Problem Skipping Limits the Accuracy of Ability Estimates in Online Learning

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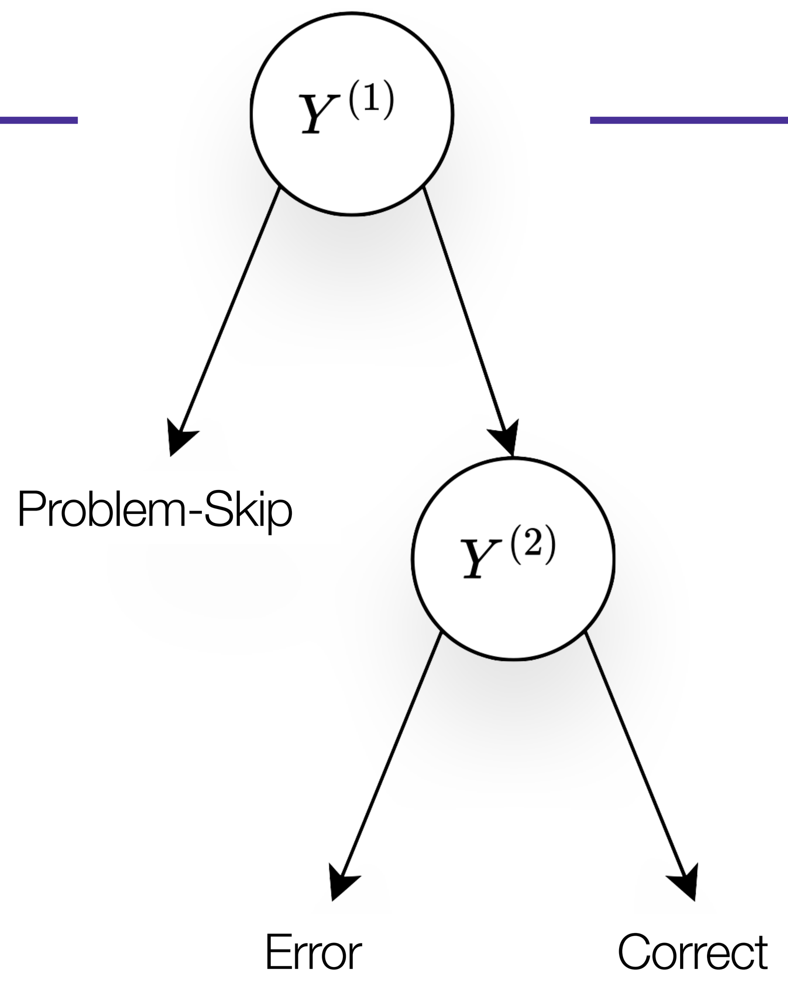
Background & Methods.

When using online learning platforms, students are often faced with the option to **skip a problem**. Traditional IRT models treat this behavior the same as incorrect responses, assuming that the tendency of a student to problem-skip is the same as their tendency to give an incorrect response.[1,2]

We used an **item response tree model** to test:

1. **Should problem-skipping be estimated separately from accuracy in online learning systems?**
2. **How are item difficulties and user ability related to problem-skipping?**

on children (N = 4110) practicing mathematical number sequences in Math Garden[3].

