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Technical Report

The Center for Educational Measurement and Evaluation

Formative Evaluation of the Ignite Games
for Young Children from Hatch Early Learning

Richard G. Lambert

THE CENTER FOR EDUCATIONAL
MEASUREMENT AND EVALUATION

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Richard G. Lambert, Ph.D.

Director, Center for Educational Measurement and Evaluation

UNC Charlotte

November, 2022

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Similar to reports (Lambert, 2020, 2021, 2022), this study was designed as a formative evaluation. It provides some beginning validation evidence to support the instructional use of the Ignite experiences and may offer evidence-based identification of experiences that may benefit from further investigation for the purpose of possible revision and enhancement. Lambert (2022) demonstrated that previous revisions made to the games resulted in improvements to the learning experiences for children.

Each game within the Ignite by Hatch™ gaming environment belongs to an overall developmental domain and skills-based subdomain and is intended to meet the developmental needs of children at specific skill levels. These skill levels (Beginning, Emerging, Intermediate, Accomplishing, and Proficient) form an intended developmental pathway. Children make progress through games of increasing difficulty and complexity to the focal skills as they complete the games. The skills they acquire in this process build upon each other. The purpose of this study was to examine how children perform in the gaming environment to determine if there is evidence that the game difficulty level actually progresses as intended.

We gathered evidence in three ways. First, we assumed that 5-year-old children would perform better than 4-year-old children, and 4-year-old children would perform better than 3-year-old children, across all games given their expected higher developmental level (Aim 1). To test this assumption, we compared overall pass rates by age groups across all domains. We also examined the overall patterns of usage across Core, Free Play, Entry / Exit, and parent-based or at home experiences. Second, we assumed that children who engage with the Ignite system at recommended levels of usage would outperform children who do not use the system at recommended levels (Aim 2). To test this assumption, we compared the highest game levels achieved by children within each

domain according to usage levels. Third, we assumed that initial pass rates would be highest for Beginning games and then would decline as game difficulty level increased in turn for Emerging, Intermediate, Accomplishing, and Proficient games. To test this assumption, we compared the initial pass rates and game difficulty levels across the skill levels within each domain (Aim 3). Finally, we examined whether there are any differences in success rates in terms of levels achieved and games passed between uses of the Ignite system at home and in school (Aim 4). The results of this study are reported by study aim and domain of development.

Description of the Sample

The analyses outlined in this report were conducted using data from the entire population of 3-, 4-, and 5-year-old children who used Ignite during the 2022–2023 academic year ($n = 63{,}780$). For each domain-specific analysis, all 3-, 4-, and 5-year-old children who attempted at least one experience within a given domain were retained. This process resulted in the following domain-specific sample sizes:

- Social Studies ($n = 63{,}285$)

- Science & Technology ($n = 49{,}328$)

- Social and Emotional Learning ($n = 47{,}071$)

- Language & Communication Development ($n = 51{,}922$)

- Physical Development ($n = 50{,}860$)

- Mathematics ($n = 50{,}689$)

- Literacy ($n = 52{,}369$)

For this report, domain-specific analyses were the focus, and, therefore, if a child attempted any experience within a particular domain, the experiences they did not attempt were considered not passed, given that the child did not progress through the experiences far enough to attempt the

more advanced experiences. The sample was split almost evenly between female (50.1%) and male (49.9%) children. Three-year-olds comprised 35.9% of the sample, 4-year-olds comprised 61.4% of the sample, and 5-year-olds comprised 2.7% of the sample. The racial and ethnic composition of the sample was as follows (see Table 1): white (non-Hispanic) = 31.7%, black (non-Hispanic) = 35.1%, Hispanic = 24.8%, multiple races = 3.6%, Asian = 1.7%, and Native American = 3.1%. Geographically, the sample comprised children from across the entire customer base, and, therefore, was national in scope.

Methods

First, to address Aim 1, we examined the minutes children engaged with the games within each domain, the number of attempts they made to pass games, the percentage of attempts which results in passing a game, and the amount of time children spent across the different games modalities (Core, Free Play, Entry / Exit, and home-based). All these values were compared across age groups.

Second, to address Aim 2, we classified children into high and low usage levels according to criteria developed for the previous report (Lambert, 2022). Children who engaged with the gaming system for at least 600 minutes across the academic year were considered high users. All other children were considered low users. A total of 600 minutes or more engaged with the games is equivalent to playing the games for the recommended 30 minutes per week for at least 5 months of the academic year. We examined whether high usage children achieved more levels than the low usage children.

Finally, to address Aim 3, we examined whether the initial game passing rates tended to decrease in a way that corresponded with increases in nominal experience skill level. Specifically, this

means that Beginning skill-level experiences should be passed at a higher rate than Emerging experiences, which, in turn, should be passed at a higher rate than Intermediate experiences, followed by Accomplishing experiences, and finally by Proficient experiences. For this report, we restricted these analyses to only Core experiences in the classroom, and only included games with nominal skill levels below 6. In previous reports, the results indicated that games with levels 6, 7, or 8 were passed so infrequently by 3, 4, or 5 year olds that they were distorting the results.

The Rasch measurement model was used as an exploratory and descriptive strategy to estimate game difficulty. This approach estimates difficulty relative to all other experiences within the same domain in terms of logit units. Experiences with model-estimated difficulty of .5 logits or higher, meaning an experience location of at least .5 logits above the average experience difficulty within the respective domain, were considered "Difficult." Experiences with model-estimated difficulty of -.5 logits or lower, meaning an experience location of at least .5 logits below the average experience difficulty within the respective domain, were considered "Easy." Experiences with locations on the ability scale within .5 logits of the average difficulty level for the respective domain were considered "Average." We then compared these empirical experience difficulty levels to the nominal or intended skill level for each experience. Experiences were labeled a mismatch if they had a nominal skill level of Beginning or Emerging and a model-estimated difficulty level of Difficult, or conversely, a nominal skill level of Accomplishing or Proficient and a model-estimated difficulty level of Easy. We examined the developmental pathway generated by the Rasch model. Each of the tables in this report are arranged so that the experiences are listed in descending order of model-estimated difficulty. As one reads from the bottom of each table to the top, the results progress from the easiest experiences to the most difficult experiences. This pathway evaluates whether the rank order of experience difficulty generally followed the expected hierarchy of skill level for each

domain. These tables also include the percentage of children who passed each game during their initial attempt.

Results

Aim 1 – Usage Patterns

Social Studies

Table 2 contains the results of the examination of usage patterns for the Social Studies domain. The children spent an average of 16.22 minutes engaged with the games across the academic year. The median number of minutes was 13.97. The distribution of minutes engaged was very right skewed as the maximum was over 600 minutes. This finding confirms a long-standing pattern that many children engage with the games for a typical amount of time and then there is also a substantial minority who make many attempts at the games and spend a great deal of time using the system.

For Social Studies, the children spend just over half of their total time engaged within the system (53.22%), working in the Core part of the system. This is related to the substantial amount of time spent in the Entry / Exit portion of the system within this domain. The Parent segment of the system occupied a small percentage of their total time and that percentage declined with age: 3 year olds – 8.38%, 4 year olds – 6.49%, and 5 year olds – 5.49%. The percentage of attempts that resulted in passing or completing a game increased with age. Three year olds passed a game during 64.07% of their attempts compared to 75.10% for 4 year olds and 78.02% of attempts for 5 year olds.

Science & Technology

Table 3 contains the results of the examination of usage patterns for the Science and Technology domain. The children spent an average of 37.50 minutes engaged with the games across the academic year. The median number of minutes was 25.02. The distribution of minutes engaged was very right skewed as the maximum was over 1,100 minutes. This finding again confirms a long-standing pattern that many children engage with the games for a typical amount of time and then there is also a substantial minority who make many attempts at the games and spend a great deal of time using the system.

For Science and Technology, the children spend almost all of their total time engaged within the system (98.20%), working in the Core part of the system. This is related to the absence of Entry / Exit games within this domain. The Parent segment of the system occupied a small percentage of their total time and that percentage declined with age: 3 year olds – 8.00%, 4 year olds – 6.56%, and 5 year olds – 5.04%. The percentage of attempts that resulted in passing or completing a game increased with age. Three year olds passed a game during 41.10% of their attempts compared to 52.80% for 4 year olds and 57.84% of attempts for 5 year olds.

