

This is a self-archived version of an original article. This version may differ from the original in pagination and typographic details.

Author(s): Niemelä, Marko, Kärkkäinen, Tommi; Äyrämö, Sami; Ronimus, Miia; Richardson, Ulla; Lyytinen, Heikki

Title: Game learning analytics for understanding reading skills in transparent writing system

Year: 2020

Version: Accepted version (Final draft)

Copyright: © 2020 British Educational Research Association

Rights: In Copyright

Rights url: <http://rightsstatements.org/page/InC/1.0/?language=en>

Please cite the original version:

Niemelä, M., Äyrämö, S., Ronimus, M., Richardson, U., & Lyytinen, H. (2020). Game learning analytics for understanding reading skills in transparent writing system. *British Journal of Educational Technology*, 51(6), 2376-2390. <https://doi.org/10.1111/bjet.12916>

Supplement S3: Results for uppercase letter data

Uppercase data

The analyses of *GraphoLearn* game play data, which was originally performed for the lowercase data set were repeated by using uppercase letter data set. These results are given in Tables S3.1 – S3.2 and Figures S3.1 – S3.2, which can be shortly summarized.

Table S3.1 shows symbols for confusions exceeding 10 % and confusions exceeding 15 % are illustrated with underlined symbols. The most frequently mixed letters were *G*, *D*, *N*, and *M* similarly to the players who used lowercase letter data. Table S3.2 shows error rates from four profiles which were in the range of 34.5 % – 42.7 %. The results are mostly better than the calculated error rates from six profiles of lowercase letter data (30.7 % – 55.3 %). This may be related to fact that uppercase letters are visually less similar than lowercase letters. The progression information was calculated based on only few players because many of players played less than one hour and did not complete the second assessment. Therefore, these numbers give only limited information about the players' progression. The players of this data set have not actively played the game because the total playing times were remarkably smaller and the interval times were higher compared to the times gained from the players who used the lowercase letter data set.

Table S3.1: Symbol table of similarities for different uppercase data profiles

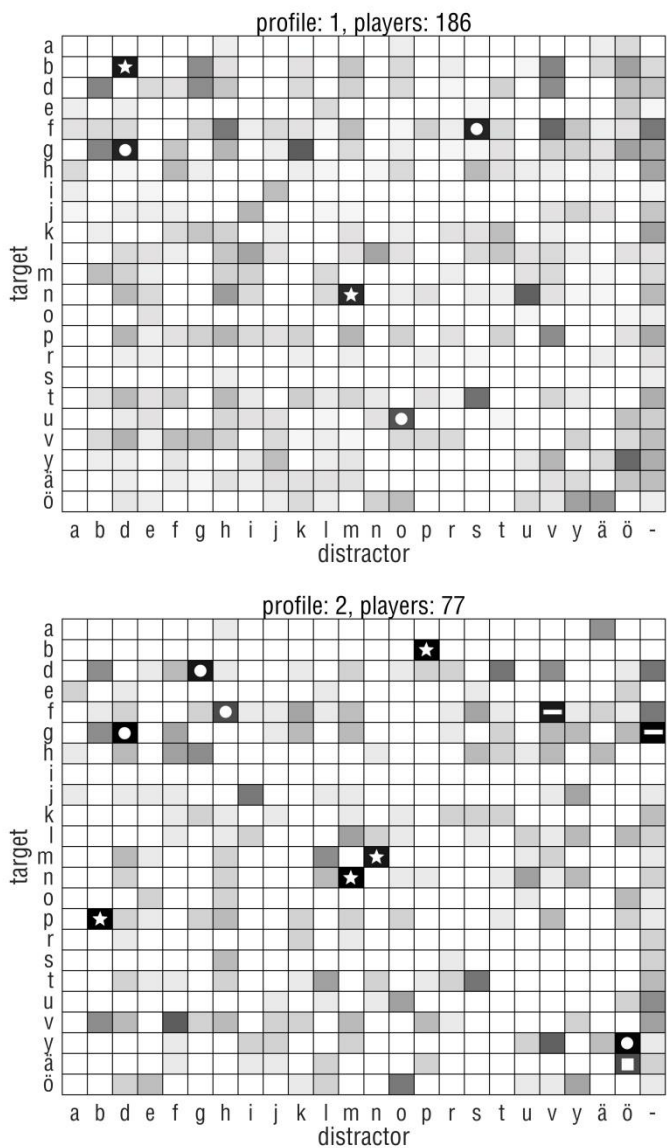
	target distractor															
	B D	B P	D B	D G	F H	F S	F V	G B	G D	K F	M N	N M	P B	U O	V F	Y Ö
profile																
P1	☆					○			○			☆		○		
P2		☆		○	○		□		○		☆	☆	☆			○
P3			☆	○				○	○		☆	☆	☆			
P4	☆				○	○		○	○	□	☆	☆			□	○
total	2	1	1	2	2	2	1	1	4	1	3	4	2	1	1	2

phonetic similarity=○, visual similarity=□, phonetic and visual similarity=☆,
unknown category=□