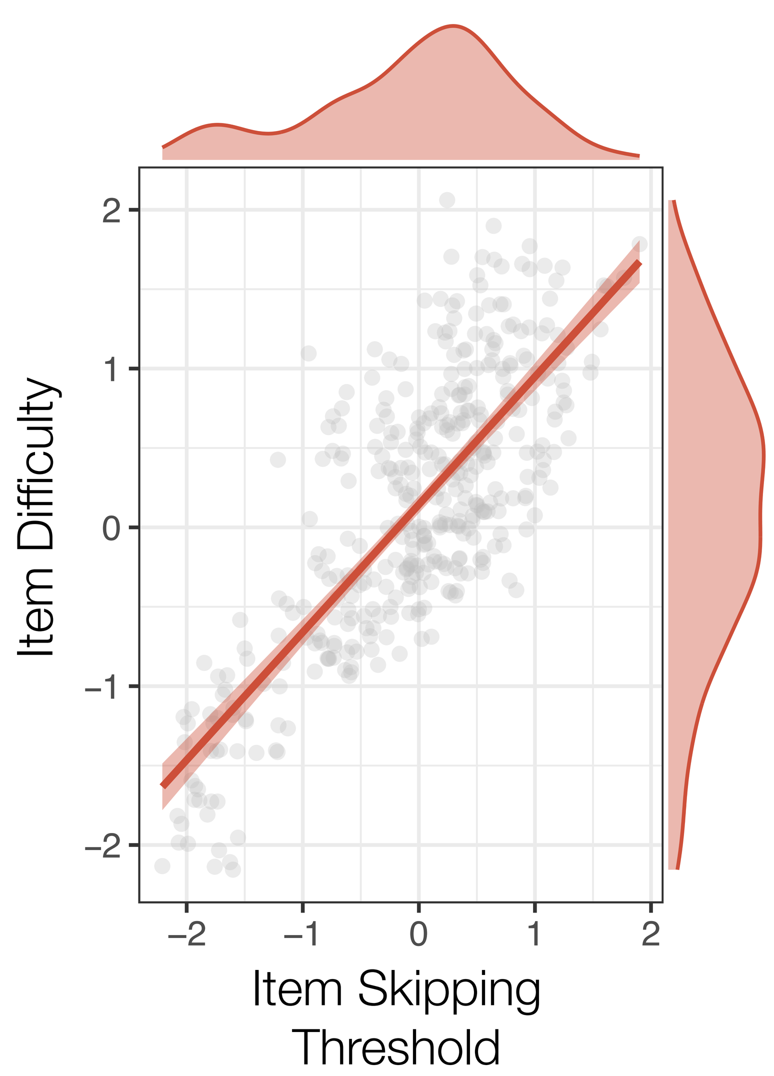


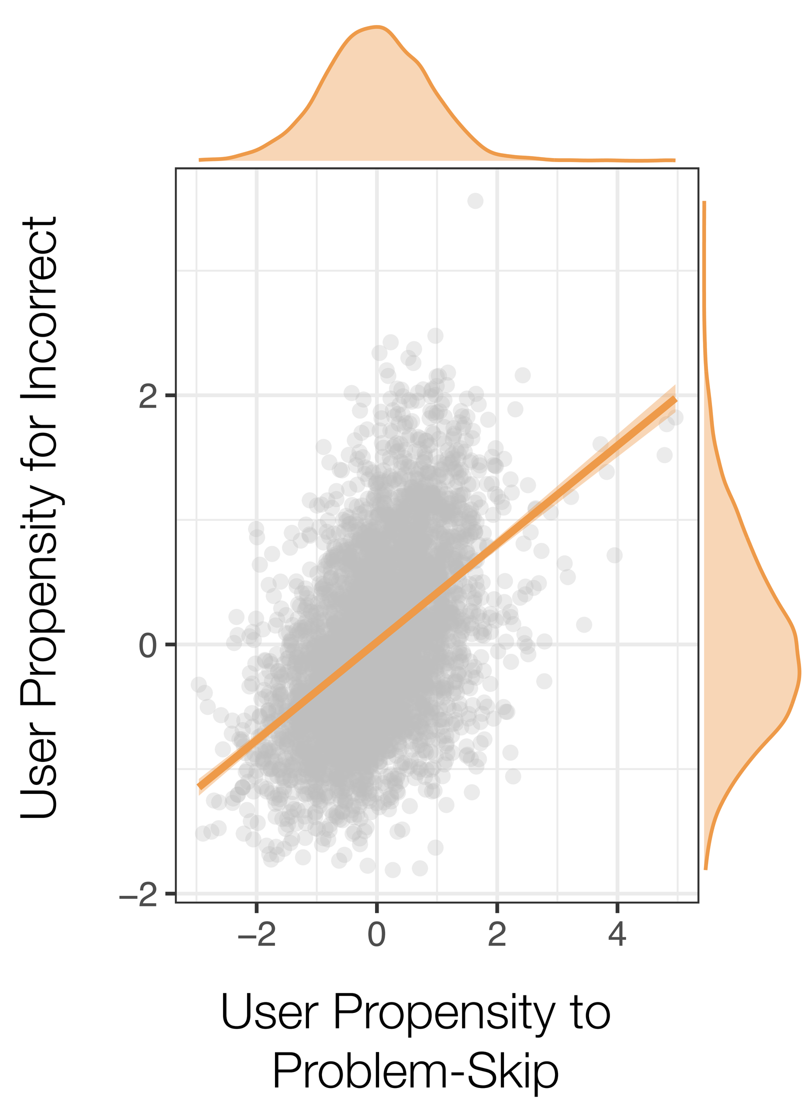
Results.

