Item	a_1	a_2	a_3	a_4	d	MDISC	MDIFF
18	0.602	3.125	-	-	0.186	3.182	-0.058
19	0.390	3.636	-	-	2.114	3.657	-0.578
20	0.463	1.920	-	-	-0.131	1.975	0.066
21	-0.152	1.740	-	-	0.837	1.747	-0.479
22	-0.005	0.761	-	-	-0.359	0.761	0.472
23	0.152	0.832	-	-	-0.159	0.846	0.188
24	1.698	0.342	-	-	0.104	1.732	-0.060
25	0.957	0.111	-	-	-0.328	0.963	0.340
26	1.589	-0.402	-	-	-0.210	1.639	0.128
27	2.744	-1.252	-	-	-1.629	3.016	0.540
28	1.666	-0.437	-	-	-0.865	1.722	0.502
29	4.145	0.720	-	-	-1.649	4.207	0.392
30	1.007	0.477	-	-	0.463	1.114	-0.416
31	3.602	-1.092	-	-	-2.311	3.764	0.614
32	4.227	-1.423	-	-	-3.818	4.460	0.856
33	0.317	0.818	-	-	0.135	0.877	-0.154
34	0.147	1.051	-	-	0.291	1.061	-0.274
35	0.531	1.478	-	-	0.639	1.570	-0.407
36	0.620	0.857	-	-	0.117	1.058	-0.111
40	1.552	2.538	-	-	0.159	2.975	-0.053
41	-0.077	1.527	-	-	0.094	1.529	-0.061
42	0.749	5.409	-	-	-3.446	5.461	0.631
43	1.035	1.763	-	-	-1.240	2.044	0.607
44	0.787	1.719	-	-	-1.009	1.891	0.534
45	-1.141	4.937	-	-	-1.222	5.067	0.241
46	-0.959	3.620	-	-	0.216	3.745	-0.058
47	-0.845	4.149	-	-	-0.412	4.234	0.097
48	2.338	-1.566	-	-	-0.678	2.814	0.241
49	1.923	-1.380	-	-	-0.462	2.367	0.195
50	2.420	0.834	-	-	-4.960	2.560	1.938
51	0.102	0.670	-	-	-0.239	0.678	0.353
52	-0.085	1.007	-	-	1.241	1.011	-1.228
53	0.144	0.811	-	-	0.266	0.824	-0.323
54	-0.273	-0.273	-	-	1.358	0.386	-3.517
55	-0.657	2.091	-	-	1.475	2.192	-0.673
56	0.327	0.138	-	-	-1.112	0.355	3.133
57	-0.962	2.409	-	-	1.726	2.594	-0.665
58	-0.562	1.712	-	-	1.011	1.802	-0.561
59	1.880	-0.351	-	-	0.176	1.912	-0.092
60	4.921	0.678	-	-	-0.652	4.967	0.131
61	0.582	0.426	-	-	0.785	0.721	-1.088
62	0.531	0.403	-	-	0.805	0.667	-1.208
63	4.108	1.314	-	-	-0.200	4.313	0.046
64	7.607	4.033	-	-	-6.434	8.610	0.747
65	7.793	4.020	-	-	-7.283	8.769	0.831
66	-0.122	0.712	-	-	0.627	0.722	-0.868
67	0.524	1.685	-	-	-0.034	1.765	0.019
68	-0.037	0.655	-	-	-0.095	0.656	0.145
69	0.360	0.360	-	-	0.159	0.509	-0.312
70	0.216	1.754	-	-	2.045	1.767	-1.157
71	0.129	1.649	-	-	1.229	1.654	-0.743
72	-0.004	1.527	-	-	1.157	1.527	-0.758
73	-0.192	1.090	-	-	0.853	1.107	-0.771
74	2.871	0.849	-	-	-1.322	2.994	0.442
75	1.484	0.591	-	-	-0.743	1.597	0.465
76	4.671	0.759	-	-	-0.209	4.732	0.044
77	5.207	0.968	-	-	-0.111	5.296	0.021
78	3.196	0.329	-	-	-0.277	3.213	0.086
79	1.149	0.373	-	-	0.386	1.208	-0.320
80	1.343	0.528	-	-	-1.111	1.443	0.770

