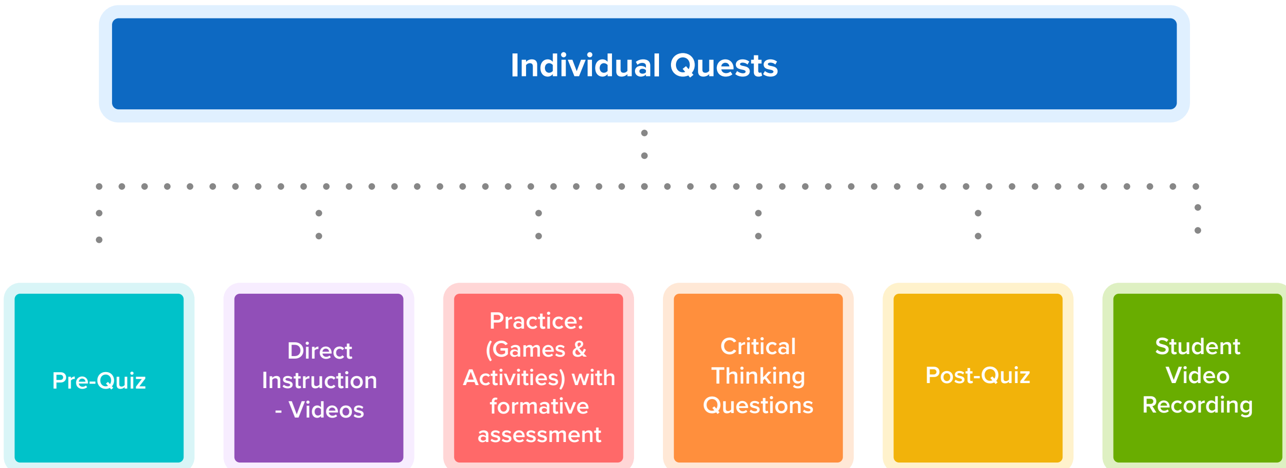
eSpark's Theory of Learning

What is eSpark?

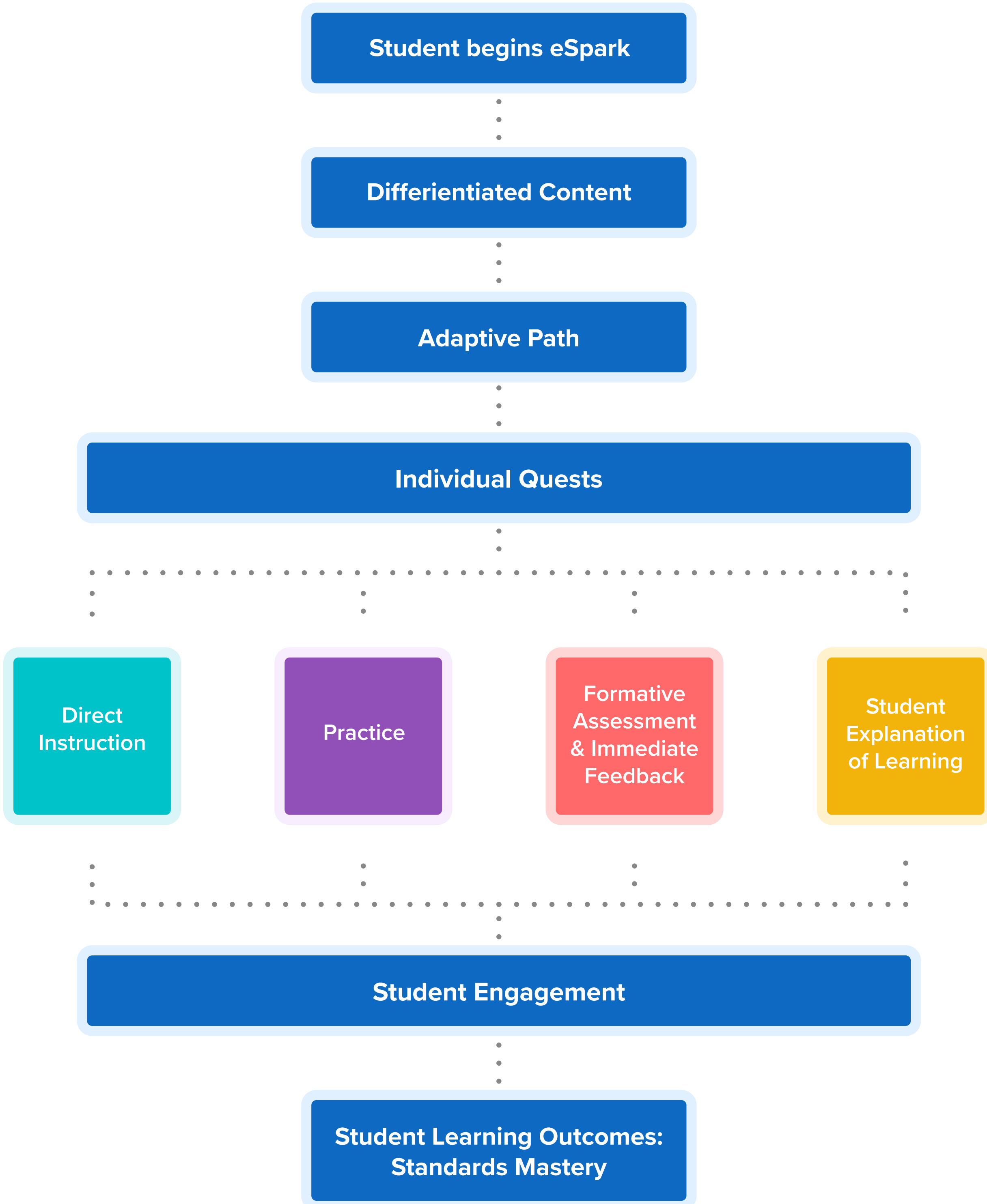
eSpark is a personalized learning program that provides kindergarten through fifth grade students with individual learning paths based on their unique needs. These paths consist of Quests, which are reading or math standards-aligned experiences with several components: a pre-quiz, direct-instruction videos, practice (games or online activities), formative assessments with feedback, critical thinking challenges, a post-quiz and a student video recording explaining their learning.