Social and Emotional Learning

Table 4 contains the results of the examination of usage patterns for the Social Emotional domain. The children spent an average of 36.43 minutes engaged with the games across the academic year. The median number of minutes was 23.05. The distribution of minutes engaged was very right skewed as the maximum was over 700 minutes. This finding again confirms a long-standing pattern that many children engage with the games for a typical amount of time and then there is also a substantial minority who make many attempts at the games and spend a great deal of time using the system.

For the Social Emotional domain, the children spend almost all of their total time engaged within the system (97.74%), working in the Core part of the system. This is related to the absence of Entry / Exit games within this domain. The Parent segment of the system occupied a small percentage of their total time and that percentage declined with age: 3 year olds – 8.57%, 4 year olds – 6.79%, and 5 year olds – 3.91%. The percentage of attempts that resulted in passing or completing a game increased with age. Three year olds passed a game during 42.48% of their attempts compared to 56.63% for 4 year olds and 61.04% of attempts for 5 year olds.

Language & Communication Development

Table 5 contains the results of the examination of usage patterns for the Language domain. The children spent an average of 37.54 minutes engaged with the games across the academic year. The median number of minutes was 22.08. The distribution of minutes engaged was very right skewed as the maximum was over 900 minutes. This finding again confirms a long-standing pattern that many children engage with the games for a typical amount of time and then there is also a substantial minority who make many attempts at the games and spend a great deal of time using the system.

For the Language domain, the children spend almost all of their total time engaged within the system (97.47%), working in the Core part of the system. This is related to the absence of Entry / Exit games within this domain. The Parent segment of the system occupied a small percentage of their total time and that percentage declined with age: 3 year olds – 8.41%, 4 year olds – 7.00%, and 5 year olds – 3.84%. The percentage of attempts that resulted in passing or completing a game increased with age, though not a clearly as it did for the other domains. Three year olds passed a game during 44.55% of their attempts compared to 54.16% for 4 year olds and 53.40% of attempts for 5 year olds.

Physical Development

Table 6 contains the results of the examination of usage patterns for the Physical domain. The children spent an average of 28.01 minutes engaged with the games across the academic year. The median number of minutes was 19.58. The distribution of minutes engaged was very right skewed as the maximum was over 1200 minutes. This finding again confirms a long-standing pattern that many children engage with the games for a typical amount of time and then there is also a substantial minority who make many attempts at the games and spend a great deal of time using the system.

For the Physical domain, the children spend almost all of their total time engaged within the system (97.97%), working in the Core part of the system. This is related to the absence of Entry / Exit games within this domain. The Parent segment of the system occupied a small percentage of their total time and that percentage declined with age: 3 year olds – 7.62%, 4 year olds – 6.70%, and 5 year olds – 4.32%. The percentage of attempts that resulted in passing or completing a game increased with age, though not a clearly as it did for the other domains. Three year olds passed a game during 38.76% of their attempts compared to 51.39% for 4 year olds and 53.71% of attempts for 5 year olds.

Mathematics

Table 7 contains the results of the examination of usage patterns for the Mathematics domain. The children spent an average of 115.80 minutes engaged with the games across the academic year. The median number of minutes was 82.10. The distribution of minutes engaged was very right skewed as the maximum was over 1,800 minutes. These results show the highest pattern of use across all the domains. This finding again confirms a long-standing pattern that many children

engage with the games for a typical amount of time and then there is also a substantial minority who make many attempts at the games and spend a great deal of time using the system.

For the Mathematics domain, the children spend almost all of their total time engaged within the system (98.46%), working in the Core part of the system. This is related to the absence of Entry / Exit games within this domain. The Parent segment of the system occupied a small percentage of their total time and that percentage declined with age: 3 year olds – 7.85%, 4 year olds – 6.92%, and 5 year olds – 4.46%. The percentage of attempts that resulted in passing or completing a game increased with age. Three year olds passed a game during 35.31% of their attempts compared to 46.39% for 4 year olds and 54.99% of attempts for 5 year olds.

Literacy

Table 8 contains the results of the examination of usage patterns for the Literacy domain. The children spent an average of 75.73 minutes engaged with the games across the academic year. The median number of minutes was 38.98. The distribution of minutes engaged was very right skewed as the maximum was over 2,000 minutes. This finding again confirms a long-standing pattern that many children engage with the games for a typical amount of time and then there is also a substantial minority who make many attempts at the games and spend a great deal of time using the system.

For the Literacy domain, the children spend almost all of their total time engaged within the system (97.77%), working in the Core part of the system. This is related to the absence of Entry / Exit games within this domain. The Parent segment of the system occupied a small percentage of their total time and that percentage declined with age: 3 year olds – 9.69%, 4 year olds – 7.43%, and 5 year olds – 5.31%. The percentage of attempts that resulted in passing or completing a game

increased with age. Three year olds passed a game during 54.16% of their attempts compared to 58.36% for 4 year olds and 60.62% of attempts for 5 year olds.

Aim 1 - Summary

Several usage patterns emerged from these analyses. First, the games within the Mathematics domain are used more frequently than those in any other domain. The children use the Literacy domain second most often. The Parent portion of the gaming system is used less frequently than the classroom portion of the system occupying generally around 5-8% of a child's time spent engaged with the games and this percentage decreases with age. These results offered some evidence that the percentage of attempts that result in passing or completing a game increases with age. Five year olds passed at higher rates than 4 year olds, who generally passed at higher rates than 3 year olds did.

Aim 2 – Highest Developmental Levels Achieved by Usage Levels

To test the assumption that more engagement with the Ignite system would lead to higher levels achieved, we first examined the correlation between the amount of time engaged with the Ignite system and the number of levels achieved within each domain. These correlations were moderately to very high: Social Studies $r = .815$, Science & Technology $r = .722$, Social Emotional $r = .742$, Language $r = .772$, Physical $r = .656$, Mathematics $r = .741$, and Literacy $r = .859$. These values indicate a strong linear positive relationship between time spent engaged with the games and the highest level achieved.

To illustrate how this relationship works, we defined two groups of children according to usage levels. We defined the low-use group as those children who used the Ignite system for less than 600 minutes, generally indicating they did not meet the 30 minutes per week standard. The

majority of children in this study were classified in this group (82.5%). We defined the high-use group as those children who used the Ignite system for at 600 minutes, generally indicating at least 5 months and at least 30 minutes per week. It is important to note that this "high"-use group may not have used the Ignite system for the entire 9 or 10 months of a typical academic year. This group comprised 17.5% of all children in this study. This percentage increased over the previous academic year when it was only 10.8%. Furthermore, when this percentage was examined by domain, the percentages of children in the high usage group increased across all domains: Social Studies = 16.72%, Science & Technology = 21.46%, Social Emotional = 22.51%, Language = 20.40%, Physical = 20.82%, Mathematics = 20.90% and Literacy = 20.24%.

It is important to note that the overall distribution of minutes engaged with the system is very right skewed. The mean for total minutes engaged is 317.08. However, the median is only 187.11 minutes with a standard deviation of 358.10 minutes. These results illustrate how there is a substantial minority of children who spend a great deal more time engaged with the system than the typical children do. The middle 50% of children spend between 65.35 and 453.54 minutes engaged with the games.

We compared the number of levels achieved across the usage groups by domain. Table 9 contains the average number of levels achieved for children of all age groups by usage level. Children in the high-use group achieved more levels on average than children in the low-use group across all domains. Specifically, children in the low-use group achieved approximately one or two levels on average. The means ranged from as low as 1.54 for Science & Technology to as high as 2.33 for Mathematics. Children in the high-use group achieved approximately four or five levels on average. This means they were generally reaching proficiency for kindergarten expectations. These means ranged from as low as 4.24 for Science and Technology to as high as 5.04 for Literacy. When these very substantial differences between the groups were expressed as Hedges unbiased

standardized mean difference effect sizes, they were all over two standard deviations in magnitude. They ranged from as little as 2.16 for Mathematics to as high as 2.73 for Language.

