DoodleMath Logic Model

Study Type: ESSA Evidence Level IV

Prepared for:
Discovery Education

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EXECUTIVE SUMMARY

Discovery Education engaged LearnPlatform, a third-party edtech research company, to develop a logic model for their product, DoodleMath. LearnPlatform designed the logic model to satisfy Level IV requirements (*Demonstrates a Rationale*) according to the Every Student Succeeds Act (ESSA).[1]

Logic Model

A logic model provides a program roadmap, detailing program inputs, participants reached, program activities, outputs, and outcomes. LearnPlatform collaborated with Discovery Education to develop and revise the logic model.

Study Design for DoodleMath Evaluation

Informed by the DoodleMath logic model, LearnPlatform developed a research plan for a study to meet ESSA Level III. The proposed research questions are as follows:

1. To what extent are grade K–5 students using the DoodleMath platform?
    a. How much time are students spending on the platform on average?
    b. How many and what types of activities have students completed on the platform?
2. How does grade K–5 student usage of DoodleMath relate to student learning of math content knowledge as evidenced by end-of-course standardized math assessments?

Conclusions

This study satisfies ESSA evidence requirements for Level IV (*Demonstrates a Rationale*). Specifically, this study met the following criteria for Level IV:

✅ Detailed logic model informed by previous, high-quality research
✅ Study planning and design is currently underway for an ESSA Level I, II or III study

[1] Level IV indicates that an intervention should include a "well-specified logic model that is informed by research or an evaluation that suggests how the intervention is likely to improve relevant outcomes; and an effort to study the effects of the intervention, that will happen as part of the intervention or is underway elsewhere…" (p. 9, U.S. Department of Education, 2016).

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Introduction

Discovery Education engaged LearnPlatform, a third-party edtech research company, to develop a logic model for DoodleMath. LearnPlatform designed the logic model to satisfy Level IV requirements (*Demonstrates a Rationale*) according to the Every Student Succeeds Act (ESSA).

The study had the following objectives:

1. Define the DoodleMath logic model and foundational research base.
2. Draft an ESSA Level I, II, or III study design.

Previous Research. The design of this logic model was guided by previous research examining the importance and efficacy of programs provided to students, supplementary to classroom instruction, that support a strong early foundation in math. Research shows that the early development of mathematics skills and knowledge is key for students' long term improvement in math and other economic, health, and career outcomes (Reyna et al., 2009). However, mathematical knowledge and skills, as represented by the National Assessment of Educational Progress (NAEP) grade 4 and 8 math scores, have plateaued in the U.S. over the past decade and worsened in the aftermath of the COVID-19 pandemic (NAEP, 2022). Studies show that students who struggle to obtain math skills and knowledge in early years may continue to struggle in later years as they lose pace with their grade level peers (Jordan et al., 2009; Duncan et al., 2007). Deficiencies in early mathematical skills and widening gaps in mathematical knowledge are worse for students from low socioeconomic backgrounds (Reardon, 2013; Morgan et al., 2009). And more, gaps in mathematics knowledge between white students of color and white students have persisted and grown in recent years (NAEP, 2022).

Therefore, it is essential that all students receive a strong early foundation in mathematics in order to improve long-term math and life outcomes (Duncan et al., 2007). Studies have shown that research-based math interventions are necessary to support the acquisition of math skills and knowledge for younger students (Butterworth et al., 2011; Jordan & Levine, 2009) but teachers often lack the time, access, and resources to provide these interventions in ways that meet the unique learning needs of each student (Goddard et al., 2015). However, recent technological advancement has made it easier for teachers to access high quality math interventions (Levine, 2018) without demanding more time from their busy schedules (Hilton, 2018; Kucian et al., 2011). Technology, when made available to schools and students, can make it easier for students to learn at any time and from any location, providing more opportunities for a diverse range of students to access supplemental support alongside classroom instruction (Levine, 2018). However, such tools have not historically been made available to all students, particularly low-income students and students of color (Kitchen & Berk, 2016).