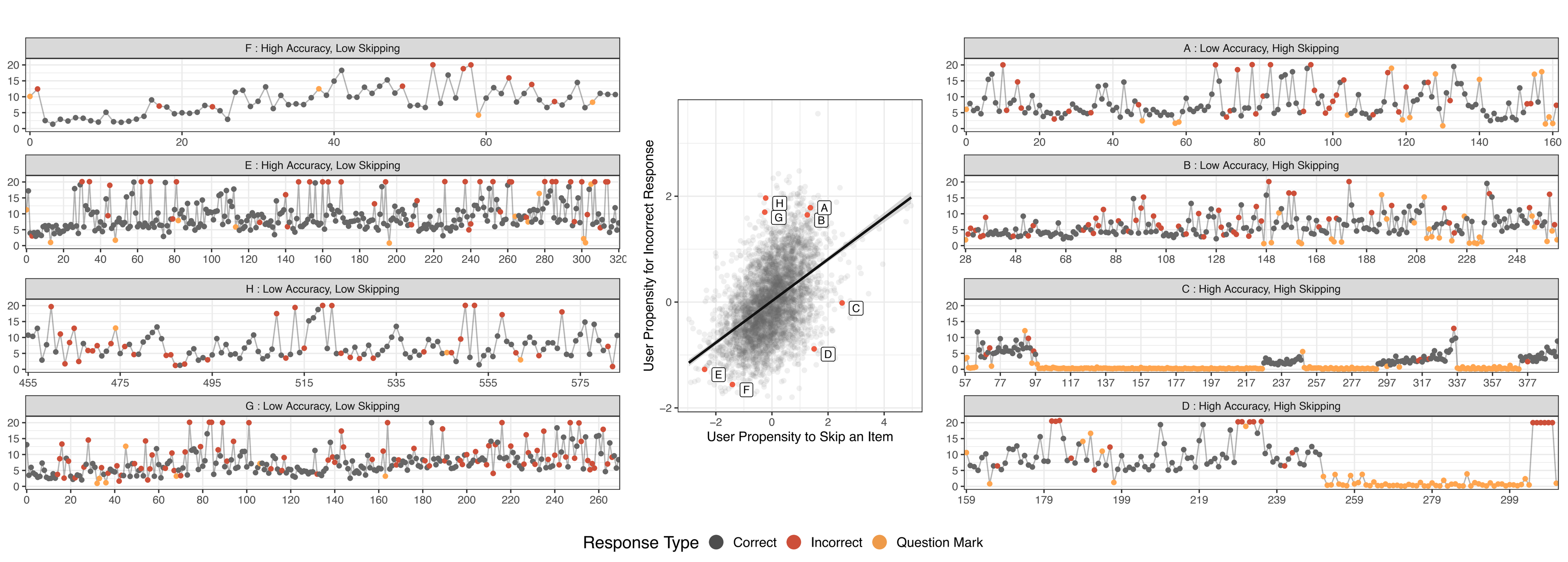
Item difficulties and user ability estimates are best captured by an IRTree model separately accounting for problem-skipping and accuracy.

Students who skip more have lower ability estimates, but are not always answering incorrectly.

Model	Random parameters	AIC	BIC	$cor(\theta^{(1)}, \theta^{(2)})$	$cor(\beta^{(1)}, \beta^{(2)})$
Fully Estimated IRTree multidimensional; response is predicted by a random node effect of items and a random node effect of users.	$\theta_p, \theta_i, \beta_p, \beta_i$	1559132	1559220	0.44	0.77
Item-Constrained IRTree multidimensional; response is predicted by a random intercept for items, and a random node effect of users.	$\theta_p, \beta_p, \theta_i = \beta_i$	1574386	1574449	0.37	-
User-Constrained IRTree multidimensional; response is predicted by a random intercept for users, and a random node effect of items.	$\theta_i, \beta_i, \theta_p = \beta_p$	1591531	1591594	-	0.72
Fully Constrained IRTree unidimensional; both item- and user-level effects are modeled with random intercepts.	$\theta_i = \beta_i, \theta_p = \beta_p$	1619044	1619081	-	-







Problem-skipping and accuracy stem from distinct processes.

Educational measurement models that rely on one latent ability measure may not be sufficient to capture ability.

Suggestions for learning analytics:

- Measure both latent traits ad-hoc and report them.
- On-the-fly problem-skipping estimation. Teacher dashboards can give insights on problem-skipping in real time.
- Restrict problem-skipping behavior.

Scan for full reference list and preprint

1. Little & Rubin (2019)
2. 3. De Boeck & Partchev (2012)
3. Klinkenberg et. al. (2011)

Based on the project:
Johansson, A.M., Savi, A.O., & Hofman, A.D. A problem that shouldn't be skipped: Problem skipping limits the accuracy of ability estimates in online learning. (Preprint, 2024)

Funded by the Ministry of Education, Culture and Science (Netherlands) and the Dutch Research Council.

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