

Slow is Good: The Effect of Diligence on Student Performance in the Case of an Adaptive Learning System for Health Literacy

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Overview

- 1 Motivation
- 2 Study Participants
- 3 Study Environment
- 4 Adaptation Mechanism
- 5 Experiments & Results
- 6 Conclusion

- Research on MOOCs and ITSs has shown that reading behavior is a predictor for student performance and reading ability an effective basis for system adaptation¹
- Our contribution?
 - Analysis of the temporal behavior in a heavily instructionally designed adaptive e-learning environment
 - Adaptive learning system that aims to support health literacy via **adapting text difficulty by mediating the same knowledge**

¹Eagle, Michael, et al. "Estimating individual differences for student modeling in intelligent tutors from reading and pretest data." International Conference on Intelligent Tutoring Systems. Springer, Cham, 2016.

¹Durlach, Paula J., and Alan M. Lesgold, eds. Adaptive technologies for training and education. Cambridge University Press, 2012.

¹Thaker, Khushboo, Paulo Carvalho, and Kenneth Koedinger. "Comprehension Factor Analysis: Modeling student's reading behaviour: Accounting for reading practice in predicting students' learning in MOOCs." Proceedings of the 9th International Conference on Learning Analytics & Knowledge. ACM, 2019.

Motivation

Research questions:

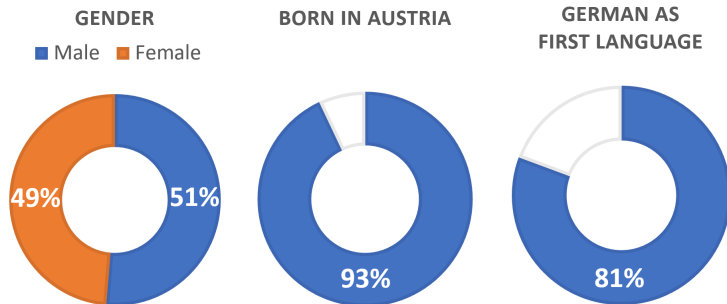
- RQ1: Is the temporal behavior a differentiator between students?
- RQ2: Is the temporal behavior correlated with performance?

Hypothesis:

- We will see four group of students

Study Participants

- Two lower-secondary schools participated in this study:
 - School 1 comes from a rural area ($N = 111$ students)
 - School 2 comes from an urban area ($N = 85$ students)
- 191 out of 196 students provided demographic data
- Students were between 11 and 15 years old ($M = 12.8$, $SD = 0.94$)



- Cumulative data counts almost 1/2 million events ($4.53 \cdot 10^5$)


Study Environment

Hallo Student!

Dein Fortschritt im aktuellen Thema: "Das Radrennen"



0
von 9 Aufgaben

Dein aktueller Punktestand beträgt: **0 Punkte**
Dir fehlt noch **1 Punkt** bis zum nächsten Apfel





Das Radrennen



0%




Das Tagebuch





Ein Tag am See



Zwei Freundinnen



Die Vogelspinne



Die Bindehautentzündung

Viele von uns haben das schon ☐ einmal ☐ einem ☐ gestern erlebt: Man wacht morgens auf und ☐ kennt ☐ kann ☐ soll die Augen nicht richtig öffnen. Die ☐ Hände ☐ Lieder ☐ Lider sind verklebt und die Augen jucken ☐ unter ☐ aber ☐ oder brennen. Der Blick in den Spiegel ☐ birgt ☐ lässt ☐ bringt dann Klarheit. Die Augen sind rot ☐ wund ☐ und ☐ wegen verkrustet. Man sieht aus, als hätte ☐ man ☐ dann ☐ es viele Nächte nicht geschlafen. Grund für ☐ den ☐ das ☐ des alles ist eine Bindehautentzündung. Meistens wird ☐ diese ☐ des ☐ dieser durch Bakterien oder Viren ausgelöst, manchmal ☐ jedes ☐ über ☐ aber auch durch eine Allergie.

Reading competence assessment.

Was ist jetzt in der Geschichte passiert?

Wähle eine Antwort:

- ☐ a. Nach dem Sturz konnten alle Männer gleich weiterfahren.
- ☐ b. Bei einem Unfall hatten sich mehrere Menschen verletzt.
- ☐ c. Alle in den Unfall verwickelten Männer mussten ins Sanitätszelt.
- ☐ d. Es gab einen Sturz, aber keiner wurde verletzt.

Absenden

Topic assessment.

Waren die Texte für dich gut zu lesen?

Wähle eine Antwort:

- ☐ a. zu leicht
- ☐ b. eher zu leicht
- ☐ c. genau passend
- ☐ d. eher zu schwierig
- ☐ e. zu schwierig

Absenden

Self-assessment.