DoodleMath is a K–5 personalized practice solution that aims to build student fluency and confidence in math. Geared at supporting students as they practice math, and to supplement classroom instruction, DoodleMath provides a self-paced, interactive, and skill-based math program that adjusts to the unique learning needs of every student. DoodleMath is recommended

to be used "little and often" (Hart, 2020b) or at least ten minutes a day (Hart, 2020a). Two University of Bath studies from the United Kingdom found that on average, children who used DoodleMath over the summer significantly improved their mathematics performance after their vacation when compared with their peers. There were also related, positive findings for students' feelings of interest and competence in math (Lyons & Joiner, n.d.). Personalized math programs, like DoodleMath, have been shown to directly improve achievement in math concepts being taught as well as indirectly improve achievement across other math concepts (van der Ven et al., 2017; Fuchs et al., 2009). DoodleMath draws on cumulative learning theory (Gagné, 1968) and is designed to support students to understand key mathematical concepts through iterative, purposeful, and scaffolded activities. The program's focus on flexible, personalized pathways aligns with research on what comprises an effective intervention that meets the unique learning needs of all students (Patrick & Sturgis, 2015; Pane et al., 2014).

Students first interact with DoodleMath through a baseline assessment that contains questions that are designed to adjust to a student's unique mathematical knowledge and locate a student's unique zone of proximal development (ZPD). The concept of ZPD was originally developed by Lev Vygotsky and refers to the difference between what a student can do without help and what he or she can achieve with guidance and encouragement from a skilled partner (Vygotsky, 1978). Products that support ZPD provide levels of activities that are personalized to the skill level/development of each student. As part of building math fluency, DoodleMath includes activities that engage students by connecting practice to relevant mathematical concepts and problems. This approach to mathematical instruction is associated with higher math achievement than approaches that focus on rote memorization (Boaler, 2016). DoodleMath incorporates games and challenges into its activities to introduce play into a child's learning experience which studies have shown can lead to more positive outcomes when compared to traditional methods of teaching math (e.g., drill and practice) (Clark et al., 2016).

DoodleMath provides engaging and personalized challenges that provide regular feedback to students (including opportunities for teachers to review and assign activities) and encourages them to extend their knowledge and skills; all elements of instruction that have been shown to foster a mathematical growth mindset in students (Dweck, 2006). This refers to a student's self-confidence in math, determination to overcome obstacles in their mathematical understanding, and knowledge that their math progress is determined by instruction and practice; not by innate ability (Boaler, 2016). When students recognize that their math ability is not fixed or innate, their achievement improves (Claro et al., 2016; Blackwell et al., 2007; Dweck, 2006).

Taken together, the literature shows that programs provided to students to support a strong early foundation in math are uniquely positioned to support student learning (with increased flexibility and access) outside and alongside classroom instruction. DoodleMath is grounded on research that champions the benefits of personalized learning, the importance of targeting instruction at a child's zone of proximal development (Vygotsky, 1978), and the urgency to foster a mathematical growth mindset in students (Boaler, 2016; Dweck, 2006). These are key elements of an effective, early math program that are essential for improving students' long term math and life outcomes.

Logic Model

A logic model is a program or product roadmap. It identifies how a program aims to impact learners, translating inputs into measurable activities that lead to expected results. A logic model has five core components: inputs, participants, activities, outputs, and outcomes (see Table 1).

Table 1. Logic model core components

Component	Description	More information
Inputs	What the provider invests	What resources are invested and/or required for the learning solution to function effectively in real schools?
Participants	Who the provider reaches	Who receives the learning solution or intervention? Who are the key users?
Activities	What participants do	What do participants do with the resources identified in Inputs? What are the core/essential components of the learning solution? What is being delivered to help students/teachers achieve the program outcomes identified?
Outputs	Products of activities	What are numeric indicators of activities? (e.g., key performance indicators; allows for examining program implementation)
Outcomes	Short-term, intermediate, long-term	Short-term outcomes are changes in awareness, knowledge, skills, attitudes, and aspirations. Intermediate outcomes are changes in behaviors or actions. Long-term outcomes are ultimate impacts or changes in social, economic, civil or environmental conditions.

