RESEARCH REPORT

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How the Dynamic Nature of IXL's SmartScore Supports Student Learning

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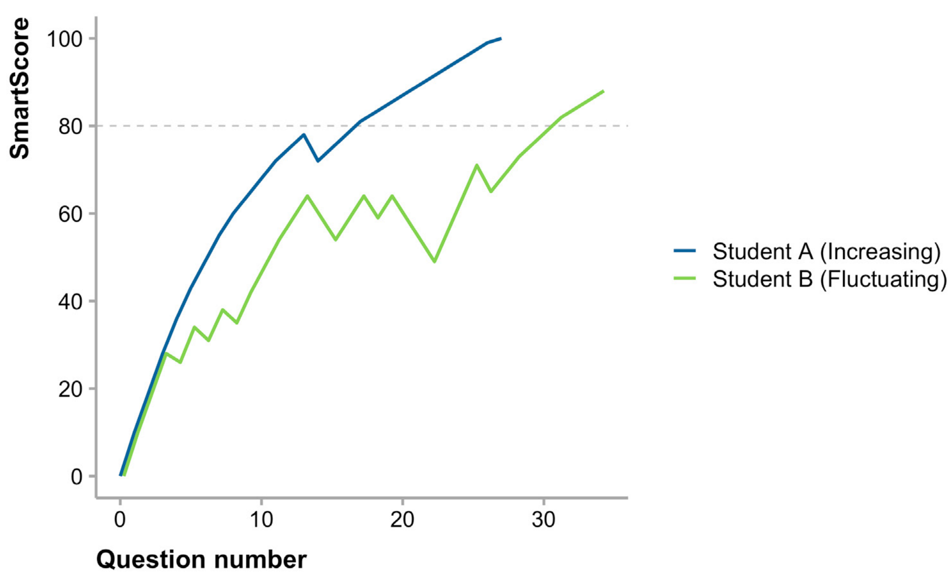
Executive Summary

IXL is an end-to-end teaching and learning solution that engages learners in grades Pre-K through 12 with a comprehensive curriculum and personalized recommendations for meeting learning goals. Previous research has shown that IXL can have a significant positive impact on students' academic performance (Bashkov, 2021; Empirical Education, 2013).

The goal of this study was to investigate a core feature of IXL—the SmartScore—and its relationship to student learning. The SmartScore is a proprietary measure of student proficiency in particular topic areas, or skills, on IXL; it increases when students answer questions correctly and decreases when students answer questions incorrectly. We examined SmartScore progressions over the course of math and English language arts (ELA) skill practice from students in grades 1-8 in a large, suburban school district. Specifically, we compared two types of progressions: *fluctuating*, in which the SmartScore both increased and decreased before the student reached the skill proficiency threshold, or *increasing*, in which the SmartScore increased relatively steadily until proficiency. In the figure below, Student A exhibits an increasing pattern, and Student B exhibits a fluctuating pattern (the dashed line indicates the proficiency threshold).



Key finding: **In both math and ELA, when students persevere through temporary SmartScore setbacks, they ultimately achieve greater learning gains.**

That is, reaching skill proficiency through a primarily *fluctuating* progression had a stronger impact on students' academic growth (as measured by IXL's Real-Time Diagnostic) than reaching skill proficiency through a steadily *increasing* progression.

How the Dynamic Nature of IXL's SmartScore Supports Student Learning

Background

IXL is an end-to-end teaching and learning solution that engages learners in grades Pre-K through 12 with a comprehensive curriculum and personalized recommendations for meeting learning goals. It covers four main subject areas: mathematics, English language arts (ELA), science, and social studies. As of this writing, IXL is used by 1 in 4 students in the U.S. and by over 14.5 million students worldwide. IXL is deeply rooted in learning sciences research (see Bashkov et al., 2021) and engages each student in a personalized learning experience tailored to their working level.

The SmartScore is named as such because it is "smart" in how it adapts to each learner's individual trajectory.