Aim 2 – Summary

Across all seven domains and all three age groups, the low-use group of children completed approximately one level to two levels on average. The high-use group of children completed approximately 4 or 5 levels on average across all domains. The differences between the usage groups were very large by effect size standards (all > 2) and were educationally meaningful given that the high usage children were generally reaching kindergarten proficiency across domains. While low usage children still represent the majority of children, there were substantial increases in the percentages of children categorized in the high usage group compared to previous academic years.

Aim 3 - Game Difficulty Levels by Domain

Prior to conducting analyses to evaluate the difficulty of each of the Ignite games within their respective domain, several classes of games were eliminated from the analyses. First, all games with a skill level of 6 or greater were eliminated from these analyses as the preschool and kindergarten children in the sample would not be expected to pass these games easily. Therefore, their extremely low initial pass rates would create a skewed distribution of initial pass rates. Second, we eliminated a class of games which are meant for initial practice purposes and not for repeated attempts until a child gains specific skills. These games were eliminated because all children "pass" these games in the sense that they are moved along in the game sequence independent of whether they master specific skills. Third, a small subset of games were eliminated because they were under revision during the 2022-2023 academic year. New versions of these games were introduced at various points during the academic year and therefore all children were not exposed to the same

versions of these games, nor can we be assured that all children were given the opportunity to engage with the revised version of each game. Finally, the Social Studies domain was eliminated from these analyses because it only contained four games after these classes of specific games were eliminated from the game difficulty analyses.

Science & Technology

For the 2019–2020 academic year, there were large differences in intended and empirical-experience difficulty levels for many of the Science & Technology experiences. For the 2020–2021 academic year, there were no mismatches between intended and empirical-experience difficulty levels. For the 2021–2022 academic year, there were no mismatches between intended and empirical-experience difficulty levels. Therefore, we found a reasonable match between nominal and empirical game difficulty levels for 100% of the games. Again, for the 2022-2023 academic year, there were no mismatches. This pattern is evident in several important ways. First, the measurement model did not classify any experiences with a nominal skill level of Beginning or Emerging as "difficult". Similarly, the measurement model did not classify any experiences with a nominal skill level of Proficient or Accomplishing as "easy". Furthermore, the initial pass rates became systematically lower as the nominal skill level of the experiences progressed from Beginning to Proficient.

For the 2022–2023 academic year, the Science & Technology domain analyses included four Beginning-level experiences, and all four had a model-estimated difficulty level of "easy". The initial pass rates for the Beginning experiences ranged from 27.9% (game 25) to 69.6% (game 48). The Science & Technology domain analyses included four Emerging-level experiences. The model classified three of these experiences as Easy and one as Average. The initial pass rates for the Emerging experiences ranged from 15.4% (game 43) to 23.4% (game 72). The Science &

Technology domain analyses included four Intermediate-level experiences. The model classified all four of these experiences as "easy" or "average". The initial pass rates for the Intermediate experiences ranged from 17.7% (game 43) to 24.6% (game 72). The Science & Technology domain analyses included four Accomplishing-level experiences, and two were classified as "average" and two as "difficult". The initial pass rates for the Accomplishing experiences ranged from 4.6% (game 81) to 14.2% (game 93). The Science & Technology domain analyses included four Proficient-level experiences, and the model classified all four as "difficult". The initial pass rate for Proficient experiences ranged from 1.4% (game 161) to 7.8% (game 134).

These results, when taken together, demonstrate a clear progression of increasing experience difficulty from the Beginning skill level to the Proficient skill level. This pattern emerged as measured by both the percentage of children passing their first attempt and model-estimated difficulty levels. The results in Table 10 illustrate a well-defined developmental pathway of skills acquisition through which children can progress as they engage with the experiences in the Science & Technology domain. The Science & Technology experiences were relatively equally represented across the Easy, Average, and Difficult model-estimated difficulty levels. The results showed a full range of experience difficulty levels ranging from as low as -3.99 logits to as high as 3.41 logits. The easiest experience was "Nature Scavenger Hunt," which had a nominal skill level of Beginning, a model-estimated difficulty level of Easy (-3.99 logits), and an initial pass rate of 69.6%. The most difficult experience was "Recycling and Reusing," which had a nominal skill level of Proficient, a model-estimated difficulty level of Difficult (3.41 logits), and an initial pass rate of 1.4%.

Social and Emotional Learning

The measurement model did not classify any Social and Emotional Learning experiences with a nominal skill level of Beginning or Emerging as "difficult". Similarly, the measurement model

did not classify any experiences with a nominal skill level of Proficient or Accomplishing as "easy".

Therefore, we found a reasonable match between nominal and empirical game difficulty levels for

100% of the games. Overall, the initial pass rates became systematically lower as the nominal skill

level of the experiences progressed from Beginning to Proficient as expected.

Specifically, the Social and Emotional Learning domain analyses included three Beginning-

level experiences, and two of them had a model-estimated difficulty level of "easy" and one was

classified as "average." The Social and Emotional Learning domain analyses included four

Emerging-level experiences, and the model classified three as "easy" and one as "average." The

Social and Emotional Learning domain analyses included four Intermediate-level experiences, and

the model classified two as "average" and two as "difficult". The Social and Emotional Learning

domain analyses included four Accomplishing-level experiences, and two were classified as

"difficult" and two as "average." The Social and Emotional Learning domain analyses included four

Proficient experiences, and all of them were classified as "difficult."

These results demonstrate a clear progression of increasing experience difficulty from the

Beginning skill level to the Proficient skill level. The results in Table 11 illustrate a well-defined

developmental pathway of skills acquisition through which children can progress as they engage with

the experiences in the Social and Emotional Learning domain. The results showed a full range of

experience difficulty levels ranging from as low as -5.13 logits to as high as 1.69 logits. The easiest

experience was "Responding to Emotions 1," which had a nominal skill level of Beginning, a model-

estimated difficulty level of Easy (-5.13 logits), and an initial pass rate of 85.3%. The most difficult

experience was "Responding to Emotions 5," with a nominal skill level of Proficient, a model-

estimated difficulty level of Difficult (1.69 logits), and an initial pass rate of 8.1%.

Language & Communication Development

The measurement model classified all three experiences with a nominal skill level of Beginning as "easy." The measurement model classified one experience with a nominal skill level of Emerging as "easy" and one as "difficult." The one Emerging game classified as "difficult" was the only game for which a mismatch between nominal and empirical difficulty was identified. This Emerging game (28, Categorizing Words) had an initial passing rate of 7.2% and an estimated game difficulty of .74 which falls in the "difficult" range. The measurement model classified two experiences with a nominal skill level of Intermediate as "easy", two as "average", and one as "difficult." The measurement model classified three experiences with a nominal skill level of Accomplishing as "average" and four as "difficult." The measurement model classified one experience with a nominal skill level of Proficient as "average" and six as "difficult." Therefore, we found a reasonable match between nominal and empirical game difficulty levels for 95.8% of the games. Overall, the initial pass rates became systematically lower as the nominal skill level of the experiences progressed from Beginning to Proficient.

The initial pass rates for the Beginning experiences ranged from 32.8% (game 7) to 83.6% (game 4). The initial pass rates for the Emerging games ranged from 7.2% (game 28) to 27.6% (game 24). The initial pass rates for the Intermediate experiences ranged from 0.0% (game 85) to 18.8% (game 57). The initial pass rates for the Accomplishing games ranged from 2.6% (game 264) to 10.7% (game 78). The initial pass rates for the Proficient games ranged from 4.1% (game 267) to 9.7% (game 130). These results demonstrate a progression of increasing experience difficulty from the Beginning skill level to the Proficient skill level. This pattern emerged as measured by both the percentage of children passing their first attempt and model-estimated difficulty levels. The results in Table 12 illustrate a developmental pathway of skills acquisition through which children can progress as they engage with the experiences in the Language & Communication Development domain. The results showed a full range of experience difficulty levels ranging from as low as -8.36

logits to as high as 10.08 logits. The easiest experience was "Classroom Cleanup," which had a nominal skill level of Beginning, a model-estimated difficulty level of Easy (-5.93 logits), and an initial pass rate of 83.6%. The most difficult experience was game 85 which focused on "Print Directionality" with a nominal skill level of Intermediate, a model-estimated difficulty level of "difficult" (10.95 logits), and an initial pass rate of 0.0%.