LearnPlatform reviewed DoodleMath resources, artifacts, and program materials to develop a draft logic model. Discovery Education reviewed the draft and provided revisions during virtual meetings. The final logic model depicted below (Figure 1) reflects these conversations and revisions.

doodlemath

Problem Statement: Personalized learning support can be costly and complicated for classroom teachers to implement. DoodleMath is a K–5 math practice solution that builds student fluency and confidence, personalized to each student's learning needs in math. Geared at supplementing classroom instruction, DoodleMath provides a self-paced, fun, interactive, skill-based math program that adjusts to the unique learning needs of every student.

Inputs
What we invest:

Provider:

A research-based online math practice program that provides students with personalized, evolving work programs and motivating, scaffolded activities designed as supplementary to classroom instruction

Carefully-authored, highly-interactive content that aligns to K–5 curriculum and standards via a personalized work program[1] for each student

Reporting of student progress via student, educator, and parent dashboards

Web based delivery of content with accessibility options (colored overlays and audio dictation for all questions)

Online support via FAQs, how-to content, and dashboard support team via help center

Dedicated partner success advisor

School/District:

Internet-enabled devices

Time and resources to allow students requisite access to, and use of, the DoodleMath program

Participants
Who we reach:

K–5 students

Educators

Parents and Guardians

Administrators

Activities
What we do:

Students complete preliminary self-assessment and baseline assessment to measure their confidence in math and determine their ZPD[2]

Students gain access to their personalized math work program

Students work independently on math activities and Assignments[3] (high frequency users are those who use the program "little and often" or at least 10 mins per day[4]) tied to their ZPD and knowledge gaps (e.g., New This Week, 6-a-Day)

Students are supported through scaffolded explanations, hints, and activities including adding activities to Tricky Questions

Students earn rewards (incl. stars, badges, certificates, streaks) after completing activities and Assignments

Students view their usage and achievement data

Students collaborate with classmates and show encouragement

Educators access educator dashboard weekly to view and export detailed student activity, manage rewards to encourage routine use of the program, and view student progress data in order to apply that information to their classroom and small group instruction

Educators can assign and reassign baseline assessments

Educators may create custom rewards for students

Educators may prescribe Assignments—including those created themselves—to students or student groups by topic, math concept, and curricular standard

Parents and guardians access parent dashboard to view their student's usage and achievement data, manage rewards, and update their information

Parent and guardians receive messages sharing student progress via their dashboard

Parents and guardians can link existing home user accounts to their student's school

Parents and guardians can solve queries (independently of teachers or administrators) using how-to content and the help center within the platform

Administrators review students' usage and progress data by student, teacher, and school

Administrators can download a whole-school annual impact report

Outputs
Products of activities:

Number and frequency of students accessing their work programs

Results and nature of baseline assessments, including a breakdown of individuals' level, strengths, and knowledge gaps

Number and nature of activities and Assignments completed, in progress, and outstanding

Number and nature of students who meet their learning goals and % of students on target

Overall activity scores at weekly intervals shown as number of stars earned by correctly answering questions and completing activities

Number and nature of explanation requests, hints, and activities submitted to Tricky Questions

Number and nature of Tricky Questions completed after submission

Number and nature of time on task or minutes spent on each activity

Number of rewards earned and used

Number and nature of student interactions with classmates

Number of times educators access their dashboard and the nature of the content and resources they engage with

Nature of baseline assessments assigned or reassigned by educators

Number and nature of rewards given to students by educators

Number and nature of Assignments prescribed

Number of times parents and guardians access their dashboard and the nature of the content and resources they engage with

Number and nature of messages sent to parents and guardians via their dashboard

Number of parent dashboards linked with their student's school

Number and nature of how-to content accessed and help center requests

Number of times administrators self-report reviewing data by student, teacher, and school

Number of whole-school annual impact reports downloaded

Outcomes
What changes or benefits result...