The SmartScore ranges from 0-100. However, it is not a percent correct score: a SmartScore of 100 is always possible.

A key feature of IXL is its proprietary *SmartScore*, which indicates a learner's progress toward proficiency within a given skill that they are practicing. The SmartScore is named as such because it is "smart" in how it adapts to each learner's individual trajectory: it incorporates item difficulty, answer accuracy, response patterns, and relative progress on a skill. The SmartScore ranges from 0-100. However, it is not a percent correct score: a SmartScore of 100 is always possible. It increases as students answer questions correctly, and decreases as students answer questions incorrectly. A SmartScore of 80 indicates proficiency in a skill, and a SmartScore of 100 indicates mastery. IXL recommends that students aim to reach proficiency in at least two skills per week (SP/week; An et al., 2022). The design of the SmartScore incorporates many key principles from learning sciences research, discussed in more detail in the following paragraphs.

One such principle is that of *desirable difficulties*, which are learning strategies that feel challenging in the moment but ultimately lead to deeper learning and higher retention compared to learning strategies that seem easier on the surface (Bjork & Bjork, 2014). Some well-established desirable difficulties include *spacing* (e.g., studying over several shorter sessions as opposed to one long session; Kornell, 2009; Kornell et al., 2010), *interleaving* (e.g., studying multiple subjects or concepts mixed together as opposed to separately; Birnbaum et al., 2013; Rohrer, 2012), and *testing* (e.g., quizzing yourself on concepts to be learned as opposed to merely reading about those concepts; Rohrer et al., 2010; Wissman et al., 2011).

[1] *When students use IXL, they complete practice problems organized within "skills," or specific topic areas within a subject. For example, a fifth-grade math skill might ask students to identify different types of quadrilaterals.*

When students practice skills on IXL, they are continuously engaging in low-stakes testing as a desirable difficulty and receiving immediate feedback (in the form of SmartScore changes and written explanations) after each submitted answer. This type of self-testing with feedback is much more effective than other learning strategies such as reviewing notes from previous days of instruction.

> *Although most students may not enjoy answering questions incorrectly, making mistakes can provide valuable learning opportunities.*

Research on the role of errors or mistakes in learning has also informed the design of the SmartScore and skill practice on IXL. Although most students may not enjoy answering questions incorrectly, making mistakes can provide valuable learning opportunities. For example, studies of errorful learning shows that learners who generate answers to new problems, even if the answers are incorrect, ultimately learn better than learners who passively receive information without the opportunity to practice (Metcalfe, 2017; Metcalfe & Kornell, 2007; Pashler et al., 2005), provided that the errors are followed by corrective feedback. Making errors during practice is one indicator of a *productive struggle* (Hiebert & Grouws, 2007; Warshauer, 2015a), which has been found to support students' learning of new concepts that are at the edge of their current understanding (i.e., their zone of proximal development; Vygotsky & Cole, 1978). In contrast, when students practice skills that they already thoroughly understand, this can be considered a form of unproductive success (Kapur, 2016): students are technically succeeding in answering questions correctly, but they are not learning anything new. The SmartScore provides a way for students to monitor their own learning and grasp of a given skill. Students receive a clear signal that they are challenging themselves at the appropriate level when their SmartScore fluctuates throughout skill practice. A steadily increasing SmartScore provides a different, but equally clear signal to students: they are ready for a new challenge.

Finally, the design of the SmartScore also draws from research on how to promote students' *self-efficacy*, *mastery orientation*, and *growth mindset*. At the beginning of a skill, the SmartScore increases rapidly, boosting students' self-efficacy and their subsequent effort for continued learning (Bandura et al., 1977; Schunk, 1982). As students make progress within a skill, the SmartScore gains for correct answers get smaller, challenging students to show that they truly understand the material and supporting their development of a mastery orientation (Elliott & Dweck, 1988). That is, the SmartScore encourages students' intrinsic motivation to learn and master challenging content, rather than learning for extrinsic reasons such as course grades. Furthermore, the forgiving design of the SmartScore algorithm helps to instill a growth mindset (Dweck, 2006) in students, supporting the belief that they can master challenging material with sufficient effort (e.g., a SmartScore of 100 is always possible).