Physical Development

For the 2022–2023 academic year, there was only one mismatch between intended and empirical-experience difficulty levels for the 15 experiences. Therefore, we found a reasonable match between nominal and empirical game difficulty levels for 93.3% of the games. The measurement model classified all three experiences with a nominal skill level of Beginning as "easy". The measurement model classified two Emerging games as "easy" and one as "difficult." Game 32, which focused on "Healthy Gormit" had a nominal level of Emerging with an initial passing rate of only 8.7% and an empirical difficulty level of "difficult" (logit=0.96). The measurement model classified one Intermediate game as "easy" and two as "average." The measurement model classified one Accomplishing game as "average" and two as "difficult." The measurement model classified all three Proficient games as "difficult." Overall, the initial pass rates became systematically lower as the nominal skill level of the experiences progressed from Beginning to Proficient.

The initial pass rates for the Beginning experiences ranged from 26.3% (game 17) to 44.9% (game 45). The initial pass rates for the Emerging experiences ranged from 8.7% (game 32) to 33.3% (game 10). The initial pass rates for the Intermediate experiences ranged from 12.4% (game 114) to 23.1% (game 68). The initial pass rates for the Accomplishing experiences ranged from 8.1% (game 137) to 14.1% (game 119). The initial pass rates for Proficient experiences ranged from 1.3% (game 179) to 9.8% (game 196).

These results demonstrate a clear progression of increasing experience difficulty from the Beginning skill level to the Proficient skill level. This pattern emerged as measured by both the percentage of children passing their first attempt and model-estimated difficulty levels. The results in Table 13 illustrate a well-defined developmental pathway of skills acquisition through which children can progress as they engage with the experiences in the Physical Development domain. The results showed a full range of experience difficulty levels ranging from as low as -2.34 logits to as high as 3.40 logits. The easiest experience was game 45, "Personal Safety," which had a nominal skill level of Beginning, a model-estimated difficulty level of "easy" (-2.34 logits), and an initial pass rate of 44.9%. The most difficult experience was game 179, "Making a Healthy Meal," which had a nominal skill level of Proficient, a model-estimated difficulty level of Difficult (3.40 logits), and an initial pass rate of 1.3%.

Mathematics

The measurement model identified only one of the 53 Ignite game experiences as mismatches. The statistical model classified one experience with a nominal level of Beginning as "difficult." For the remaining 52 of the 53 games (99.1%) the model identified a reasonable match between nominal and empirical difficulty levels. Overall, the initial pass rates became systematically lower as the nominal skill level of the experiences progressed from Beginning to Proficient.

Specifically, the Mathematics domain analyses included 10 Beginning-level experiences, and the model classified nine of them as "easy" and one as "difficult". The initial pass rates for the Beginning experiences ranged from 4.5% (game 104) to 50.2% (game 231). The Mathematics domain analyses included 10 Emerging-level experiences, and six of them were classified as "easy" and four as "average". The initial pass rates for the Emerging experiences ranged from 13.0% (game 138) to 43.3% (game 117). The Mathematics domain analyses included 11 Intermediate-level

experiences. Six of them were classified as "easy," three as "average," and two as "difficult". The

initial pass rates for the Intermediate experiences ranged from 2.5% (game 96) to 34.9% (game 169).

The Mathematics domain analyses included 11 Accomplishing-level experiences. The model

classified six of them as "average," and five as "difficult". The initial pass rates for the

Accomplishing experiences ranged from 1.8% (game 131) to 16.2% (game 162). The Mathematics

domain analyses included 11 Proficient experiences. The model classified all of them as "difficult."

The initial pass rates for the Proficient experiences ranged from 1.2% (game 235) to 8.1% (game

157).

These results demonstrate a relatively clear progression of increasing experience difficulty

from the Beginning skill level to the Proficient skill level. This pattern emerged as measured by both

the percentage of children passing their first attempt and model-estimated difficulty levels. The

results in Table 14 illustrate a plausible developmental pathway of skills acquisition through which

children can progress as they engage with the experiences in the Mathematics domain. The results

showed a full range of experience difficulty levels ranging from as low as -2.91 logits to as high as

3.17 logits. The easiest experience was "Number Sequencing One," which had a nominal skill level

of Beginning, a model-estimated difficulty level of Easy (-2.91 logits), and an initial pass rate of

50.2%. The most Difficult experience, "Number Sequencing Five," had a nominal skill level of

Proficient, a model-estimated difficulty level of Difficult (3.17 logits), and an initial pass rate of only

1.2%.

Literacy

The measurement model identified only one of the 55 Ignite game experiences as

mismatches. The statistical model classified one experience with a nominal level of Accomplishing as

"easy" and one experience with a nominal level of Emerging as "difficult." For the remaining 53 of

the 55 games (96.4%) the model identified a reasonable match between nominal and empirical difficulty levels. Overall, the initial pass rates became systematically lower as the nominal skill level of the experiences progressed from Beginning to Proficient.

Specifically, the Literacy domain analyses included eight Beginning-level experiences, and seven of them had a model-estimated difficulty level of "easy" and was classified as "average." The initial pass rates for the Beginning experiences ranged from 14.6% (game 8) to 85.7% (game 71). The Literacy domain analyses included eight Emerging-level experiences, and the model classified five of them as "easy", two as "average", and one as "difficult". The initial pass rates for the Emerging experiences ranged from 5.2% (game 23) to 66.6% (game 89). The Literacy domain analyses included 10 Intermediate-level experiences. Two of them were classified as "easy", six as "average", and two as "difficult". The initial pass rates for the Intermediate experiences ranged from 0.8% (game 85) to 19.7% (game 152). The Literacy domain analyses included 14 Accomplishing-level experiences. The model classified one of them as "easy", four as "average", and nine as "difficult". The initial pass rates for the Accomplishing experiences ranged from 1.7% (game 109) to 22.4% (game 142). The Literacy domain analyses included 15 Proficient experiences. The model classified all of them as "difficult." The initial pass rates for the Proficient experiences ranged from 1.8% (game 173) to 8.1% (game 438).

These results demonstrate a relatively clear progression of increasing experience difficulty from the Beginning skill level to the Proficient skill level. This pattern emerged as measured by both the percentage of children passing their first attempt and model-estimated difficulty levels. The results in Table 15 illustrate a plausible developmental pathway of skills acquisition through which children can progress as they engage with the experiences in the Literacy domain. The results showed a full range of experience difficulty levels ranging from as low as -6.48 logits to as high as 3.51 logits. The easiest experience was "Key Ideas and Details 1A," which had a nominal skill level

of Beginning, a model-estimated difficulty level of Easy (-6.48 logits), and an initial pass rate of 85.7%. The most difficult experience, "Print Directionality," had a nominal skill level of Intermediate, a model-estimated difficulty level of Difficult (3.51 logits), and an initial pass rate of only 0.8%.

Aim 3 - Summary

      A wide range of game difficulty levels, from easy to difficult, emerged for all seven developmental domains. This finding demonstrates that children can be challenged and continue to grow, develop, and learn at all skill levels. Very well defined and sequenced developmental pathways emerged from Beginning to Proficient games, with matching initial passing rates and game difficulty levels for all seven domains. This finding continues the substantial improvements from previous formative evaluation studies, which found a substantial number of games with potential mismatches between intended and actual game difficult levels. For 97.3% of the games, 181 of the 186 games evaluated across the domains, the results demonstrated a close match between the intended skill level and the initial passing rates and game difficulty levels. This pattern was consistent across all as follows:

1. Science & Technology: 100.0%

2. Social and Emotional Learning: 100.0%

3. Language & Communication Development: 95.8%

4. Physical Development: 93.3%

5. Mathematics: 98.1%

6. Literacy: 96.4%

Therefore, almost all of the games showed a reasonable match between nominal and empirical difficulty levels. It is important to note that these results represent a substantial improvement from

previous formative evaluations indicating the effectiveness of the improvements to specific games. These results will need to be replicated with new data that includes all of the recently improved games after children have had the opportunity to engage with those games across an entire academic year.