Short-term

Product Use Outcomes

Students develop an expanded understanding of math and how math concepts can be applied to their lives through fun and purposeful activities

Students have increased confidence as they learn math and apply their knowledge in activities tailored to their strengths and needs

Students build resilience by working through incrementally challenging tasks with increased independence

Implementation/Contextual Outcomes

Educators spend less classroom time on skills practice instruction

Educators access progress data to identify students' knowledge gaps in math and differentiate instruction based on students' unique learning needs

Educators observe increased student engagement and interest in math through use of the program

Parents and guardians have access to information about their student's progress in math

Administrators promote use of personalized math programs to improve math proficiency and fluency across their school/district

Administrators have more information about student progress in math learning and skill development in their school/district

Intermediate

Product Use Outcomes

Students have increased self-assurance and excitement for learning math

Students reflect on and learn from mistakes, and find relevance and personal meaning while developing a mathematical growth mindset[5]

Gaps in students' math knowledge and understanding are narrowed

Students engage in math learning experiences and apply newly attained skills to experiences outside of the classroom

Implementation/Contextual Outcomes

Educators focus instructional time on problem solving, building conceptual understanding, and application of skills to real-world math problems

Educators routinely address learner variability and increase opportunities for differentiated practice and application in their classroom

Parents and guardians gather insights on their student's fluency and skill development in math and provide supports at home

Administrators provide direct support for adoption of the program to improve students' math outcomes across their school or district

Administrators use student data to make informed decisions about math instruction and learning in their school/district

Administrators direct and allocate resources and supports for math instruction for educators and schools in most need

Long-term

Product Use Outcomes

Students' interest, self-efficacy, and motivation to learn math increases

Students have the math skills and knowledge to succeed in elementary school and beyond

Students measurably improve their math content knowledge and skills

Students develop a lifelong passion for learning math

Students build fluency and conceptual understanding in math

Implementation/Contextual Outcomes

Educators construct learning experiences where self-efficacy and reflection are present and promoted in students' acquisition of new math skills

Educators become more effective practitioners by differentiating learning at scale and using data to regularly drive instructional decisions in the classroom

Parents and guardians become more in touch with their student's development in math and more confident in their ability to support their student

Administrators support the development of a mathematical growth mindset for students and teachers

Administrators promote and foster a culture of data-informed math instruction throughout their school/district

[1]DoodleMath uses a proprietary algorithm called Proxima to create a work program for each student that adjusts based on their performance throughout the program.
[2]The concept of a student's zone of proximal development (ZPD), originally developed by Lev Vygotsky (Vygotsky, 1978), refers to the difference between what a student can do without help and what he or she can achieve with guidance and encouragement from a skilled partner.
[3]Assignments refer to specific activities that include interactive, detailed math concept explanations. Students can select their own Assignments and/or teachers can prescribe specific pre-made or self-created Assignments to students.
[4]Recommended usage for DoodleMath is "little and often" (Hart, 2020b) or at least ten minutes a day (Hart, 2020a). High frequency DoodleMath users (students who use the product for 20 or more mins per week) have been associated with more positive math outcomes (Lyons & Joiner, n.d.).
[5]Mathematical growth mindset (Boaler, 2015) refers to a student's self-confidence in math, determination to overcome obstacles in their mathematical understanding, and knowledge that their math progress is determined by instruction and practice; not by innate ability.