> *Students receive a clear signal that they are challenging themselves at the appropriate level when their SmartScore fluctuates throughout skill practice.*

Previous research has shown that students' academic achievement improves as they reach proficiency (i.e., a SmartScore of 80) in more IXL skills (e.g., An, 2023; Hargis, 2023; Schonberg & Hochstein, 2022). However, as described above, students may take markedly different paths to skill proficiency. Here, we investigated the impact of two general paths that students may take to reach skill proficiency. In the first one, as a student is practicing a skill that is challenging but within reach, their productive struggle may be evidenced by a SmartScore that fluctuates as they answer questions both correctly and incorrectly. In the other, as a student is practicing a skill that is already well within their understanding, their SmartScore would mostly increase throughout skill practice and they would reach proficiency relatively easily. Based on the bodies of research showing the benefits of the productive struggle and errorful learning, we hypothesized that students would benefit more from reaching proficiency in skills where their SmartScore fluctuated, relative to reaching proficiency in skills where their SmartScore steadily increased.

> *The SmartScore algorithm helps to instill a growth mindset in students, supporting the belief that they can master challenging material with sufficient effort.*

Study Design and Methodology

DATA SOURCES

IXL Diagnostic Data

IXL Real-Time Diagnostic data were obtained from IXL's database. When a student completes a sufficient number of questions in a subject (math or ELA) in IXL's Diagnostic, they receive a pinpointed score that indicates their overall grade-level proficiency in that subject. For example, a score of 350 indicates that the student has acquired about 50% of third-grade material, whereas a score of 400 indicates that the student is ready to learn fourth-grade material. We obtained all available pinpointed diagnostic scores in math and ELA for students in a large, suburban district in the West South Central U.S. across the 2021-22 school year. The earliest available diagnostic score served as the pretest measure, and the latest available diagnostic score served as posttest.

IXL Usage Data

IXL usage data were obtained from IXL's database. Because this study focused on students' paths to skill proficiency, we only analyzed usage in skills where students reached proficiency (i.e., a SmartScore of 80 or higher). In addition, we included only skills in which (1) students started practicing after their pretest Real-Time Diagnostic was completed, and (2) students reached proficiency before their posttest Real-Time Diagnostic was completed. These criteria ensured that any growth in students' diagnostic scores could be attributed to practicing and reaching proficiency in new skills between pretest and posttest during the 2021-22 school year, aside from regular classroom instruction and learning.

The goal of this study was to investigate the impact of two different practice paths toward skill proficiency: a fluctuating SmartScore versus a primarily increasing SmartScore. We defined *fluctuating* practice as practice in which a student's SmartScore fluctuated before they reached proficiency (i.e., a SmartScore of 80), meaning that the student answered questions both correctly and incorrectly during practice. Fluctuating practice was operationally defined as answering between 50-80% of questions correctly before reaching proficiency. The lower bound of this range, 50%, was selected because it is only possible to reach proficiency by answering more questions correctly than incorrectly. The upper bound of 80% was selected because if a student is answering the vast majority of questions correctly, they likely already have a solid grasp of the material covered in that skill; therefore, practicing the skill would not have as large of an impact on their knowledge growth. Thus, a skill in which a student reached proficiency by answering more than 80% of the questions correctly was classified as *increasing*, i.e., the student's SmartScore in that skill increased relatively steadily until they reached proficiency. Examples of fluctuating and increasing progressions to proficiency are shown in Figure 1, and descriptive statistics of students' IXL usage (e.g., increasing skills proficient, fluctuating skills proficient) are reported in Table 1.