To be continued

Continued

Item	a_1	a_2	a_3	a_4	d	MDISC	MDIFF
81	-0.048	-0.014	0.347	-	-3.880	0.351	11.07
82	3.802	1.631	2.051	-	-4.163	4.618	0.902
83	-0.208	0.593	0.758	-	-1.106	0.985	1.123
84	0.046	0.144	0.183	-	-1.962	0.237	8.266
85	0.361	-0.178	0.002	-	-1.305	0.403	3.242
86	0.736	0.016	-0.061	-	0.084	0.739	-0.114
87	0.848	-0.190	-0.909	-	-1.055	1.258	0.839
88	1.494	0.278	1.985	-	-2.385	2.500	0.954
89	0.721	-0.106	-0.272	-	-1.060	0.778	1.363
90	0.179	0.034	-0.059	-	-1.342	0.192	7.007
91	0.397	-0.195	-0.162	-	-1.434	0.471	3.044
92	1.615	1.168	1.113	-	-1.347	3.559	0.378
93	-4.650	1.397	1.890	-	-4.069	5.210	0.781
94	2.058	4.208	0.518	-	0.069	4.713	-0.015
95	0.826	0.897	0.070	-	-0.459	1.221	0.376
96	0.650	0.496	0.338	-	-0.053	0.885	0.060
97	0.212	0.574	0.130	-	1.040	0.626	-1.663
98	0.628	0.265	0.335	-	-0.373	0.759	0.491
99	0.957	0.701	0.580	-	-0.681	1.320	0.516
100	4.910	1.697	2.444	-	-4.521	5.741	0.787
101	1.255	-0.037	0.574	-	-1.185	1.381	0.858
102	0.658	-1.024	-1.884	-	10.370	2.243	-4.624
103	0.230	-1.075	-0.960	-	4.483	1.459	-3.072
104	-0.150	-0.861	-1.909	-	10.580	2.100	-5.041
105	0.148	-0.173	0.536	-	-2.576	0.582	4.423
106	5.004	2.160	2.809	-	-8.799	6.132	1.435
107	4.968	2.083	2.783	-	-6.031	6.063	0.995
108	3.312	1.373	1.240	-	1.168	3.794	-0.308
109	-0.015	0.266	0.217	0.222	-1.825	0.409	4.461
110	0.662	-0.279	-0.310	0.195	-1.227	0.806	1.522
111	1.524	0.177	0.060	1.209	-2.821	1.954	1.444
112	0.631	0.470	0.232	1.326	-1.344	1.559	0.862
113	0.086	0.586	-0.606	1.763	-2.784	1.956	1.423
114	0.108	0.150	-0.177	-0.327	-1.334	0.415	3.213
115	1.284	0.945	0.676	2.224	-3.301	2.819	1.171
116	0.472	0.458	0.685	0.864	-1.613	1.284	1.256
117	-0.091	1.341	-0.609	0.370	-1.588	1.521	1.044
118	-0.319	-0.002	0.085	-0.273	-1.103	0.428	2.575
119	3.327	-2.372	-0.475	2.025	-5.028	4.585	1.097
120	0.244	-0.241	-0.032	0.421	-1.694	0.544	3.114
121	0.220	0.493	0.054	1.214	-2.870	1.330	2.158
122	0.335	-0.222	0.042	0.106	-1.050	0.418	2.514
123	0.124	-1.176	-1.586	-0.342	6.506	2.008	-3.241
124	0.415	-0.356	-0.310	0.056	1.098	0.631	-1.740
125	0.333	0.409	0.279	0.041	-1.315	0.598	2.199
126	0.172	0.318	-0.229	0.439	-0.225	0.613	0.367
127	0.225	-0.338	-0.896	0.435	2.914	1.076	-2.709
128	-0.573	0.053	0.432	-0.055	-3.533	0.722	4.896
129	-0.307	0.107	0.328	-0.036	-2.547	0.463	5.498
130	0.338	0.685	0.838	-0.136	0.461	1.142	-0.404
131	-0.485	-0.391	-0.015	-0.009	-2.325	0.623	3.731
132	3.572	1.398	2.024	-0.018	-7.383	4.337	1.702
133	3.685	0.874	2.008	-0.061	-3.318	4.287	0.774
134	0.148	0.467	0.707	-0.117	-0.418	0.868	0.482
135	-0.806	-0.590	0.577	-0.108	-3.001	1.159	2.590
136	-1.947	-0.962	0.542	-0.212	-5.081	2.248	2.260
$\overline{X}$	1.002	0.751	0.339	0.401	-0.734	1.963	0.693
S	1.715	1.307	1.016	0.728	2.506	1.686	2.251
Min	-4.650	-2.372	-1.909	-0.342	-8.799	0.095	-5.041
Max	7.793	5.409	2.809	2.224	10.584	8.769	12.916