Prepared for Discovery Education, January, 2023

Figure 1. Discovery Education's DoodleMath Logic Model

LEARN PLATFORM

DoodleMath Logic Model Components. Discovery Education invests several resources into their program, including a research-based online math practice program that provides students with personalized, evolving work programs and motivating, scaffolded activities designed as supplementary to classroom instruction; carefully-authored, highly-interactive content that aligns to K–5 curriculum and standards via a personalized work program for each student;[2] student progress reporting via student, educator, and parent dashboards; web-based delivery of content with accessibility options (colored overlays and audio dictation for all questions); online support via FAQs, how-to content, and a dashboard support team accessible via a help center; and a dedicated partner success advisor. Schools and/or districts would also be expected to provide internet-enabled devices and the requisite time and resources to allow students access to, and use of, the DoodleMath program.

Ultimately, the Discovery Education program aims to reach K–5 students, educators, parents and guardians, and administrators. Using these program resources, the aforementioned participants can engage with the DoodleMath program in the following activities:

K–5 Students:

- complete preliminary self-assessment and baseline assessment to measure their confidence in math and determine their ZPD;[3]
- gain access to their personalized math work program;
- work independently on math activities and Assignments[4] (high frequency users are those who use the program "little and often" or at least 10 mins per day) tied to their ZPD and knowledge gaps (e.g., New This Week, 6-a-Day);
- are supported through scaffolded explanations, hints, and activities including adding activities to Tricky Questions;
- earn rewards (incl. stars, badges, certificates, streaks) after completing activities and Assignments;
- view their usage and achievement data; and
- collaborate with classmates and show encouragement.

Educators:

- access educator dashboard weekly to view and export detailed student activity, manage rewards to encourage routine use of the program, and view student progress data in order to apply that information to their classroom and small group instruction;
- can assign and reassign baseline assessments;
- may create custom rewards for students; and

[2] DoodleMath uses a proprietary algorithm called Proxima to create a work program for each student that adjusts based on their performance throughout the program.
[3] The concept of a student's zone of proximal development (ZPD), originally developed by Lev Vygotsky, refers to the difference between what a student can do without help and what he or she can achieve with guidance and encouragement from a skilled partner (Vygotsky, 1978).
[4] Assignments refer to specific activities that include interactive, detailed math concept explanations. Students can select their own Assignments and/or teachers can prescribe specific pre-made or self-created Assignments to students.

- may prescribe Assignments—including those created themselves—to students or student groups by topic, math concept, and curricular standard.

Parents and Guardians:

- access parent dashboard to view their student's usage and achievement data, manage rewards, and update their information;
- receive messages sharing student progress via their dashboard;
- can link existing home user accounts to their student's school; and
- can solve queries (independently of teachers or administrators) using how-to content and the help center within the platform.

Administrators:

- review students' usage and progress data by student, teacher, and school; and
- can download a whole-school annual impact report.

Discovery Education can examine the extent to which core activities were delivered and participants were reached by examining the following quantifiable outputs:

K–5 Students

- Number and frequency of students accessing their work programs
- Results and nature of baseline assessments, including a breakdown of individuals' level, strengths, and knowledge gaps
- Number and nature of activities and Assignments completed, in progress, and outstanding
- Number and nature of students who meet their learning goals and percentage of students on target
- Overall activity scores at weekly intervals shown as number of stars earned by correctly answering questions and completing activities
- Number and nature of explanation requests, hints, and activities submitted to Tricky Questions
- Number and nature of Tricky Questions completed after submission
- Number and nature of time on task or minutes spent on each activity
- Number of rewards earned and used
- Number and nature of student interactions with classmates

Educators

- Number of times educators access their dashboard and the nature of the content and resources they engage with
- Nature of baseline assessments assigned or reassigned by educators
- Number and nature of rewards given to students by educators
- Number and nature of Assignments prescribed

Parents and Guardians

- Number of times parents and guardians access their dashboard and the nature of the content and resources they engage with
- Number and nature of messages sent to parents and guardians via their dashboard
- Number of parent dashboards linked with their student's school
- Number and nature of how-to content accessed and help center requests