Aim Four – Differences between Home and School Engagement

These analyses were limited to engagement with the Core games for children who passed at least one game. Passing at least one game was used as an admissibility criteria for these analyses to exclude those children who engaged with the system so briefly that they did not use the system enough to contribute useful information to these analyses. The home and school groups are not independent as a child could play the games in both contexts. We chose not to restrict the analyses to only those children who had played games in both contexts as we could not assume they would have engaged with games of equal difficulty in both contexts. Therefore, neither an independent nor a dependent statistical significance test was appropriate and these results are strictly descriptive in nature. These results are useful to describe the distributions of maximum levels achieved within domain for children who engaged with the games at home and at school.

Social Studies

For Domain 1, 3,874 children played the games at home and 49,376 children played the games in school. Children who played the games at home achieved an average of 2.46 levels (Min=1, Median=2, Max=5, SD=1.39). Children who played the games at school achieved an average of 2.24 levels (Min=1, Median=2, Max=5, SD=1.34). The percent of children who passed level four or higher at home was 21.71% and 17.22% at school.

Science and Technology

For Domain 4, 3,887 children played the games at home and 44,564 children played the games in school. Children who played the games at home achieved an average of 2.42 levels (Min=1, Median=2, Max=5, SD=1.49). Children who played the games at school achieved an average of 2.23 levels (Min=1, Median=2, Max=5, SD=1.47). The percent of children who passed level four or higher at home was 26.73% and 23.60% at school.

Social and Emotional Learning

For Domain 9, 3,803 children played the games at home and 44,325 children played the games in school. Children who played the games at home achieved an average of 2.64 levels (Min=1, Median=2, Max=8, SD=1.89). Children who played the games at school achieved an average of 2.39 levels (Min=1, Median=2, Max=8, SD=1.71). The percent of children who passed level four or higher at home was 28.16% and 24.95% at school.

Language and Communication Development

For Domain 12, 4,135 children played the games at home and 49,391 children played the games in school. Children who played the games at home achieved an average of 2.81 levels (Min=1, Median=2, Max=8, SD=1.78). Children who played the games at school achieved an average of 2.51 levels (Min=1, Median=2, Max=8, SD=1.58). The percent of children who passed level four or higher at home was 25.44% and 20.12% at school.

Physical Development

For Domain 19, 3,925 children played the games at home and 46,378 children played the games in school. Children who played the games at home achieved an average of 2.42 levels (Min=1, Median=2, Max=5, *SD*=1.47). Children who played the games at school achieved an average of 2.23 levels (Min=1, Median=2, Max=5, *SD*=1.46). The percent of children who passed level four or higher at home was 25.94% and 22.67% at school.

Mathematics

For Domain 23, 4,225 children played the games at home and 46,366 children played the games in school. Children who played the games at home achieved an average of 3.22 levels (Min=1, Median=3, Max=8, *SD*=1.73). Children who played the games at school achieved an average of 3.01 levels (Min=1, Median=3, Max=8, *SD*=1.55). The percent of children who passed level four or higher at home was 36.54% and 32.19% at school.

Literacy

For Domain 35, 4,399 children played the games at home and 50,111 children played the games in school. Children who played the games at home achieved an average of 2.83 levels (Min=1, Median=2, Max=8, *SD*=1.83). Children who played the games at school achieved an average of 2.58 levels (Min=1, Median=2, Max=8, *SD*=1.65). The percent of children who passed level four or higher at home was 29.07% and 24.64% at school.

Aim 4 Summary

These results demonstrate very small differences in the distributions of maximum levels achieved across the home and school contexts. The mean levels achieved were slightly higher at home as was the percentage of children passing at least level 4 games. These results suggest a small

advantage for playing the games at home, or for engaging with the Ignite system in both contexts. The results suggest that those children who engage with the system both at home and in school are likely to achieve, on average, slightly more levels within the system, and are slightly more likely to achieve at least level 4 within each domain of development.

It is unclear from these analyses whether children of higher ability are more likely to play at home, whether children with parents who are more engaged in their child's learning are more likely to play at home, whether children who do not play at home have limited computer access, and the extent to which parents support their child's engagement with the games when playing at home. Limited access to computers and or internet at home would also suggest an association with economic disadvantage for the family, which in turn is associated with a range of other socioeconomic conditions. Future analyses would be helpful that included covariates such as overall time spent engaging with the Ignite system, family socioeconomic status, and school resources.

It is also important to note when interpreting these results that the Ignite system remembers where a child finished during their most recent engagement with the system. For example, if a child reached level 3 within a specific domain at school and then engaged with the system at home, they could achieve level 4 at home without passing any level 3 games at home within the respective domain. It is also important to note the limitations with interpreting these results that would have arisen had we created groups of children who only play at home, only played at school, or played in both contexts. The children who only played at home would have been very rare and non-representative of the population as all children access the system through a license purchased by their school location. The children who only played in school would likely not be representative of the population either. These children may be much less likely to have a variety of home resources including home access to the internet and to the computer hardware needed to engage with the system at home.

Summary and Conclusion

This report outlines additional validity evidence for the instructional usefulness of the Ignite experiences. The main focal points were performance differences between 3-year-olds, 4-year-olds, and 5-year-olds, the relationship between time spent engaged with the games and the levels achieved, and the match or mismatch between intended experience skill levels and empirically generated experience difficulty levels.

Overall, the findings of this study present some validity evidence suggesting that the Ignite experiences are generally functioning as intended. The results also highlight a very limited need to continue to investigate those games that evidenced potential mismatches between nominal and empirical difficulty levels. However, much fewer experiences presented potential mismatches between intended skill level and empirical difficulty level than were identified in previous research.

Child age was related to passing rates as expected. A plausible developmental pathway emerged for each domain that ranged from the easiest experiences to the most difficult experiences, and the pathway generally corresponded very well to the intended nominal skill levels. Usage level was also strongly correlated with the number of levels achieved as expected. Specifically, the results of this study demonstrate that when children engage with the Ignite experiences at recommended usage levels, they can reach levels 4 and 5. When analyses were limited to high-use children, the results show that these children completed approximately 4 or 5 levels on average, depending on the domain of development. This means that if a child started at the beginning of the sequence of experiences and completed 4 or 5 levels, the child would be functioning at the Accomplishing or Proficient level.

The results of the descriptive analyses related to Aim 4 suggest a small advantage for engaging with the Ignite system both at home and at school. Future research is needed to make firm

conclusions about the meaning of these results. Such research would benefit from including a range of family, child, and school level covariates including home access to computer hardware and internet access.

Future research will also need to focus on the factors that are associated with higher usage levels in classrooms. A minority of children used the Ignite system for at least 30 minutes per week across at least 5 months of the academic year. It will be important to provide teachers with resources that inform their instructional practice, illustrate the benefits of child engagement with the system, and support instructionally appropriate and consistent use of the Ignite system throughout the academic year. The development of an implementation fidelity guide for teachers may help in this regard. It will also be important to gather information that can help demonstrate whether the child gains made within the system generalize to demonstrated skills and abilities in both classroom activities and external measures of child developmental progress.

Table 1

Characteristics of the Sample

Variable	Category	Percentage
Gender	Male	49.9%
	Female	50.1%
Age level	3-year-old	35.9%
	4-year-old	61.4%
	5-year-old	2.7%
Race/ethnicity	White (non-Hispanic)	31.7%
	Black (non-Hispanic)	35.1%
	Asian (non-Hispanic)	1.7%
	Native American (non-Hispanic)	3.1%
	Multiple races	3.6%
	Hispanic	24.8%