Table S3.2: Findings of uppercase data profiles

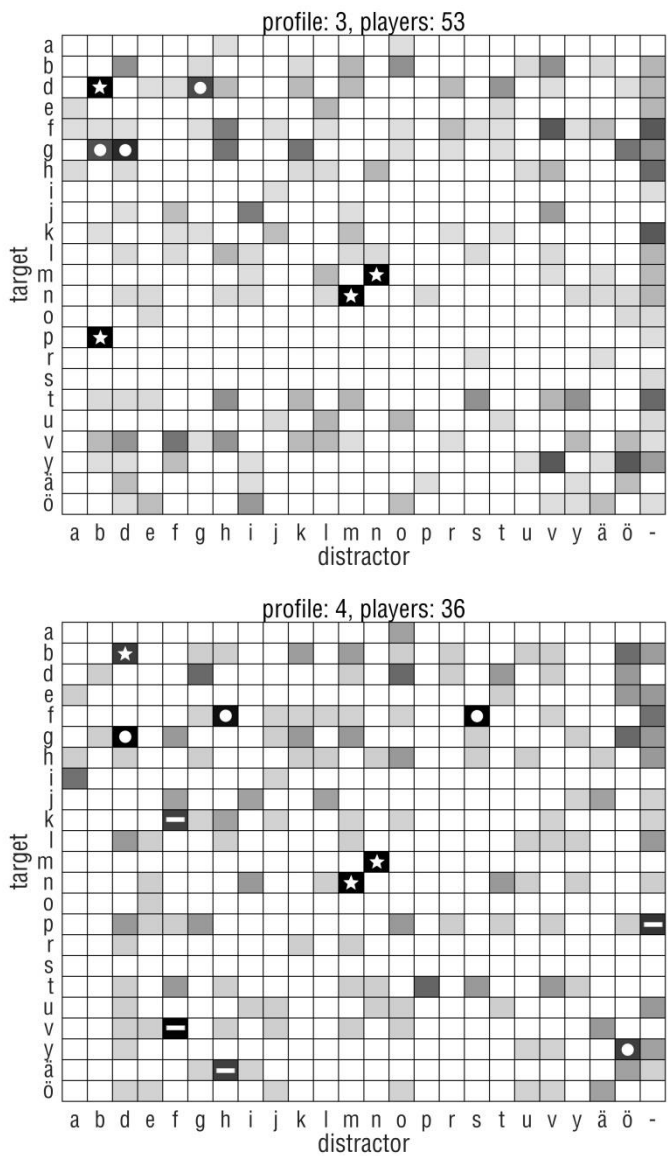
	profile				all P
	P1	P2	P3	P4	
statistics					
size (in %)	52.8%	21.9%	15.1%	10.2%	100.0%
error rate	34.5%	38.7%	36.2%	42.7%	36.5%
progression*	10.2%	23.0%	13.1%	11.9%	13.8%
playing time	36.8 min	46.5 min	38.2 min	29.7 min	39.5 min
interval time	7.0 days	8.1 days	7.0 days	9.5 days	7.5 days

*Only players who completed both assessments are included.



Darker colors indicate more confusion. Confusions exceeding 10 % are marked with symbols. There are two main categories of letters' similarity: phonetic similarity (marked with a "circle") and visual similarity (marked with a "square"). It is also possible that both or neither categories are occurring (marked with a "star" and a "rectangle", respectively).

Figure S3.1: Profiles 1 and 2 for uppercase letter data



Darker colors indicate more confusion. Confusions exceeding 10 % are marked with symbols. There are two main categories of letters' similarity: phonetic similarity (marked with a "circle") and visual similarity (marked with a "square"). It is also possible that both or neither categories are occurring (marked with a "star" and a "rectangle", respectively).

Figure S3.2: Profiles 3 and 4 for uppercase letter data