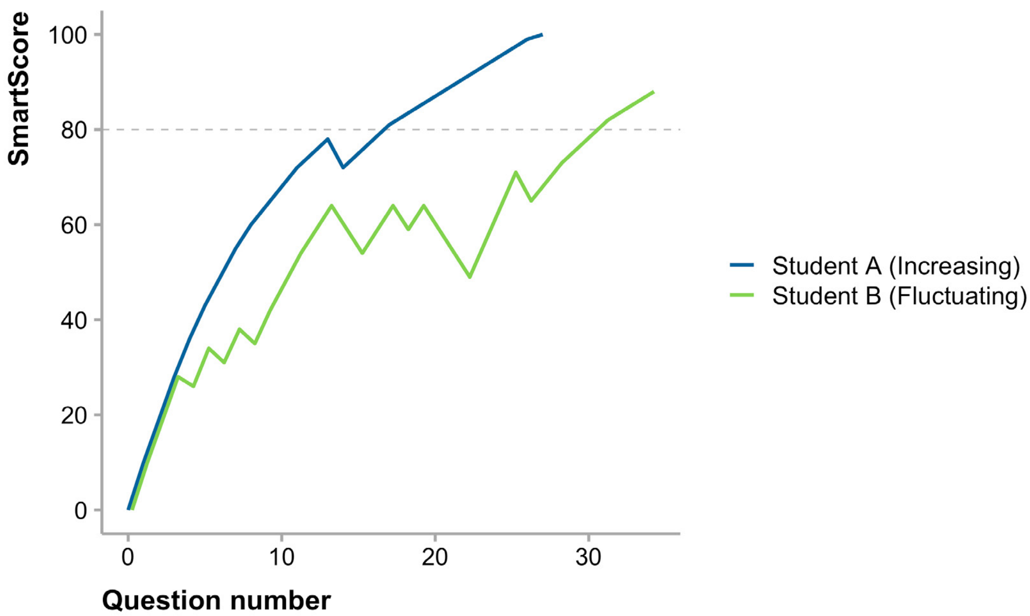


Figure 1. Two fifth-grade students' SmartScore progressions on the same skill. Student A (blue line) exhibits an increasing path to skill proficiency, whereas Student B (green line) exhibits a fluctuating path to skill proficiency.

Table 1. IXL Usage During the 2021-22 School Year

Weekly IXL usage	IXL Math (n = 6,290)				IXL ELA (n = 8,736)			
	M	*SD*	Min	Max	*M*	*SD*	Min	Max
Questions answered	77.81	55.86	1.50	733.05	67.91	46.25	1.57	786.40
Increasing skills proficient	1.89	1.54	0.03	23.16	1.25	1.06	0.03	25.10
Fluctuating skills proficient	0.36	0.34	0.03	4.32	0.37	0.33	0.03	4.13
Time spent (in minutes)	27.20	17.54	0.84	204.49	22.02	14.77	0.49	441.22

PARTICIPANTS

We included data from all students who met the following criteria: (1) they reached proficiency in at least one skill during the study period, and (2) they had pretest and posttest Real-Time Diagnostic scores at least 60 days apart. After applying these criteria, the IXL Math analysis included 6,290 students in grades 2-6, and the IXL ELA analysis included 8,736 students in grades 1-8. Overall, the racial/ethnic makeup of the studied district was as follows: 6.0% Asian, 7.7% Black, 20.7% multiracial or other, 4.7% Native American, and 60.8% White. In addition, 5.7% of students in the district were English language learners, 41.4% of students were classified as economically disadvantaged, and 17.9% of students qualified for or were enrolled in IEP/504 plans.

ANALYSIS

We specified and tested separate multilevel models for each analysis (IXL Math and IXL ELA) to account for clustering at the school level (i.e., students within a school tend to be more similar to each other than students in other schools). In previous studies, we have examined the effect of IXL usage by including a predictor such as SP/week in the model (e.g., Hargis, 2023). In this study, because we were interested in the effects of different paths to skill proficiency, we included two IXL usage predictors in each model: fluctuating SP/week and increasing SP/week. Together, these two variables add up to each student's total SP/week; by including them concurrently in the same model, we could examine the relative impact of each. In addition, pretest Real-Time Diagnostic score was included as a covariate in each model. Because of the nature of the scale on which Real-Time Diagnostic scores lie, diagnostic scores are very highly correlated with grade level (r = .75). Thus, it was not necessary to include grade as an additional covariate.