Adaptation Mechanism

Symbol	Description
r_n	Reading competence assessment score
p_n	Performance score
s_n	Self-assessment score
res_n	Result for the current topic
d_{n+1}	Next text difficulty level

$$r_n(x) = \begin{cases} 1, & \text{if } x > 49\% \text{ correct tasks} \\ 2, & \text{if } 35\% < x \leq 49\% \text{ correct tasks} \\ 3, & \text{if } 29\% < x \leq 35\% \text{ correct tasks} \\ 4, & \text{if } x \leq 29\% \text{ correct tasks} \end{cases} \quad (1)$$

$$d_1 = r_1(x) \quad (2)$$

Adaptation Mechanism

Symbol	Description
r_n	Reading competence assessment score
p_n	Performance score
s_n	Self-assessment score
res_n	Result for the current topic
d_{n+1}	Next text difficulty level

$$res_n = r_n + p_n + s_n \quad \begin{cases} r_n, res_n \in \{1, 2, 3, 4\} \\ p_n \in \{-1, 0\} \\ s_n \in \{-1, 0, 1\} \end{cases} \quad (3)$$

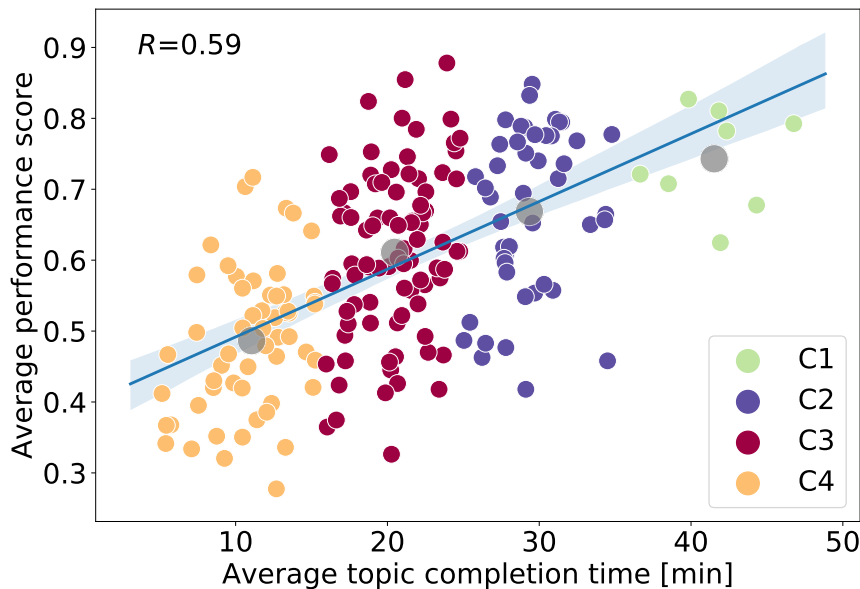
$$d_{n+1} = \frac{1}{3}[res_n + 2r_{n+1}(x)] \quad \begin{cases} d_{n+1} \in \{1, 2, 3, 4\} \end{cases} \quad (4)$$

- Unsupervised clustering: **k-means algorithm**
 - Selection of k based on silhouette score metric

Input features	
s_n	Self-Assessment
p_n	Performance score
<i>completion time</i>	Avg. topic completion time

- Linear regression analyses
 - Predict students' performance using solely the *completion time* feature

Results



	Improved	Aggravated	Constant	Varied
C1 (n=8)	62.5%	0%	12.5%	25%
C2 (n=46)	58.7%	6.5%	15.2%	19.6%
C3 (n=85)	57.6%	12.9%	16.5%	12.9%
C4 (n=57)	40.4%	15.8%	12.3%	31.6%
Total (n=196)	53,1%	11.7%	14.8%	20.4%

- Positive statistics from adaptation mechanism usage
- On a wider level, these results highlight the necessity of teaching strategies for learning and performance

Cluster	Final difficulty level			
	L1 (n=20)	L2 (n=52)	L3 (n=60)	L4 (n=64)
C1 (n=8)	5% (n=1)	7.5% (n=3)	3.3% (n=2)	3.1% (n=2)
C2 (n=46)	50% (n=10)	30.2% (n=16)	6.6% (n=4)	25% (n=16)
C3 (n=85)	45% (n=9)	43.4% (n=23)	50.8% (n=30)	35.9% (n=23)
C4 (n=57)	0.0%	18.9% (n=10)	39.3% (n=24)	35.9% (n=23)

- Diverse distribution of students across clusters coming from all difficulty levels
- Interesting relationship between the final text difficulty level and cluster membership

RQ1 Students can be clearly separated into a class of slow and a class of fast students

RQ2 Temporal behaviour is a predictor of performance

H We did not find expected groups of students

Future work:

- One particular group of students was less likely to show diligent behavior than the other groups



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Thank you for your attention!

Questions?

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