Teachers receive insight into students' performance on their pathways through dashboards which show real-time assessment results, student minutes spent on eSpark, and individual and class growth.

eSpark's Theory of Learning

eSpark's Theory of Learning guides its product development:



eSpark's Theory of Learning is grounded in research-based elements (teaching practices or design elements) that are linked to student learning outcomes. These elements are: differentiation, adaptivity, student engagement, direct instruction, practice, formative assessment with immediate feedback, and student explanation of learning. Two elements, differentiation and adaptivity, are integrated into how students move between individual Quests. These elements are incorporated into how students' individualized pathways through Quests are configured. Student engagement is incorporated into the Quest-unit level, but also across all activities (videos, games, assessments) within a Quest. Finally, direct instruction, practice, assessment with feedback, and student explanation of learning are designed into the smallest eSpark components, the individual activities within Quests.

	Designed into pathway **between** Quests	Designed into all activities **within** a Quest	Designed into individual activities **within** a Quest
Research-Based Element	**1:** Differentiation **2:** Adaptivity	**3:** Student Engagement	**4:** Direct Instruction **5:** Practice **6:** Formative Assessment with Immediate Feedback **7:** Student Explanation of Learning

Research-Based Element 1: Differentiation

When eSpark students begin the program, rather than being exposed to all Quests in the curriculum they are provided content differentiated to their unique needs. eSpark uses third-party assessment data (ex. NWEA MAP) or eSpark's own placement quiz to determine on which grade level and learning domain to start students on their math and reading pathways. eSpark's placement quiz is adaptive. Based on results on the first set of assessment questions, students are moved to an easier or harder set to continue pinpointing their appropriate instructional level. Using adaptive testing to pinpoint student levels and pair instructional content to those levels is tied to student learning outcomes (Huey-Min, 2017).

After placement students receive their differentiated materials. Any given eSpark classroom will thus have students working on several different levels and skills. Differentiating student material in this manner, rather than simply providing students with grade-level content, is essential to eSpark's design, given the strong correlation between exposure to differentiated content and student learning outcomes (Reis et al., 2011; Otaiba et al., 2011). In particular, research supports the success of using technology to support differentiation by assessing student needs and suggesting related material dynamically based on scores (Otaiba et al., 2011).