Results

MATH

We found that both fluctuating and increasing skills proficient per week (SP/week) were significant, positive predictors of students' Real-Time Diagnostic scores in math at the end of the year, controlling for beginning-of-year diagnostic scores. Specifically, fluctuating SP/week had a greater impact on students' end-of-year scores ($b = 60.55$, $p < .001$, $\beta = .14$) than increasing SP/week ($b = 3.44$, $p < .001$, $\beta = .04$; see Table A2 in the Appendix for full model results). That is, for each math skill per week where students reached proficiency with a fluctuating SmartScore, their end-of-year diagnostic score would be predicted to increase by about 60 points. In contrast, for each math skill per week where students reached proficiency with an increasing SmartScore, their end-of-year diagnostic scores would be predicted to increase by about 3 points.

ELA

Similar to the math analysis, we found that both fluctuating and increasing skills proficient per week (SP/week) were significant, positive predictors of students' Real-Time Diagnostic scores in ELA at the end of the year, controlling for beginning-of-year diagnostic scores. Specifically, fluctuating SP/week had a bigger impact on students' end-of-year scores ($b = 112.80$, $p < .001$, $\beta = .14$) than increasing SP/week ($b = 9.13$, $p < .001$, $\beta = .04$; see Table A3 in the Appendix for full model results). That is, for each ELA skill per week where students reached proficiency with a fluctuating SmartScore, their end-of-year diagnostic scores would be predicted to increase by about 113 points. In contrast, for each ELA skill per week where students reached proficiency with an increasing SmartScore, their end-of-year diagnostic scores would be predicted to increase by about 9 points.

Discussion

In this study, we investigated the impact of different paths that students may take to reach proficiency in IXL skills. Specifically, we compared the impact of fluctuating SP (i.e., skills in which students' SmartScores fluctuated before students reached proficiency) to increasing SP (i.e., skills in which students' SmartScores steadily increased until students reached proficiency). In both math and ELA, we found that although fluctuating and increasing SP both had significant, positive impacts on students' academic growth, fluctuating SP had a much larger impact on growth than increasing SP (controlling for baseline performance). These findings replicate and extend previous research showing that increased IXL usage is associated with significant achievement gains (e.g., An, 2023).

In both math and ELA, the academic growth associated with one additional fluctuating SP/week was much larger than the growth associated with one additional increasing SP/week. We hypothesize that this is because a fluctuating SmartScore indicates that students were engaging in a form of self-testing, making mistakes, and receiving immediate feedback to correct misconceptions and try again—all of which are known to boost learning (Bjork & Bjork, 2014; Metcalfe, 2017; Metcalfe & Kornell, 2007; Pashler et al., 2005). In contrast, an increasing SmartScore largely indicates that students were practicing material that might have been too easy or already known; thus, reaching proficiency in these skills was less impactful. That said, the SmartScore still served its purpose as a self-assessment, allowing students to check their grasp on current skills and move on to new or more challenging skills. In other words, a steadily increasing SmartScore in itself is not a bad thing, as long as students are engaging in this practice path on skills appropriate for their grade level.

> *Educators should encourage students to persist through temporary SmartScore decreases and view these fluctuations as part of the pathway to meaningful growth.*

It should be noted that overall, students in this district reached proficiency in a higher number of increasing skills per week than fluctuating skills per week (see Table 1). To experience even greater achievement gains with IXL, we recommend that students aim to reach proficiency in skills that provide an appropriate level of challenge. IXL's seamless integration between its assessment suite and comprehensive curriculum makes it easy to identify skills that will maximize growth for each individual student: after students complete the IXL Real-Time Diagnostic, they receive a diagnostic action plan that recommends specific skills to practice based on students' current knowledge levels in key strands of math and ELA. These diagnostic-driven recommendations, skill plans aligned with textbooks or state standards, and teacher assigned skills are all powerful ways to keep learning on IXL.