Remark: Discrimination, dimension 1(a_1), Discrimination, dimension 2 (a_2), Discrimination, dimension 3(a_3), Discrimination, dimension 4(a_4), Eassiness Intercept (d), Multidimensional discrimination (MDISC) and Multidimensional difficulty (MDIFF)

Results of choosing 136 test items to an item bank: From Table 2, the test discrimination power of each dimension was not in negative value, MDIFF was between -4.00 - 4.00, MDISC was higher than 0.30 and each dimension didn't seem to have different discrimination power from each other. There were 59 items passing the standard. 38 items were based on remembering factual knowledge and understanding conceptual knowledge. 8 items were based on remembering factual knowledge, 1 dimension, while the items that measured the remembering factual knowledge, understanding conceptual knowledge and applying procedural knowledge consisted of 8 items as well, and 5 items belonged to the 4 dimensional item that focused on remembering factual knowledge, understanding conceptual knowledge, applying procedural knowledge and analyzing conceptual knowledge as presented in Table 3.

Table 3
A Number of Items Chosen to an Item Bank of Classified by Cognitive Process Dimension

Cognitive process dimension	Testing and parameter analysis	The test items' parameter passed the standard	
		Numbers of item	Ordinal items
A1	10	8	1, 2, 3, 5, 6, 8, 9, 10
A1 and B2	70	38	12, 16, 17, 18, 19, 20, 23, 24, 25, 29, 30, 33, 34, 35, 36, 37, 39, 40, 43, 44, 51, 53, 56, 60, 61, 62, 63, 67, 69, 70, 71, 74, 75, 76, 77, 78, 79, 80
A1, B2 and C3	27	8	88, 92, 94, 95, 96, 97, 98, 99
A1, B2, C3 and B4	29	5	111, 112, 116, 121, 125
Total	136	59	

Remark: A1 refers to remembering the factual knowledge, B2 refers to understanding conceptual knowledge, C3 refers to applying procedural knowledge and B4 refers to analyzing conceptual knowledge.

Table 4
Parameter Values of 59 Items Chosen to Item Bank of Order and Graph

Item	a_1	a_2	a_3	a_4	d	MDISC	MDIFF
1	0.652	-	-	-	0.147	0.652	-0.225
2	1.111	-	-	-	-0.762	1.111	0.686
3	0.712	-	-	-	-0.151	0.712	0.212
4	1.285	-	-	-	-0.800	1.285	0.623
5	1.115	-	-	-	0.319	1.115	-0.286
6	0.825	-	-	-	0.475	0.825	-0.576
7	0.367	-	-	-	-0.705	0.367	1.921
8	0.350	-	-	-	0.213	0.350	-0.609
9	0.201	1.020	-	-	-0.428	1.040	0.412
10	0.685	0.342	-	-	-0.291	0.766	0.380
11	0.164	1.738	-	-	0.635	1.746	-0.364
12	0.602	3.125	-	-	0.186	3.182	-0.058
13	0.390	3.636	-	-	2.114	3.657	-0.578
14	0.463	1.920	-	-	-0.131	1.975	0.066
15	0.152	0.832	-	-	-0.159	0.846	0.188
16	1.698	0.342	-	-	0.104	1.732	-0.060
17	0.957	0.111	-	-	-0.328	0.963	0.340
18	4.145	0.720	-	-	-1.649	4.207	0.392
19	1.007	0.477	-	-	0.463	1.114	-0.416
20	0.317	0.818	-	-	0.135	0.877	-0.154
21	0.147	1.051	-	-	0.291	1.061	-0.274
22	0.531	1.478	-	-	0.639	1.570	-0.407
23	0.620	0.857	-	-	0.117	1.058	-0.111
24	0.067	1.853	-	-	0.995	1.854	-0.537
25	0.668	0.590	-	-	-0.063	0.891	0.071
26	1.552	2.538	-	-	0.159	2.975	-0.053
27	1.035	1.763	-	-	-1.24	2.044	0.607
28	0.787	1.719	-	-	-1.009	1.891	0.534
29	0.102	0.670	-	-	-0.239	0.678	0.353
30	0.144	0.811	-	-	0.266	0.824	-0.323
31	0.327	0.138	-	-	-1.112	0.355	3.133
32	4.921	0.678	-	-	-0.652	4.967	0.131
33	0.582	0.426	-	-	0.785	0.721	-1.088
34	0.531	0.403	-	-	0.805	0.667	-1.208
35	4.108	1.314	-	-	-0.200	4.313	0.046
36	0.524	1.685	-	-	-0.034	1.765	0.019
37	0.360	0.360	-	-	0.159	0.509	-0.312
38	0.216	1.754	-	-	2.045	1.767	-1.157
39	0.129	1.649	-	-	1.229	1.654	-0.743
40	2.871	0.849	-	-	-1.322	2.994	0.442
41	1.484	0.591	-	-	-0.743	1.597	0.465
42	4.671	0.759	-	-	-0.209	4.732	0.044
43	5.207	0.968	-	-	-0.111	5.296	0.021
44	3.196	0.329	-	-	-0.277	3.213	0.086
45	1.149	0.373	-	-	0.386	1.208	-0.320
46	1.343	0.528	-	-	-1.111	1.443	0.770
47	1.494	0.278	1.985	-	-2.385	2.500	0.954
48	1.615	1.168	1.113	-	-1.347	3.559	0.378
49	2.058	4.208	0.518	-	0.069	4.713	-0.015
50	0.826	0.897	0.070	-	-0.459	1.221	0.376
51	0.650	0.496	0.338	-	-0.053	0.885	0.060
52	0.212	0.574	0.130	-	1.04	0.626	-1.663
53	0.628	0.265	0.335	-	-0.373	0.759	0.491
54	0.957	0.701	0.580	-	-0.681	1.320	0.516
55	1.524	0.177	0.060	1.209	-2.821	1.954	1.444
56	0.631	0.470	0.232	1.326	-1.344	1.559	0.862
57	0.472	0.458	0.685	0.864	-1.613	1.284	1.256
58	0.220	0.493	0.054	1.214	-2.87	1.330	2.158
59	0.333	0.409	0.279	0.041	-1.315	0.598	2.198
$\overline{X}$	1.120	1.016	0.491	0.931	-0.258	1.744	0.188
S	1.247	0.875	0.541	0.527	0.973	1.282	0.831
Min	0.067	0.111	0.054	0.041	-2.870	0.350	-1.663
Max	5.207	4.208	1.985	1.326	2.114	5.296	3.133