Table 2
Usage patterns - Social Studies Domain

Domain		Total Minutes	Minutes Core	Percent Core	Minutes Entry/Exit	Minutes Free Play	Minutes Parent	Percent Parent	Total Attempts	Total Attempts Passed	Percent Passed	Max Level Passed
All, n=63,285	Mean	16.22	8.63	53.22%	7.27	0.32	1.20	7.38%	6.31	4.54	71.97%	2.09
	Median	13.97	6.22		6.85	0.00	0.00		5.00	3.00		2.00
	SD	12.54	9.34		4.66	3.65	6.29		4.90	4.43		1.41
	Min	0.83	0.00		0.00	0.00	0.00		1	0		0
	Max	611.82	113.77		46.48	593.58	611.82		236	223		5
Three year olds, n=22,782	Mean	13.42	6.36	47.39%	6.76	0.30	1.12	8.38%	5.05	3.23	64.07%	1.69
	Median	12.22	5.05		6.07	0.00	0.00		4.00	3.00		2.00
	SD	10.73	7.08		4.22	4.96	6.45		4.08	3.62		1.27
	Min	0.87	0.00		0.00	0.00	0.00		1	0		0
	Max	611.82	84.28		35.47	593.58	611.82		236	223		5
Four year olds, n=38,828	Mean	18.19	10.16	55.83%	7.70	0.34	1.27	6.99%	7.16	5.38	75.10%	2.33
	Median	15.63	7.10		7.35	0.00	0.00		6.00	4.00		2.00
	SD	13.15	10.23		4.79	2.69	6.29		5.17	4.69		1.44
	Min	0.83	0.00		0.00	0.00	0.00		1	0		0
	Max	303.02	113.77		46.48	300.53	303.02		107	99		5
Five year olds, n=1,675	Mean	8.67	4.24	48.93%	4.28	0.15	0.48	5.49%	3.76	2.94	78.02%	2.18
	Median	4.93	1.83		1.73	0.00	0.00		2.00	1.00		2.00
	SD	10.41	6.63		5.45	1.35	3.46		4.17	3.69		1.09
	Min	0.93	0.00		0.00	0.00	0.00		1	0		0
	Max	81.17	61.13		26.83	25.57	76.25		33	33		5

Table 3

Usage patterns - Science and Technology Domain

Domain		Total Minutes	Minutes Core	Percent Core	Minutes Entry/Exit	Minutes Free Play	Minutes Parent	Percent Parent	Total Attempts	Total Attempts Passed	Percent Passed	Max Level Passed
All, n=49,328	Mean	37.50	36.83	98.20%	----	0.68	2.62	6.99%	15.14	7.48	49.38%	2.12
	Median	25.02	24.65		----	0.00	0.00		10.00	5.00		1.00
	SD	36.88	35.46		----	6.58	15.23		14.26	6.91		1.52
	Min	0.83	0.00		----	0.00	0.00		1	0		0
	Max	1125.23	414.92		----	1043.23	1125.23		461	267		5
Three year olds, n=16,430	Mean	34.48	33.82	98.08%	----	0.66	2.76	8.00%	13.52	5.56	41.10%	1.73
	Median	24.11	23.83		----	0.00	0.00		10.00	4.00		1.00
	SD	34.87	32.58		----	9.78	16.63		13.23	5.66		1.33
	Min	1.15	0.00		----	0.00	0.00		1	0		0
	Max	1125.23	347.35		----	1043.23	1125.23		461	267		5
Four year olds, n=31,791	Mean	39.78	39.08	98.25%	----	0.69	2.61	6.56%	16.25	8.58	52.80%	2.32
	Median	26.37	25.97		----	0.00	0.00		11.00	5.00		2.00
	SD	37.85	36.82		----	4.17	14.65		14.73	7.28		1.58
	Min	0.83	0.00		----	0.00	0.00		1	0		0
	Max	578.30	414.92		----	363.87	578.30		236	113		5
Five year olds, n=1,107	Mean	17.23	16.86	97.89%	----	0.36	0.87	5.04%	7.52	4.35	57.84%	2.20
	Median	8.47	8.47		----	0.00	0.00		4.00	2.00		2.00
	SD	27.09	26.00		----	2.90	7.79		10.37	5.65		1.27
	Min	1.42	1.42		----	0.00	0.00		1	0		0
	Max	388.67	388.67		----	60.38	189.83		134	44		5

Table 4
Usage patterns - Social Emotional Domain

Domain		Total Minutes	Minutes Core	Percent Core	Minutes Entry/Exit	Minutes Free Play	Minutes Parent	Percent Parent	Total Attempts	Total Attempts Passed	Percent Passed	Max Level Passed
All, n=47,071	Mean	36.43	35.61	97.74%	----	0.82	2.65	7.27%	13.86	7.28	52.56%	2.38
	Median	23.05	22.63		----	0.00	0.00		9.00	5.00		2.00
	SD	36.90	35.49		----	7.14	15.11		13.20	7.26		1.74
	Min	0.83	0.00		----	0.00	0.00		1	0		0
	Max	728.30	545.78		----	454.08	721.48		283	136		8
Three year olds, n=15,383	Mean	32.68	32.08	98.16%	----	0.60	2.80	8.57%	12.40	5.27	42.48%	1.95
	Median	20.47	20.15		----	0.00	0.00		8.00	3.00		1.00
	SD	34.99	34.04		----	5.68	15.27		12.48	5.36		1.50
	Min	0.83	0.00		----	0.00	0.00		1	0		0
	Max	545.78	545.78		----	308.95	532.17		177	69		8
Four year olds, n=30,404	Mean	39.04	38.09	97.56%	----	0.95	2.65	6.79%	14.87	8.42	56.63%	2.60
	Median	25.67	25.13		----	0.00	0.00		11.00	6.00		2.00
	SD	37.92	36.30		----	7.88	15.28		13.58	7.88		1.83
	Min	1.40	0.00		----	0.00	0.00		1	0		0
	Max	728.30	538.25		----	454.08	721.48		283	136		8
Five year olds, n=1,284	Mean	19.54	19.14	97.95%	----	0.40	0.76	3.91%	7.51	4.59	61.04%	2.30
	Median	11.54	11.48		----	0.00	0.00		5.00	3.00		2.00
	SD	24.03	22.84		----	3.09	6.16		8.18	5.65		1.43
	Min	1.98	1.98		----	0.00	0.00		1	0		0
	Max	250.27	248.05		----	63.08	129.67		78	51		8

Table 5
Usage patterns - Language Domain

Domain		Total Minutes	Minutes Core	Percent Core	Minutes Entry/Exit	Minutes Free Play	Minutes Parent	Percent Parent	Total Attempts	Total Attempts Passed	Percent Passed	Max Level Passed
All, n=51,922	Mean	37.54	36.59	97.47%	----	0.95	2.77	7.37%	15.06	7.74	51.41%	2.51
	Median	22.08	21.77		----	0.00	0.00		9.00	5.00		2.00
	SD	42.70	40.29		----	9.42	18.36		16.47	8.67		1.60
	Min	0.83	0.00		----	0.00	0.00		1	0		0
	Max	916.95	650.87		----	805.47	916.95		426	237		8
Three year olds, n=17,385	Mean	33.34	32.49	97.46%	----	0.85	2.80	8.41%	12.81	5.71	44.55%	2.15
	Median	20.62	20.23		----	0.00	0.00		8.00	4.00		2.00
	SD	37.85	35.60		----	9.32	18.09		13.72	6.23		1.36
	Min	1.03	0.00		----	0.00	0.00		1	0		0
	Max	763.32	439.90		----	726.65	763.32		288	203		8
Four year olds, n=33,087	Mean	40.45	39.42	97.47%	----	1.02	2.83	7.00%	16.54	8.96	54.16%	2.71
	Median	23.95	23.58		----	0.00	0.00		10.00	6.00		2.00
	SD	45.12	42.58		----	9.62	18.82		17.70	9.54		1.70
	Min	0.83	0.00		----	0.00	0.00		1	0		0
	Max	916.95	650.87		----	805.47	916.95		426	237		8
Five year olds, n=1,450	Mean	21.67	21.21	97.89%	----	0.46	0.83	3.84%	8.43	4.50	53.40%	2.48
	Median	13.23	13.20		----	0.00	0.00		5.00	3.00		2.00
	SD	32.05	30.65		----	4.35	7.73		12.48	7.32		1.19
	Min	1.13	1.13		----	0.00	0.00		1	0		0
	Max	524.80	514.77		----	113.48	189.38		169	99		8