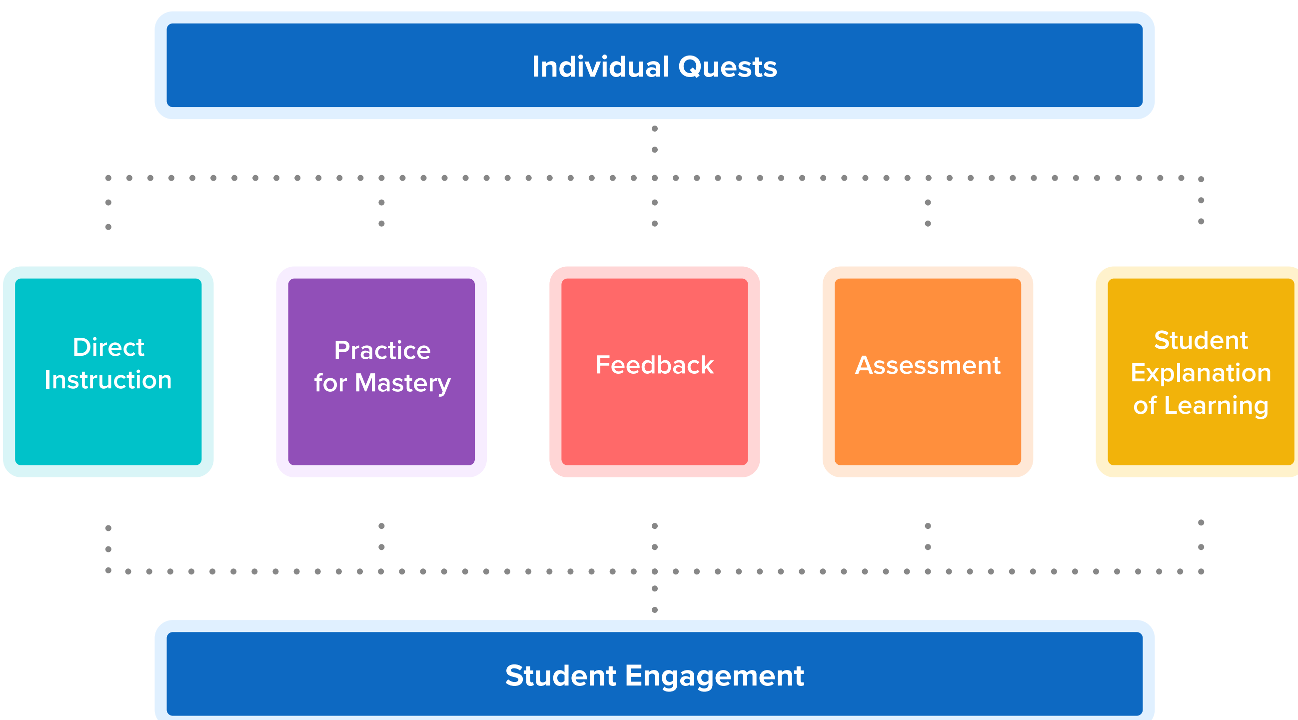
Research-Based Element 2: Adaptivity

Beyond the adaptive placement quiz, eSpark continues to assess students' levels and accordingly adapt their instruction throughout their experience. Each Quest consists of a pre and post-quiz to measure students' learning of the Quest's target math or reading skill. At any point in a grade-level domain (a collection of 8-10 Quests), if students struggle to master more than 50% of the Quests (measured using post-quiz scores), eSpark drops them down to an easier version of the same material. After completing the easier content, students are brought back up to their original level to try again.

The theoretical benefits of students completing work at just the right level (slightly beyond what they know), in their Zone of Proximal Development, is well accepted (Vygotsky, 1978). eSpark continually checks that students are in that zone by adjusting students' levels up or down based on post-quiz scores after each Quest. Beyond theory, using technology to dynamically assess and then assign students appropriately leveled content has indeed been correlated to student learning outcomes (Huey-Min, 2017).

Research-Based Element 3: Student Engagement

eSpark's first two research-based elements describe the overall functioning of the eSpark program (i.e. how students move between Quests in ways that support student learning outcomes). The remaining research-based elements around which eSpark is designed are found within Quests:



Research shows the correlation between student learning outcomes and motivation, particularly intrinsic, to complete work (Bodovski et al., 2007; Lepper, 2005). eSpark is designed to promote students' intrinsic motivation to complete each activity within a Quest. Learning videos, songs, games, and texts are created or curated by eSpark's learning designers to promote student enjoyment and a desire to complete the task simply for the fun of it, versus relying on extrinsic motivators like scores, grades, rewards, or praise. eSpark measures student enjoyment of each activity through a thumbs up/down rating that students complete after each activity. The learning design team uses an 85% positive rating as a baseline to evaluate activities as enjoyable for students or not. Activities below that baseline are systematically revisited, removed or improved.

Research-Based Element 4: Direct Instruction

The next research-based element, direct instruction, is found in individual activities (videos) within Quests. eSpark Learning provides students with multiple opportunities to engage with direct instruction when learning a new skill. Students need more than just practice to learn a skill, so direct instruction is front-and-center in the curriculum. Whether students are learning content for the first time or reviewing a standard their teacher has previously taught, by engaging with a variety of instructional videos, students are much more successful in their subsequent practice activities and assessments.

Every Quest starts with a framing video that explicitly states what students will be learning, with a real-world example, and is followed by a direct instruction video. Multiple direct instruction videos are interspersed between practice activities to ensure every skill is taught explicitly in a way that students will be able to transfer to independent practice (Fisher & Frey, 2007). The quality of the instructional videos makes a significant difference on students' understanding. Providing high quality audio and visual support in every video is recognized as essential to effective instruction, as well as making sure the skill is explicitly taught in a sequential manner (Al-Makahleh, 2011). eSpark ensures the quality of its instructional videos by not only ensuring the skill is explicitly taught in a sequential manner but by using a rubric to confirm it is culturally relevant, developmentally appropriate, standards aligned, engaging, clear and easy to understand, and has sufficient scaffolds. Every instructional video is followed by a check for understanding, which allows eSpark to assess students' ability to apply what they learned from the video. That data allows eSpark to ensure the effectiveness of our instructional videos and the impact they have on subsequent learning.