3. Creating an Item Bank

The results of creating 59 items to an item bank of Order and Graph in Microsoft Access Program were;

1. The item bank was set as a multimedia including text and pictures that were questions, Choices, Answer, Discrimination power; dimension 1(a_1), dimension 2 (a_2), dimension 3(a_3), dimension 4(a_4), Eassiness Intercept (d), Multidimensional discrimination (MDISC),Multidimensional difficulty (MDIFF) and Guessing (c).

2. The manner of the difficulty index of the item bank on Order and Graph showed that the difficulty index of MDIFF was between -1.663 - 3.133, average value 0.188 with 0.831 of its standard deviation. This showed the symmetry of the graph with the average value was a little higher than 0 and meant the test had its medium difficultyto quite difficulty as showed in the Figure 2.

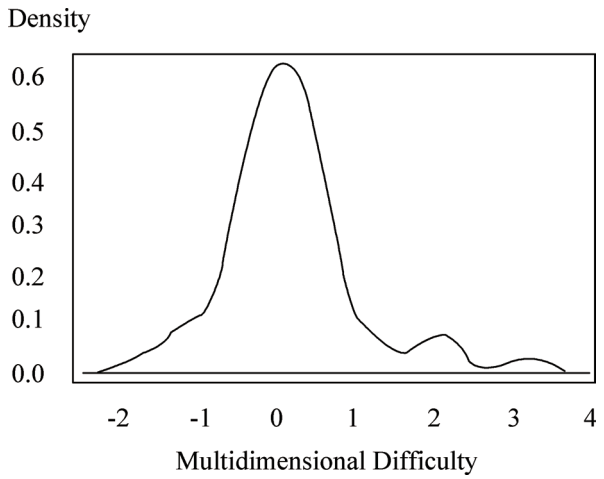


Figure 2
The Manner of the Difficulty Index of the Item Bank on Order and Graph

CONCLUSIONS

The item bank of Order and Graph, Mattayousuksa 1, 5 multiple choice, 140 items that the researcher and math teachers made passed the standard, approved by 16 experts, then 136 of them were chosen to the item bank.