These results demonstrate that the SmartScore is a strong indicator of students' learning and growth within a given topic, and more broadly within a subject area. Reaching proficiency in skills has a positive impact on academic achievement, and when students have to put forth more effort to reach proficiency—as indicated by a fluctuating SmartScore during skill practice—the benefits of that effort are especially impactful. In light of these findings, we recommend that teachers emphasize to their students the importance of perseverance when working through challenging material and provide scaffolding as appropriate (see Warshauer, 2015b for teaching strategies that support the productive struggle). Educators should encourage students to persist through temporary SmartScore decreases and view these fluctuations as part of the pathway to meaningful growth. The SmartScore provides students with an effective way to monitor their own learning, empowering them to engage with challenging concepts and develop mastery at their own pace. As IXL's most formative assessment, the SmartScore is a powerful tool enabling students to take agency in their learning and make significant strides along their academic journey.

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Appendix

Table A1. Sample Size and Real-Time Diagnostic Performance by Grade

	Math			ELA		
Grade Level	***n***	***M* Pretest**	***M* Posttest**	***n***	***M* Pretest**	***M* Posttest**
1	--	--	--	342	142.89	202.25
2	1,213	182.75	258.90	1,260	180.37	278.49
3	1,304	257.18	342.75	1,344	267.55	384.20
4	1,307	337.74	423.89	1,279	363.14	498.66
5	1,207	393.70	502.53	1,252	438.43	584.00
6	1,259	462.40	562.40	1,295	514.88	674.06
7	--	--	--	981	619.03	766.60
8	--	--	--	983	705.12	850.30

Note. M = mean.

Table A2. Full Model Predicting 2022 End-of-Year Real-Time Diagnostic Score in Math from IXL Math Fluctuating and Increasing SP and Baseline Real-Time Diagnostic Score

Predictor	*b*	*SE*	95% CI	β	*t*	*p*
(Intercept)	415.39	3.54	408.31 – 422.46	-0.01	117.275	<.001
Baseline Real-Time Diagnostic score[1]	0.93	0.01	0.92 – 0.94	0.86	168.099	<.001
IXL Math Fluctuating SP[1,2]	**60.55**	**2.47**	**55.71 – 65.38**	**0.14**	**24.524**	**<.001**
IXL Math Increasing SP[1,2]	**3.44**	**0.52**	**2.41 – 4.46**	**0.04**	**6.591**	**<.001**

Note. b = unstandardized regression coefficient, *SE* = standard error, CI = confidence interval, β = standardized regression coefficient, SP = skills proficient.

[1] Grand-mean centered. [2] Weekly average amount.

Table A3. Full Model Predicting 2022 End-of-Year Real-Time Diagnostic Score in ELA from IXL ELA Fluctuating and Increasing SP and Baseline Real-Time Diagnostic Score

Predictor	*b*	*SE*	95% CI	β	*t*	*p*
(Intercept)	535.33	3.59	528.17 – 542.47	0.00	148.925	<.001
Baseline Real-Time Diagnostic score[1]	0.99	0.01	0.98 – 1.00	0.87	186.034	<.001
IXL ELA Fluctuating SP[1,2]	**112.80**	**3.58**	**105.79 – 119.82**	**0.14**	**31.524**	**<.001**
IXL ELA Increasing SP[1,2]	**9.13**	**1.04**	**7.09 – 11.17**	**0.04**	**8.777**	**<.001**

Note. b = unstandardized regression coefficient, *SE* = standard error, CI = confidence interval, β = standardized regression coefficient, SP = skills proficient.

[1] Grand-mean centered. [2] Weekly average amount.