Research-Based Element 5: Practice

Application and multiple opportunities for practice of a skill or standard are core to the eSpark experience. After receiving direct instruction and seeing a skill modeled, students are provided with many opportunities to practice the skill and demonstrate mastery. Practice opportunities are given to students in multiple formats including game-based practice, traditional practice activities, quick checks for understanding, and deeper critical thinking challenges. Students using eSpark are provided with both reading and math learning pathways. While both pathways have incorporated multiple opportunities for practice, the type of practice and instruction varies depending on the content area and standard.

eSpark's math curriculum is aligned to the Common Core State Standards and is rooted in modeling conceptual math through visual representations such as area models, number lines, arrays, etc. Students are equipped with explicit instruction modeling the use of these visual models and then given the opportunity to apply their knowledge of these models through multiple practice activities. By using visual models, students gain a deeper understanding of mathematics concepts and develop strong mathematical knowledge (Gersten, 2009). eSpark's math curriculum is also designed to support a specific sequence and range of examples that promotes understanding of foundational math skills (Gersten, 2009). Instruction and activities are delivered through a scaffolded gradual release model in which students see a math skill modeled before they are provided with guided practice opportunities followed by deeper critical thinking questions that they complete independently. This scaffolded approach ensures that students are learning the foundational skills necessary to demonstrate mastery of a standard and concept.

eSpark's reading curriculum is similarly designed to support a specific sequence and range of examples to provide a scaffolded learning experience for students. The reading curriculum incorporates a variety of reading strategies which are explicitly taught and modeled for students. Students are then provided a text at their reading level to practice the newly learned strategy. While many different strategies are included in eSpark's curriculum, there is a heavy focus on monitoring comprehension, asking questions, generating questions, summarization, and the use of graphic organizers which are proven to lead to increased learning, better transfer of learning, increased retention, and overall improvements in comprehension (National Reading Panel, 2000). After reading a text within eSpark, students are required to answer a text-dependent question. Question formats vary from text to text and can be anything from a multiple choice question to a categorizing question to completing a graphic organizer. Students are also provided with opportunities upon completion of a Quest or series of reading activities to record a video synthesizing their learning. These videos allow students to verbalize their understanding of a text as well as ask questions that they still have about the text.

Research-Based Element 6: Formative Assessment with Immediate Feedback

eSpark bakes formative assessment with immediate feedback into several spots in a Quest. Every video, practice activity, or game is paired with a check-for-understanding question. When students answer these questions, not only do they immediately receive feedback on whether their answer is right or wrong, they also receive instructional feedback on how to answer in the future. Even simple feedback, such as right or wrong, has been correlated with student learning outcomes (Faber et al., 2017).

eSpark's feedback is also designed around the research-based concept of giving students multiple tries, after feedback, to improve their answers on their work. Allowing students multiple attempts to master content has been correlated to higher learning levels, particularly for students with new or "average rated" teachers (Martinez J., & Martinez, 1992). Each eSpark Quest has a critical thinking challenge in which students receive three attempts to solve the challenge. Students receive feedback on whether they were right or wrong and are prompted to try again.

The final component of eSpark's assessment and feedback system involves teacher knowledge of student assessment results and resulting actions they can take using that data. Providing teachers with data on their students' learning levels and suggested materials aligned to their gaps is correlated to student learning outcomes (Bergan et al., 1991). eSpark provides teachers with live data on student skill gaps in several data reports. Teachers can see student and class performance on pre and post-quizzes for each skill students practice. One view of this data is compiled by class results on the standard. Teachers can also drill into student-level data to see item-level performance on formative assessment questions (check for understanding questions and critical thinking questions) throughout a Quest as well as in post-quiz results. Further, eSpark provides teachers with a weekly email summarizing classroom learning trends with materials (videos and questions) aligned to assessment results, as educational research shows the value of tying data to suggested aligned materials (Bergan et al., 1991).

eSpark's mini-lessons feature (short Quests with only three resources) provides teachers a report with real-time data updating student results on a series of quiz questions. Class results are compiled into a "commonly missed questions" section which teachers can project and analyze to immediately respond to data. Providing teachers with real-time formative assessment data, particularly presenting it in a rolled-up view with combined class results, is linked to student learning outcomes (Pape et al., 2012).

Research-Based Element 7: Student Explanation of Learning

At eSpark, it is important that students not only learn in the moment, but are able to retain and transfer the important skills they have gained. The student explanation of learning gives students the opportunity to demonstrate higher level understanding by making a video of themselves explaining the answer to a high level open-ended question. By verbally responding to a prompt, students are able to become the teachers and are much more likely to be able to transfer what they have learned (Rittle-Johnson, 2006). This is the last activity students complete in a Quest, given to all students K - 5. In addition to supporting students in demonstrating deeper understanding of a skill, videos also help reveal misconceptions students have that may go unobserved in more traditional assessments. This then allows teachers to strategically intervene and support students. By engaging in a verbal explanation of what they have learned, versus a written response, students of all ages are better able to retain what they have learned (Hoogerheide et al., 2016).

Conclusion

In summary, eSpark is designed using its Theory of Learning based on seven research-based elements: differentiation, adaptivity, student engagement, direct instruction, practice, formative assessment with immediate feedback, and student explanation of learning. Some of these elements (differentiation and adaptivity) are designed into how students move through their individual pathways of Quests. Some (engagement) are designed into each activity in a Quest. And some (direct instruction, practice, formative assessment with feedback and student explanation of learning) are designed into the individual activities within Quests.