The researcher found out according to inspecting to find the quality of the test which its parameter value was analyzed by Multidimensional normal ogive Model with guessing. The finding were as follow: (1) The results from estimating parameters of items of Order and Graph by NOHARM and adjusting the 136 test items' parameter by NOP showed that the discriminations of dimension 1, 2, 3 and 4 were between -4.650 - 7.793, -2.372 - 5.409, -1.909 - 2.809 and -0.342 - 2.224 respectively. d value was between -8.799 - 10.584, average -0.734 and its standard deviation was 2.506. MDISC 0.095 - 8.769, the average value was 1.963 and its standard deviation was 1.686. And MDIFF was between -5.041 - 12.916, average 0.693 and the standard deviation was 2.251. (2) The results of selecting the test items to an item bank of Order and Graph showed that 59 items passed the standard and mostly were the 2 dimension items; 38 items which measured remembering factual knowledge and understanding conceptual knowledge, 8 items were 1 dimension item measuring only remembering factual knowledge, other 8 items were 3 dimension one measuring remembering factual knowledge, understanding conceptual knowledge and applying procedural knowledge, and the rests were 4 dimension items measuring 4 elements; remembering factual knowledge, understanding conceptual knowledge, applying procedural knowledge and analyzing conceptual knowledge. (3) The results of 59 items'parameters analysis of an item bank of Order and Graph indicated that The discrimination power values of dimension 1, 2, 3 and 4 were between 0.067 - 5.207, 0.111 - 4.208, 0.054 - 2.113 and 0.041 - 1.326 respectively, d value was between -2.870 - 2.114, average value -0.258 with 0.973 of the standard deviation. MDISC was between 0.350 - 5.296, average value, 1.744 with 1.282 of the standard deviation. At last, MDIFF was between -1.663 - 3.133, average value, 0.188 with 0.831 of its standard deviation.

The results of creating an item bank of Order and Graph, Mattayomsuksa 1 level revealed that 59 of the test items were chosen to the item bank and gathered in Microsoft Access 2003. Each item was a 5 multiple choice. The details, pictures and information such as questions, answers and the test parameters were also included. This data base could also apply with the computer base test.

DISCUSSIONS

It was found out due to considering the relation of the item bank of Order and Graph, and an appropriation between cognitive process dimension and the experts' test items that all of the 140 items of the test passed the standard inspected by experts. It showed that each item of the test met its quality since the researcher, math teachers in high a school and a university helped each other to sift the best quality of each item.

When selecting the item to an item bank of Order and Graph, there were only 59 items passed the standard. It indicated that the Order and Graph was quite difficult. The guessing values were then high which affected the negative discrimination power. The study results of Science and Technology Institute (Dechri and Kamparasiri, 2009, p. B-C) indicated that Thai students had lowest scores on Order and Graph. In this study, the criteria of MDIFF was between -4.00 - 4.00 and the discrimination of each dimension was not to be negative. From the analysis, MDIFF of Order and Graph was 0.693, while d value was between -8.799 - 10.584, average, -0.734 and the discrimination was between - 4.650 - 7.793.

It was found that MDIFF was higher than 0, the normal standard. When considering d value, we found that it was negative which considered the high difficulty index. In order to get more items in the item bank, the researcher was to provide more items.

The discrimination power of the test didn't go together, some of it were positive while some were negative. It could be predicted that the relation of cognitive process dimension of Order and Graph in each item was complicated. Krathwohl (2002, p.215) also cited that the processes of cognitive dimension developed from Bloom *et al.* (1956) by Anderson *et al.* (2001) were flexible depending on the leaning climate.

It could be concluded from the test that had only one and negative discrimination value that the lesson, Order and Graph was quite difficult. Most of the students who got the right answer were owing to guessing. Some smarter students got lower scores than their friends. The discrimination was; therefore, negative. The difficulty index was undoubtedly related to the discrimination as showed in Table 3, item 4 that the discrimination power in dimension 1 was -0.095, d value was -1.227, MDISC was 0.095 and MDIFF was 12.920. It indicated that the test was difficult because MDIFF was higher than 0, the normal standard and d value was negative. Thus, it's obviously true that the higher the difficulty index the lower the discrimination value. This related to Kanjanawasri (2009, p. 233) who cited that the difficulty index and the discrimination were related to each other, too easy or too difficult tests would identify lowtest discrimination.

Providing the data base as a multimedia of an item bank including pictures and some important information so as to apply with computer base test would result the convenience and accuracy of testing. Parshall *et al.* (2002, p.23-25) also stated that the advantages of a computer base test was that it could provide the tester multimedia. The scores from the test could be reported immediately. Moreover, the reading effect of the tester who had low reading skills would be lessened because there would be some guideline information such as pictures to guide doing the test. The test would then be accurate and effective.

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