β^3-IRT: A New Item Response Model and its Applications - Supplementary Material

1 Experiment results of abilities on CLUSTERS dataset

Table 1 shows the comparison between abilities and several popular classifier evaluation metrics on the experiments of CLUSTERS dataset. Table 2 gives the Spearman's rank correlation between these metrics in Table 1.

Table 1: Comparison between Ability and other Classifier Performance Metrics (CLUSTERS)

	Avg. Resp.	Ability	Accuracy	F1	Brier	Log loss	AUC
DT	0.7113	0.7226	0.7175	0.7154	0.2456	1.0114	0.7596
NB	0.7217	0.7388	0.75	0.7487	0.2221	1.0718	0.7682
MLP	0.7195	0.7263	0.7375	0.7342	0.2233	1.0092	0.7652
Ada.	0.5478	0.4623	0.725	0.7277	0.2148	0.6204	0.7571
RF	0.7206	0.7741	0.7275	0.7241	0.2304	5.7305	0.7648
LDA	0.7251	0.7488	0.745	0.745	0.2244	1.1623	0.7683
QDA	0.7255	0.7549	0.7475	0.7469	0.2242	1.1802	0.768
LR	0.7017	0.6848	0.7375	0.7328	0.2141	0.8071	0.7677
KNN	0.7212	0.7899	0.7325	0.7332	0.2389	6.8574	0.7582

Table 2: Spearman's Rank Correlation between Ability and other Classifier Performance Metrics (CLUSTERS)

	Avg. Resp.	Ability	Accuracy	F1	Brier	Log loss	AUC
Avg. Resp.	1.0	0.75	0.7197	0.7333	-0.3167	-0.7333	0.6667
Ability	0.75	1.0	0.2678	0.2833	-0.6	-0.9833	0.1667
Accuracy	0.7197	0.2678	1.0	0.954	0.3766	-0.1925	0.8619
F1	0.7333	0.2833	0.954	1.0	0.3167	-0.2	0.7333
Brier	-0.3167	-0.6	0.3766	0.3167	1.0	0.6833	0.2167
Log loss	-0.7333	-0.9833	-0.1925	-0.2	0.6833	1.0	-0.1333
AUC	0.6667	0.1667	0.8619	0.7333	0.2167	-0.1333	1.0

2 Complete experiment results of student answers

The Table 3 shows complete experiment results of student answers and details of datasets which has been described and partially shown in Section 4 of the main body of the paper.

Table 3: Student answer datasets (Log-loss) for continuous (student's average) and first attempt performance.

course	students	questions	answers	continuous		first attempts	
				β^3-IRT	2PL-ND	β^3-IRT	2PL-ND
1	4460	190	8619	**0.631 ± 0.003**	0.713 ± 0.004	**0.623 ± 0.004**	0.699 ± 0.005
2	55001	532	423665	**0.630 ± 0.022**	0.972 ± 0.081	**0.623 ± 0.023**	0.953 ± 0.060
3	64261	663	313522	**0.617 ± 0.004**	0.695 ± 0.004	**0.628 ± 0.024**	0.760 ± 0.086
4	53152	959	466135	**0.671 ± 0.004**	0.742 ± 0.009	**0.669 ± 0.004**	0.731 ± 0.007
5	27269	438	484601	**0.594 ± 0.004**	0.692 ± 0.008	**0.597 ± 0.004**	0.696 ± 0.013
6	17431	354	140546	**0.661 ± 0.009**	0.899 ± 0.039	**0.651 ± 0.009**	0.892 ± 0.030
7	11765	366	45924	**0.630 ± 0.007**	0.795 ± 0.020	**0.632 ± 0.007**	0.791 ± 0.015
8	4121	134	8165	**0.648 ± 0.014**	0.941 ± 0.044	**0.641 ± 0.023**	0.967 ± 0.059
9	4389	259	16110	**0.657 ± 0.011**	0.941 ± 0.030	**0.660 ± 0.011**	0.931 ± 0.032
10	11331	265	117131	**0.649 ± 0.007**	0.847 ± 0.030	**0.655 ± 0.009**	0.841 ± 0.032
11	10071	240	31274	**0.633 ± 0.016**	0.889 ± 0.051	**0.630 ± 0.012**	0.891 ± 0.067
12	9089	65	37816	**0.650 ± 0.013**	0.938 ± 0.063	**0.662 ± 0.016**	0.883 ± 0.051
13	1130	3	1926	**0.697 ± 0.066**	1.002 ± 0.218	**0.659 ± 0.086**	1.023 ± 0.423
14	78700	1011	1090037	**0.642 ± 0.028**	0.936 ± 0.074	**0.623 ± 0.028**	0.909 ± 0.057
15	68250	931	866785	**0.588 ± 0.002**	0.650 ± 0.003	**0.584 ± 0.003**	0.642 ± 0.003
16	2621	175	4962	**0.605 ± 0.002**	0.674 ± 0.003	**0.603 ± 0.002**	0.663 ± 0.002
17	50386	902	764195	**0.603 ± 0.002**	0.665 ± 0.003	**0.596 ± 0.003**	0.657 ± 0.003
18	28952	463	266205	**0.598 ± 0.006**	0.725 ± 0.008	**0.608 ± 0.005**	0.729 ± 0.011
19	8190	24	28780	**0.651 ± 0.015**	0.923 ± 0.064	**0.644 ± 0.020**	0.934 ± 0.074
20	3342	118	7857	**0.640 ± 0.021**	0.959 ± 0.060	**0.636 ± 0.018**	0.933 ± 0.040
21	1819	50	14896	**0.639 ± 0.016**	0.949 ± 0.072	**0.650 ± 0.014**	0.968 ± 0.094
22	7432	208	15351	**0.629 ± 0.020**	0.935 ± 0.050	**0.622 ± 0.016**	0.931 ± 0.060
23	57034	442	405037	**0.602 ± 0.004**	0.692 ± 0.011	**0.609 ± 0.004**	0.682 ± 0.005
24	4466	160	12839	**0.657 ± 0.014**	0.950 ± 0.046	**0.652 ± 0.011**	0.950 ± 0.044
25	4317	199	12842	**0.642 ± 0.015**	0.917 ± 0.034	**0.627 ± 0.010**	0.871 ± 0.038
26	2288	59	24226	**0.572 ± 0.011**	0.836 ± 0.045	**0.593 ± 0.014**	0.874 ± 0.038
27	2169	56	4501	**0.662 ± 0.022**	0.998 ± 0.093	**0.647 ± 0.028**	0.971 ± 0.073
28	156676	4475	2737867	**0.603 ± 0.001**	0.647 ± 0.002	**0.603 ± 0.001**	0.645 ± 0.002
29	1274	31	16865	**0.553 ± 0.021**	0.916 ± 0.056	**0.558 ± 0.017**	0.856 ± 0.051
30	2918	214	6480	**0.646 ± 0.019**	1.001 ± 0.075	**0.647 ± 0.019**	0.979 ± 0.048
31	9894	42	34277	**0.647 ± 0.014**	0.911 ± 0.060	**0.634 ± 0.014**	0.918 ± 0.053
32	158871	2529	2446221	**0.578 ± 0.001**	0.627 ± 0.001	**0.578 ± 0.002**	0.626 ± 0.002
33	2527	93	4989	**0.663 ± 0.021**	0.929 ± 0.060	**0.674 ± 0.025**	0.993 ± 0.074