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This school year, eSpark students have mastered (achieved 80% or above on post-quiz) 6,014,495 standards within eSpark. Students' average growth from pre to post quiz, a measure of their learning of a Quest's material, is 18%. eSpark is continually tracking student engagement and learning metrics to improve its curriculum and design to support stronger learning outcomes. Underpinning any changes, improvements, or new feature development is eSpark's research-based Theory of Learning, guiding design decisions to drive strong student learning outcomes.

Annotated Bibliography

Al-Makahleh, A. A. (2011). The Effect of Direct Instruction Strategy on Math Achievement of Primary 4th and 5th Grade Students with Learning Difficulties. *International Education Studies, 4(4)*. https://doi.org/10.5539/ies.v4n4p199

In this study, 60 fourth and fifth grade students with learning difficulties participated in an experimental study on the effectiveness of using the Direct Instruction Strategy. Thirty students were part of a control group that were taught math using traditional methods and the other 30 students were part of an experimental group that were taught math using the Direct Instruction Strategy. The Direct Instruction Strategy focused on explicit, sequential instruction that allowed students to learn mathematical concepts step by step. The process involved clear goal and expectation setting, making the steps to completing the instructional task sequential and systematic, allowing sufficient time for the task, providing student feedback, and giving clear instructions for practice to achieve mastery. All of the participants in the study were given a pre-test and a post-test; statistical significant differences were found among the control and experimental group. The experimental group members had higher mean scores compared with the control group, showing that the Direct Instruction Strategy effectively improved the attitudes of students who struggle with math. eSpark Learning math Quests also use the Direct Instruction Strategy to promote standards mastery. The skills that will be covered in a Quest are first presented in a framing video to clearly lay out the goal and expectations to students. Once they are given a clear idea of what they will be expected to do by the end of the Quest, they are presented with a direct instruction video that systematically presents step-by-step how students can complete the mathematical tasks. Students are presented with multiple direct instruction videos per Quest, with practice in between, giving them sufficient time to process, practice, and get feedback on the newly learned skills.

Bergan, J. R., Sladeczek, I. E., Schwarz, R. D., & Smith, A. N. (1991). Effects of a Measurement and Planning System on Kindergartners' Cognitive Development and Educational Programming. *American Educational Research Journal, 28(3)*, 683–714. https://doi.org/10.3102/00028312028003683

In this study, researchers looked at math, reading and science achievement data, promotion into first grade, and referrals to special education of 838 kindergartners in public schools. Teachers in experimental classrooms were provided with assessment data on their students' learning levels, with skills organized in a developmentally appropriate sequence, classroom materials aligned to their students' skills gaps, and bimonthly meetings with a site manager, where the teacher and coach co-planned which provided activities aligned to skill gaps and evaluated progress from the preceding weeks. Researchers found that students in treatment classrooms had significantly higher reading and science post-test scores, with math results also higher, though the results were not

significant. However, when evaluating a subset of classrooms with high treatment implementation compared to control groups, all three subjects saw significantly higher scores. Finally, students whose teachers had a “high implementation” for using the aligned classroom materials versus those with a lower implementation had significantly higher results as well. eSpark, similarly, provides teachers with rolling data on student skill gaps in our two data reports. Teachers can see student and class performance on post-quizzes for each skill students practice. Teachers can also drill into student-level data to see item-level performance on formative assessment questions throughout a Quest as well as post-quiz results. Further, eSpark provides teachers with a weekly email with materials (videos and questions) aligned to assessment results, similar to the design of this experiment. While eSpark cannot provide live coaching to support fidelity of implementation and use of data or activities, eSpark does provide professional development to encourage data and suggested materials use.

Bodovski, K., & Farkas, G. (2007). Mathematics Growth in Early Elementary School: The Roles of Beginning Knowledge, Student Engagement, and Instruction. *The Elementary School Journal, 108(2)*, 115–130. https://doi.org/10.1086/525550

Researchers used a data set of 13,048 kindergartners from a larger, nationally representative sample of kindergarteners in a longitudinal study that followed the students from kindergarten to eighth grade to evaluate the effects of time on instruction and student engagement on mathematics achievement. Both time on instruction and (teacher perceived) student engagement were found to have a significant, positive association with achievement, with engagement having a stronger association than time on instruction. Engagement’s effect was strongest for the students who started out lowest performing. eSpark is designed to promote intrinsic student engagement with its content. Every activity is vetted or designed by experienced educators with two goals to meet prior to being added to our curriculum: educational quality (pedagogy) and student engagement. Activities which are rated low on our student-generated engagement score (a thumbs up/down rating) are removed from the curriculum.

Faber, J. M., Luyten, H., & Visscher, A. J. (2017). The effects of a digital formative assessment tool on mathematics achievement and student motivation: Results of a randomized experiment. *Computers & Education, 106*, 83–96. https://doi.org/10.1016/j.compedu.2016.12.001

In this study, researchers evaluated the effect of a digital formative assessment tool on 1808 third grade students in 79 Dutch elementary schools. The tool provided students with mathematics assessment questions, gave simple feedback on their results (right, wrong, new problem, corrected problem), and, based on results, provided adaptive assignments. Teachers could also assign curriculum aligned content. Researchers found a significant, positive effect of using the digital formative assessment tool on the third graders’ standardized test scores. eSpark, similarly, bakes

formative assessment into all the work students complete in our product. Each activity students complete in a Quest or mini-lesson is followed by a check-for-understanding question (question with a variety of formats ranging from multiple choice to written response). Students are provided with simple feedback, whether their answer was right or wrong and, if wrong, what the right answer is and a tip for how to find it in the future. eSpark also has at least one "Critical Thinking Question" using more complex question stems, like matching or sorting, to check students' progress and provide them with feedback during their Quest.