Administrators

- Number of times administrators self-report reviewing data by student, teacher, and school
- Number of whole-school annual impact reports downloaded

If implementation is successful, based on a review of program outputs, Discovery Education can expect the following outcomes:

Product use outcomes

Short term, students will develop an expanded understanding of math and how math concepts can be applied to their lives through fun and purposeful activities. They will gain confidence as they learn math and apply their knowledge in activities tailored to their strengths and needs while building resilience by working through incrementally challenging tasks with increased independence.

In the intermediate term, students will reflect on and learn from mistakes, and find relevance and personal meaning while developing a mathematical growth mindset.[5] In turn, this will lead to students having increased self-assurance and excitement for learning math. Gaps in students' math knowledge and understanding will be narrowed while they engage in math learning experiences and apply newly attained skills to experiences outside of the classroom.

Long term, as students develop a mathematical growth mindset, their self-efficacy, and motivation to learn math will increase. They will measurably improve their math content knowledge and skills while having the math skills and knowledge to succeed in elementary school and beyond. Finally, increased student engagement in math learning experiences and the application of math skills to real-world contexts will help students develop a lifelong passion for learning mathematics and build fluency and conceptual understanding in math.

Implementation/contextual outcomes

Short term, educators will spend less classroom time on skills practice instruction. They will also access progress data to identify students' knowledge gaps in math and differentiate instruction based on students' unique learning needs. In turn, they will be able to observe increased student engagement and interest in math through use of the program. Parents and guardians will have access to information about their student's progress in math. Finally, administrators will promote

[5] Mathematical growth mindset (Boaler, 2016) refers to a student's self-confidence in math, determination to overcome obstacles in their mathematical understanding, and knowledge that their math progress is determined by instruction and practice; not by innate ability.

use of personalized math programs to improve math proficiency and fluency across their school or district and have more information about student progress in math learning and skill development.

In the intermediate term, educators will be able to re-purpose instructional time to focus on problem solving, building conceptual understanding, and application of skills to real-world math problems. They will be able to routinely address learner variability and increase opportunities for differentiated practice and application in their classroom. Parents and guardians will gather insights on their student's fluency and skill development in math and provide support at home. Administrators will provide direct support for adoption of the program to improve students' math outcomes across their school or district. They will use student data to make informed decisions about math instruction and learning while directing and allocating resources and supports for math instruction to educators and schools in most need

Long term, educators will construct learning experiences where self-efficacy and reflection are present and promoted in students' acquisition of new math skills. They will also become more effective practitioners by differentiating learning at scale and using data to regularly drive instructional decisions in the classroom. Parents and guardians will become more in touch with their student's development in math and more confident in their ability to support their student. Administrators will promote and foster a culture of data-informed math instruction throughout their school or district. This, in turn, will support the development of a mathematical growth mindset for students and teachers leading to students measurably improving their mathematical knowledge and skills.

Study Design for DoodleMath Evaluation

To continue building evidence of effectiveness and to examine the proposed relationships in the logic model, Discovery Education has plans to conduct an evaluation to determine the extent to which DoodleMath produces the desired outcomes. Specifically, Discovery Education has plans to begin an ESSA Level III study to answer the following research questions:

1. To what extent are grade K–5 students using the DoodleMath platform?
    a. How much time are students spending on the platform on average?
    b. How many and what types of activities have students completed on the platform?
2. How does grade K–5 student usage of DoodleMath relate to student learning of math content knowledge as evidenced by end-of-course standardized math assessments?

Conclusions

This study satisfies ESSA evidence requirements for Level IV (*Demonstrates a Rationale*). Specifically, this study met the following criteria for Level IV:

✅ Detailed logic model informed by previous, high-quality research
✅ Study planning and design is currently underway for an ESSA Level I, II or III study

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