Table 6
Usage patterns - Physical Domain

Domain		Total Minutes	Minutes Core	Percent Core	Minutes Entry/Exit	Minutes Free Play	Minutes Parent	Percent Parent	Total Attempts	Total Attempts Passed	Percent Passed	Max Level Passed
All, n=50,860	Mean	28.01	27.44	97.97%	----	0.57	1.95	6.96%	12.15	5.77	47.48%	2.14
	Median	19.58	19.32		----	0.00	0.00		9.00	4.00		2.00
	SD	26.93	25.43		----	6.51	12.05		10.88	5.31		1.50
	Min	0.83	0.00		----	0.00	0.00		1	0		0
	Max	1230.22	352.18		----	1179.12	1230.22		531	330		5
Three year olds, n=17,030	Mean	26.72	26.12	97.76%	----	0.60	2.04	7.62%	11.32	4.39	38.76%	1.75
	Median	19.22	18.97		----	0.00	0.00		8.00	3.00		1.00
	SD	26.53	23.73		----	10.30	13.75		10.66	4.81		1.31
	Min	1.33	0.00		----	0.00	0.00		1	0		0
	Max	1230.22	266.92		----	1179.12	1230.22		531	330		5
Four year olds, n=32,648	Mean	29.16	28.60	98.07%	----	0.56	1.95	6.70%	12.80	6.58	51.39%	2.34
	Median	20.40	20.10		----	0.00	0.00		9.00	4.00		2.00
	SD	27.18	26.29		----	3.25	11.24		10.99	5.42		1.57
	Min	0.83	0.00		----	0.00	0.00		1	0		0
	Max	452.05	352.18		----	246.57	452.05		178	78		5
Five year olds, n=1,182	Mean	14.84	14.59	98.31%	----	0.25	0.64	4.32%	6.28	3.37	53.71%	2.28
	Median	8.85	8.79		----	0.00	0.00		4.00	2.00		2.00
	SD	20.61	19.80		----	1.82	5.20		7.81	4.20		1.17
	Min	1.27	1.27		----	0.00	0.00		1	0		0
	Max	256.63	247.33		----	35.32	121.87		68	40		5

Table 7
Usage patterns - Mathematics Domain

Domain		Total Minutes	Minutes Core	Percent Core	Minutes Entry/Exit	Minutes Free Play	Minutes Parent	Percent Parent	Total Attempts	Total Attempts Passed	Percent Passed	Max Level Passed
All, n=50,689	Mean	115.80	114.01	98.46%	----	1.79	8.31	7.18%	39.60	17.15	43.32%	2.89
	Median	82.10	81.18		----	0.00	0.00		30.00	12.00		3.00
	SD	117.25	113.88		----	11.12	49.64		36.07	16.23		1.66
	Min	1.03	0.00		----	0.00	0.00		1	0		0
	Max	1856.82	1807.67		----	712.23	1856.82		696	298		8
Three year olds, n=16,905	Mean	104.75	103.44	98.75%	----	1.31	8.23	7.85%	34.06	12.03	35.31%	2.45
	Median	73.92	73.15		----	0.00	0.00		26.00	9.00		2.00
	SD	104.29	102.23		----	9.71	42.39		30.76	11.50		1.51
	Min	1.03	0.00		----	0.00	0.00		1	0		0
	Max	1255.33	1216.12		----	612.62	994.07		405	209		8
Four year olds, n=32,310	Mean	124.83	122.74	98.33%	----	2.08	8.64	6.92%	43.53	20.19	46.39%	3.11
	Median	91.72	90.68		----	0.00	0.00		35.00	16.00		3.00
	SD	123.94	119.96		----	11.93	53.91		38.44	17.74		1.71
	Min	1.07	0.00		----	0.00	0.00		1	0		0
	Max	1856.82	1807.67		----	712.23	1856.82		696	298		8
Five year olds, n=1,474	Mean	44.57	43.87	98.45%	----	0.69	1.99	4.46%	16.87	9.28	54.99%	3.11
	Median	31.31	31.22		----	0.00	0.00		13.00	7.00		3.00
	SD	55.52	52.73		----	6.50	19.82		17.55	9.24		1.20
	Min	1.10	1.10		----	0.00	0.00		1	0		0
	Max	599.68	599.68		----	189.80	594.77		200	121		8

Table 8
Usage patterns - Literacy Domain

Domain		Total Minutes	Minutes Core	Percent Core	Minutes Entry/Exit	Minutes Free Play	Minutes Parent	Percent Parent	Total Attempts	Total Attempts Passed	Percent Passed	Max Level Passed
All, n=52,369	Mean	75.73	74.04	97.77%	----	1.69	6.03	7.97%	29.62	16.98	57.33%	2.59
	Median	38.98	38.48		----	0.00	0.00		17.00	11.00		2.00
	SD	97.28	91.91		----	15.73	41.50		34.47	19.07		1.67
	Min	0.83	0.00		----	0.00	0.00		1	0		0
	Max	2040.82	1285.00		----	952.75	2015.53		787	420		8
Three year olds, n=17,586	Mean	56.84	55.68	97.95%	----	1.17	5.51	9.69%	22.32	12.09	54.16%	2.20
	Median	29.20	28.72		----	0.00	0.00		13.00	9.00		2.00
	SD	76.58	72.95		----	11.67	34.63		26.54	12.74		1.41
	Min	1.03	0.00		----	0.00	0.00		1	0		0
	Max	1223.87	1049.55		----	486.98	1223.87		356	192		8
Four year olds, n=33,328	Mean	87.09	85.11	97.72%	----	1.98	6.47	7.43%	34.01	19.85	58.36%	2.80
	Median	48.30	47.49		----	0.00	0.00		21.00	13.00		2.00
	SD	105.48	99.42		----	17.49	45.15		37.50	21.19		1.78
	Min	0.83	0.00		----	0.00	0.00		1	0		0
	Max	2040.82	1285.00		----	952.75	2015.53		787	420		8
Five year olds, n=1,455	Mean	43.82	42.57	97.15%	----	1.25	2.32	5.31%	17.07	10.35	60.62%	2.54
	Median	23.20	23.13		----	0.00	0.00		10.00	6.00		2.00
	SD	81.23	74.02		----	15.77	27.91		28.46	18.13		1.25
	Min	1.75	1.75		----	0.00	0.00		1	0		0
	Max	929.60	783.15		----	502.28	885.33		336	279		8

Table 9

Maximum number of levels achieved by usage level

		n	Mean Levels Achieved	*SD*	Effect Size
Domain 1	Low Use	52,701	1.67	1.04	
	High Use	10,584	4.23	1.01	2.49
Domain 4	Low Use	38,740	1.54	1.04	
	High Use	10,588	4.24	1.04	2.59
Domain 9	Low Use	36,476	1.68	1.01	
	High Use	10,595	4.77	1.61	2.64
Domain 12	Low Use	41,330	1.91	0.91	
	High Use	10,592	4.85	1.56	2.73
Domain 19	Low Use	40,272	1.57	1.01	
	High Use	10,588	4.29	1.03	2.67
Domain 23	Low Use	40,093	2.33	1.21	
	High Use	10,596	5.02	1.37	2.16
Domain 35	Low Use	41,772	1.97	1.00	
	High Use	10,597	5.04	1.53	2.71

Table 10

Difficulty Levels for Games within Science & Technology

	Game ID	% Passed first attempt	Skill Level		Difficulty Level	Game Difficuly	Game Name
Science and Technology	161	1.4	Proficient	5	Difficult	3.41	Recycling and Reusing
	195	4.1	Proficient	5	Difficult	2.11	Uses of Scientific Tools
	81	4.6	Accomplishing	4	Difficult	1.94	How Living Things Change
	127	6.5	Proficient	5	Difficult	1.47	Living Things Game Show
	134	7.8	Proficient	5	Difficult	1.19	Magnet Fun
	187	8.9	Accomplishing	4	Difficult	1.01	Which Tools to Use?
	154	12.6	Accomplishing	4	Average	0.44	Weather Windows
	93	14.2	Accomplishing	4	Average	0.24	Sorting Living Things
	53	17.3	Intermediate	3	Average	-0.12	What Our Senses Do
	42	17.6	Intermediate	3	Average	-0.15	Basic Needs
	43	17.7	Emerging	2	Average	-0.16	Senses and Texture
	95	19.5	Intermediate	3	Average	-0.34	Weather Game Show
	112	19.8	Intermediate	3	Average	-0.38	Sorting Scientific Tools
	29	22.0	Emerging	2	Easy	-0.59	Which Is a Living Thing 2
	62	22.6	Emerging	2	Easy	-0.64	Environmental Changes
	72	24.6	Emerging	2	Easy	-0.81	Everyday Tools
	25	27.9	Beginning	1	Easy	-1.08	Object Properties
	2	34.6	Beginning	1	Easy	-1.58	Living or Nonliving?
	37	40.2	Beginning	1	Easy	-1.97	Simple Scientific Tools
	48	69.6	Beginning	1	Easy	-3.99	Nature Scavenger Hunt

Note. n = 47,383. **Bolded and italicized** games may represent mismatch between intended and empirical difficulty.