Fisher, D., & Frey, N. (2007). Implementing a Schoolwide Literacy Framework: Improving Achievement in Urban Elementary Schools. *The Reading Teacher, 6(1)*, 32–43.

Fisher and Frey discuss the importance of a cohesive literacy framework to ensure implementation of the most effective literacy strategies. Extensive research, gathered over years, went into creating a literacy framework that focuses on grade-level standards and integrates not only reading, but writing and oral language as well. One of the goals of the framework is to ensure a transfer of learning from teacher modeling to students' independent work. The framework starts by addressing the importance of teaching in flexible small groups, based on needs. The components of the literacy framework include: direct instruction and modeling, guided instruction, collaborative learning, independent practice, and assessment.

The eSpark Learning curriculum is based on the principles of Fisher and Frey in that each Quest is designed with a sequence of direct instruction and modeling, independent practice, and assessment. Every Quest (a series of eSpark activities aligned to one specific standard) has a gradual increase in responsibility that begins with direct instruction, then provides activities with guidance, and finally gives the opportunity for independent practice. High-quality instructional videos model each skill. The practice activities that follow this direct instruction provide step-by-step support of skill practice. In literacy activities, reading, writing, and oral language are integrated and practice is embedded in the context of texts. eSpark offers needs-based group instruction by using assessments to place students on Quests that are according to their levels. Teachers can also assign Quests based on a student's needs, and each week teachers receive an email with information on how to group their students and the shared skills those students need to work on.

Gersten, R., Chard, D. J., Jayanthi, M., Baker, S. K., Morphy, P., & Flojo, J. (2009). Mathematics Instruction for Students With Learning Disabilities: A Meta-Analysis of Instructional Components. *Review of Educational Research, 79(3)*, 1202–1242. https://doi.org/10.3102/0034654309334431

In this meta-analysis, researchers synthesized the findings of 42 randomized controlled trials or quasi-experimental design interventions on instructional approaches to support students with learning disabilities in the development of math proficiency. Four instructional approaches

were identified as the interventions used with students: direct instruction, student verbalization of mathematical reasoning, visual representations to solve problems, and a range of examples. Both the use of visual representations and a range of examples produced significant effects. Visual representations include both modeling a mathematical problem with a visual model and having students then solve problems using the same visual model. Sequence and range of examples especially during early acquisition of skills has positive effects on mathematics learning when examples are scaffolded and multiple opportunities for practice are presented. eSpark's mathematics curriculum is designed around providing students with scaffolded learning strategies and repeated opportunities for practice. eSpark's curriculum is aligned to the Common Core math standards and is rooted in modeling conceptual math through the use of visual representations such as area models, number lines, arrays, etc. Students are provided with explicit instruction modeling the use of these visual models and are then given the opportunity to apply their knowledge of these models through multiple practice activities.

Hoogerheide, V., Deijkers, L., Loyens, S. M. M., Heijltjes, A., & van Gog, T. (2016). Gaining from explaining: Learning improves from explaining to fictitious others on video, not from writing to them. *Contemporary Educational Psychology, 44-45*, 95–106. https://doi.org/10.1016/j.cedpsych.2016.02.005

In this study, researchers conducted two experiments to find out the effect of explaining content on video versus in writing. Each experiment involved over 100 participants that engaged in a pre-test, two phases of learning, and a post-test. During the learning phases, students were given different conditions. The three conditions were: restudy, written response, and video response. The results showed that explaining on video, but not in writing, had a greater effect on learning than restudy. This finding supports eSpark Learning's student video creation activity, showing the impact of creating videos on learning.

Huey-Min Wu, Bor-Chen Kuo, & Su-Chen Wang. (2017). Computerized Dynamic Adaptive Tests with Immediately Individualized Feedback for Primary School Mathematics Learning. *Journal of Educational Technology & Society, 20(1)*, 61–72.

In this study, researchers split 118 student participants from a Taiwanese elementary school into 3 groups for remedial mathematics instruction. The groups received either an adaptive test and individualized instruction tied to test results, individualized instruction based on pre-test (which was a non-computer adaptive test), and remedial instruction based on generalized class errors on the pre-test. Researchers found that students in the adaptive testing and resultlingly tailored instruction performed significantly better than the other two groups in test growth, though all forms of remediation had positive results. eSpark's program is designed around the idea of adaptivity and instruction tailored to the results of adaptive testing. Students begin the program with an adaptive math or reading placement quiz. Based on results in the first set of 3-5 questions, students

are moved up or down to an easier or harder test to continue pinpointing their appropriate level for instruction. Once students begin their eSpark Quests, the program monitors their results on each Quest's post-quiz. If students ever dip below 50% mastery on their Quest post-quizzes, they are adapted to a lower, vertically aligned, skill. While the Quest post-quiz itself is not adaptive, instruction is tailored and adapted based on a computer-measured cut point which dynamically measures student level.

Lepper, M. R., Corpus, J. H., & Iyengar, S. S. (2005). Intrinsic and Extrinsic Motivational Orientations in the Classroom: Age Differences and Academic Correlates. *Journal of Educational Psychology, 97(2)*, 184–196. https://doi.org/10.1037/0022-0663.97.2.184

The researchers measured the relationship between intrinsic or extrinsic motivation and academic achievement in a group of 797 third through eighth grade students. They found significant, positive correlation between intrinsic motivation and achievement (GPA and standardized test scores) and negative relationships between extrinsic motivation and the same achievement scores. eSpark is designed to create intrinsic motivation for students to complete their activities. This is done through selecting and creating learning videos, songs, games and texts that students enjoy completing, purely for the fun of engaging in the activity, versus relying on extrinsic motivators like scores, grades, rewards, or praise to propel students forward in the program. eSpark measures student enjoyment of each activity through a thumbs up/down rating students complete after each activity and the curriculum team uses an 85% positive rating as a baseline to evaluate activities as enjoyable for students or not.

Martinez J., & Martinez, N. (1992). Re-examining Repeated Testing and Teacher Effects in a Remedial Mathematics Course. *British Journal of Educational Psychology, 62(3)*, 356–363. https://doi.org/10.1111/j.2044-8279.1992.tb01028.x

In this study, 120 college students in a remedial algebra class were randomly assigned to one of four groups, two experimental and two control. In the experimental condition, students were permitted to take a chapter test 3 times and in the control condition, students could only try once. Two educators, one experienced and rated excellent and one new and rated average, taught the 4 classes. This means the experimental group had one experienced and one new teacher, and the control group had one experienced and one new teacher. Researchers found that students who were permitted repeated attempts on their chapter assessments had significantly better results on their course final assessment. These results were moderated by a teacher effect, with no significant difference between final test scores found for the experienced and "excellent" teacher, suggesting repeated testing is most beneficial for students with less experienced or "average" teachers. eSpark's design allows for repeated testing in several stages of the program. Each Quest has one or more "Critical Thinking Challenge," questions for which students are given 3 attempts to complete it correctly, along with feedback after each attempt suggesting a route to complete the problem. Further, at the end of each Quest, if students do not achieve mastery (similarly defined at 80%) on a post-quiz, students are given the opportunity to repeat the quiz again (with new questions) after also repeating materials from the Quest. eSpark does not simply assess student learning with one summative assessment but is designed around formative assessment throughout a Quest with multiple opportunities for repeated assessment.

National Reading Panel. (2000). *Teaching children to read: An evidence-based assessment of the scientific research litera- ture on reading and its implications for reading instruction* (NIH Publication No. 00-4769). Washington DC: U.S. Depart- ment of Health and Human Services, National Institute of Child Health and Human Development.

The National Reading Panel reviewed and analyzed 205 studies on reading comprehension instruction. The qualifications for the included studies were: they must be relevant to reading comprehension, they must have been published in a scientific journal, they must be a randomized control study. The panel identified 16 unique categories of instruction. Of the 16 categories, 8 were determined to be effective: comprehension monitoring, cooperative learning, graphic organizers, story structure, question answering, question generating, summarization, multiple-strategy teaching. The panel concluded that teaching students a variety of reading strategies supports increased learning, better transfer of learning, increased retention, and overall improvements in comprehension. eSpark's reading curriculum incorporates a variety of reading strategies which are explicitly taught and modeled for students. Students are then provided a text at their reading level to practice the newly learned strategy. While many different strategies are included in eSpark's curriculum, there is a heavy focus on monitoring comprehension, asking questions, generating questions, summarization, and the use of graphic organizers. After reading a text within eSpark, students are required to answer a question about the text. Question formats vary from text to text and can be anything from a multiple choice question to a categorizing question to completing a graphic organizer. Students are also provided with opportunities upon completion of a Quest or series of reading activities to record a video synthesizing their learning. These videos allow students to verbalize their understanding of a text as well as ask questions that they still have about the text.

Otaiba, S. A., Connor, C. M., Folsom, J. S., Greulich, L., Meadows, J., & Li, Z. (2011). Assessment data-informed guidance to individualize kindergarten reading instruction: Findings from a Cluster-Randomized Control Field Trial. *Elementary School Journal, 111(4)*, 535–560.

In this study, researchers sought to find the effect of Individualized Student Instruction on kindergarten reading outcomes. Researchers provided both teachers in treatment and control groups with professional development in individualizing instruction, but treatment groups

received three additional components: ongoing professional development, including resources to individualize instruction; access to a computer program which suggests individualized instruction (topics, homogenous groupings and amount of time) based on student scores; and coaching. While both groups saw growth in student reading outcomes, those in the treatment group both provided more individualized instruction and saw greater reading growth. Individualizing instruction is at the heart of eSpark's program. While eSpark's program differs from the ISI-K treatment in this study in that it does not provide professional development or coaching, eSpark is designed to help teachers continually use data on student performance to create homogenous groupings. Every week, teachers are sent a "Small Groups Email" which suggests homogenous groups and provides resources (videos and questions) for teachers to use for instruction on the identified growth areas.

Reis, S., McCoach, D., Little, C., Muller, L., & Kaniskan, R. (2011). The Effects of Differentiated Instruction and Enrichment Pedagogy on Reading Achievement in Five Elementary Schools. *American Educational Research Journal, 48(2)*, 462-501. Retrieved June 13, 2021, from http://www.jstor.org/stable/27975296

In this study, researchers assigned 63 teachers (with 1192 students in second through fifth grade) to complete a program with differentiated reading instruction or a whole group instruction program based on a basal. Across the 5 elementary schools studied, researchers found students who used the differentiated program had significantly higher reading fluency outcomes and students in high-poverty urban schools also saw significantly higher reading comprehension outcomes. Similar to the SEM-R intervention design, eSpark's reading content is built around highly engaging read aloud videos, with paired scaffolded questions for students to process the literature as well as independent reading of text that is at a student's independent reading level (measured by eSpark's placement test and adaptive placement on subsequent post-quizzes as well as independent third-party assessments provided by teachers). Finally, eSpark's program incorporates several elements from the Phase 3 of the SEM-R intervention, including using technology-enhanced reading practice and practice with advanced question formats, which are presented in eSpark's critical thinking challenges (at least one of which is designed to be in every eSpark Quest).

Rittle-Johnson, B. (2006). Promoting Transfer: Effects of Self-Explanation and Direct Instruction. *Child Development, 77(1)*, 1–15. https://doi.org/10.1111/j.1467-8624.2006.00852.x

In this study, researchers looked at the effects of self-explanation on learning transfer and whether it was more effective with direct instruction or intervention. The study was conducted with 85 third through fifth grade students learning mathematical concepts. The results showed that students that engaged in self-explanation were better able to recall and transfer their knowledge than students with no explanation. In this study, the self-explanation method involved prompting students to explain verbally why a set of answers to a given problem were incorrect or correct and why. The study demonstrated that this method was beneficial to students whether they learned the content

through direct instruction or invention. eSpark Learning utilizes the self-explanation method at the end of each learning Quest. Students are provided with a prompt and given the opportunity to record a video of themselves verbally answering the prompt and explaining their thinking. The prompt is directly associated with the content of the Quest and Common Core Standard and is aligned with higher levels of Bloom's Taxonomy. Once students make their video, it is sent to their teacher who can provide them with feedback.

Stephen J. Pape, Karen E. Irving, Douglas T. Owens, Christy K. Boscardin, Vehbi A. Sanalan, A. Louis Abrahamson, Sukru Kaya, Hye Sook Shin & David Silver (2012) Classroom connectivity in Algebra I classrooms: results of a randomized control trial, *Effective Education, 4 (2)*, 169-189, DOI: 10.1080/19415532.2013.841059

In this study, researchers analyzed the results of 182 classrooms (with 1224 students) in which experienced mathematics teachers were randomly assigned a treatment, using a classroom connectivity technology (CCT) after professional development, or control. In the treatment classrooms, teachers had access to a CCT in which they could do a quick poll, pose formative assessment questions, compile and project student results graphically, and screen share students' graphing calculators. The treatment also included professional developments on using the technology and pedagogical moves or outcomes tied to its use such as formative assessment, student engagement, and classroom interaction. Students in treatment classrooms saw a medium-sized, statistically significant association between the treatment and their post-test scores. eSpark is designed around providing quick formative assessment results to teachers to inform their instruction in real-time. In the product's Mini-Lessons feature, teachers can see real-time updated student results on assessment questions as well as compiled results on student misconception on these questions. Teachers can project the common misconceptions to the class and immediately respond to the formative assessment data.

Vygotsky, L. S. (1978). *Mind In Society: Development of Higher Psychological Processes.* Harvard UP.

Vygotsky's famous research that developed into the theory of the Zone of Proximal Development has had a dramatic influence on modern education. The Zone of Proximal Development ensures students are given instruction that is neither too easy nor hard – providing instruction in each student's "sweet spot" so students can construct their own learning without getting frustrated. This theory has ensured that students are given instruction at their level and receive support as they master essential skills.

eSpark's placement test and adaptive path were directly informed by this theory in order to provide students with curriculum at their optimal level and support them through their productive struggle to make meaning and learn. Students start their eSpark experience by taking reading and math placement tests. The placement tests determine what content is in a student's Zone of Proximal Development by adapting up and down depending on how a student responds, ultimately finding their "sweet spot". Once a starting point is determined, eSpark's adaptive path takes over. The adaptive path is a prescribed sequence of Quests or learning standards that is determined by students' pre-quiz and post-quiz data. This ensures that students receive support and stay in their Zone of Proximal Development by directing them to the Quest most appropriate for their level. The adaptive path is frequently analyzed and updated to ensure it is correctly placing students.