Table 11

Difficulty Levels for Games within Social and Emotional Learning

	Game ID	% Passed first attempt	Skill Level		Difficulty Level	Game Difficuly	Game Name
Social Emotional	281	8.1	Proficient	5	Difficult	1.69	Responding to Emotions 5
	139	8.2	Proficient	5	Difficult	1.67	Identifying Emotions 5
	118	8.2	Accomplishing	4	Difficult	1.66	Causes of Complex Emotions
	201	9.6	Proficient	5	Difficult	1.41	Addressing Our Own Emotions
	423	10.5	Intermediate	3	Difficult	1.27	Self-Management 3
	425	13.0	Proficient	5	Difficult	0.89	Self-Management 5
	76	14.3	Intermediate	3	Difficult	0.73	Identifying Complex Emotions
	170	14.6	Accomplishing	4	Difficult	0.69	Solving Social Problems
	66	16.4	Beginning	1	Average	0.46	Recognizing Social Problems
	123	19.5	Intermediate	3	Average	0.11	Solving Social Problems 3
	280	19.8	Accomplishing	4	Average	0.08	Responding to Emotions 4
	422	21.5	Emerging	2	Average	-0.10	Self-Management 2
	279	21.6	Intermediate	3	Average	-0.11	Responding to Emotions 3
	424	22.4	Accomplishing	4	Average	-0.19	Self-Management 4
	278	28.2	Emerging	2	Easy	-0.73	Responding to Emotions 2
	99	30.0	Emerging	2	Easy	-0.88	Pro-Social Behaviors
	9	32.1	Emerging	2	Easy	-1.06	Causes of Basic Emotions
	3	51.0	Beginning	1	Easy	-2.45	Identifying Basic Emotions
	276	85.3	Beginning	1	Easy	-5.13	Responding to Emotions 1

Note. n = 45,201. **Bolded and italicized** games may represent mismatch between intended and empirical difficulty.

Table 12
Difficulty Levels for Games within Language & Communication Development

	Game ID	% Passed first attempt	Skill Level		Difficulty Level	Game Difficuly	Game Name
Language & Comm.	85	0.0	Intermediate	3	Difficult	10.95	Print Directionality
	264	2.6	Accomplishing	4	Difficult	2.22	Academic Vocabulary 4B
	267	4.1	Proficient	5	Difficult	1.61	Academic Vocabulary 5B
	111	4.4	Proficient	5	Difficult	1.49	Building a Spaceship
	268	4.8	Proficient	5	Difficult	1.36	Academic Vocabulary 5C
	159	5.0	Proficient	5	Difficult	1.32	Another Day at the Museum
	67	5.1	Accomplishing	4	Difficult	1.27	Understanding Antonyms
	266	6.1	Proficient	5	Difficult	1.01	Academic Vocabulary 5A
	265	6.4	Accomplishing	4	Difficult	0.93	Academic Vocabulary 4C
	263	6.5	Accomplishing	4	Difficult	0.90	Academic Vocabulary 4A
	274	7.2	Proficient	5	Difficult	0.74	Conventions of Language 5
	28	7.2	***Emerging***	***2***	***Difficult***	0.74	Categorizing Words
	64	9.2	Accomplishing	4	Average	0.35	Underwater Instructions
	35	9.2	Intermediate	3	Average	0.34	2-Step Directions
	273	9.6	Accomplishing	4	Average	0.28	Conventions of Language 4
	130	9.7	Proficient	5	Average	0.25	How Questions
	78	10.7	Accomplishing	4	Average	0.08	Understanding Complex Sentences
	272	10.9	Intermediate	3	Average	0.05	Conventions of Language 3
	41	16.8	Intermediate	3	Easy	-0.75	The "Where" Machine
	57	18.8	Intermediate	3	Easy	-0.97	Comparative Adjectives
	24	27.6	Emerging	2	Easy	-1.79	The "What" Machine
	7	32.8	Beginning	1	Easy	-2.18	Basic Words
	14	49.9	Beginning	1	Easy	-3.33	Color Words
	4	83.6	Beginning	1	Easy	-5.93	Classroom Cleanup

Note. n = 49,921. **Bolded and italicized** games may represent mismatch between intended and empirical difficulty.

Table 13

Difficulty Levels for Games within Physical Development

	Game ID	% Passed first attempt	Skill Level		Difficulty Level	Game Difficuly	Game Name
Physical Development	179	1.3	Proficient	5	Difficult	3.40	Making a Healthy Meal
	137	8.1	Accomplishing	4	Difficult	1.06	Safe & Healthy Behaviors 2
	32	8.7	***Emerging***	***2***	***Difficult***	***0.96***	Healthy Gormit
	190	8.8	Proficient	5	Difficult	0.93	Self-Care Collage
	196	9.8	Proficient	5	Difficult	0.77	Stay and Play or Walk Away?
	84	10.8	Accomplishing	4	Difficult	0.62	Washing Your Hands
	114	12.4	Intermediate	3	Average	0.39	Safe & Healthy Behavior
	105	12.9	Intermediate	3	Average	0.32	Healthy Breakfast
	119	14.1	Accomplishing	4	Average	0.17	Healthy Menu
	74	22.0	Emerging	2	Easy	-0.66	Playing Safely
	68	23.1	Intermediate	3	Easy	-0.76	Self-Care Shopping Trip
	17	26.3	Beginning	1	Easy	-1.03	Nutritious Meal
	10	33.3	Emerging	2	Easy	-1.56	Morning Routine
	5	43.8	Beginning	1	Easy	-2.27	Self-Care Game Show
	45	44.9	Beginning	1	Easy	-2.34	Personal Safety

Note. n = 48,825. **Bolded and italicized** games may represent mismatch between intended and empirical difficulty.

Table 14
Difficulty Levels for Games within Mathematics

	Game ID	% Passed first attempt	Skill Level		Difficulty Level	Game Difficuly	Game Name
Mathematics	235	1.2	Proficient	5	Difficult	3.17	Number Sequencing 5
	182	1.4	Proficient	5	Difficult	2.93	Measurement 5
	158	1.7	Proficient	5	Difficult	2.71	Counting On to 10
	131	1.8	Accomplishing	4	Difficult	2.68	Adding 8 or Less
	194	1.9	Proficient	5	Difficult	2.60	Patterns 5
	86	2.1	Proficient	5	Difficult	2.49	Comparing Quantities 5
	96	2.5	Intermediate	3	Difficult	2.26	Adding Zebras
	124	2.7	Proficient	5	Difficult	2.19	Set Counting 5
	143	3.0	Proficient	5	Difficult	2.05	Spatial Relationships 5
	191	3.7	Proficient	5	Difficult	1.77	Classification and Data 5
	230	4.5	Proficient	5	Difficult	1.54	Subitizing 5
	234	4.5	Accomplishing	4	Difficult	1.54	Number Sequencing 4
	104	4.5	***Beginning***	***1***	***Difficult***	***1.52***	Measurement 1
	174	4.9	Proficient	5	Difficult	1.42	3-Dimensional Shape Spinner
	61	6.1	Accomplishing	4	Difficult	1.13	Comparing Quantities 4
	129	7.0	Accomplishing	4	Difficult	0.93	First, Second, & Last
	94	7.5	Accomplishing	4	Difficult	0.83	Set Counting 4
	157	8.6	Proficient	5	Difficult	0.64	Lining Up For Snack Time
	79	8.8	Intermediate	3	Difficult	0.61	Set Counting 3
	186	9.5	Accomplishing	4	Average	0.49	Patterns 4
	229	10.9	Accomplishing	4	Average	0.29	Subitizing 4
	167	11.0	Intermediate	3	Average	0.26	Measurement 3
	110	12.5	Intermediate	3	Average	0.06	Identifying First & Second
	138	13.0	Emerging	2	Average	-0.01	Patterns 2
	183	13.8	Intermediate	3	Average	-0.09	Patterns 3
	126	14.1	Accomplishing	4	Average	-0.14	Spatial Relationships 4
	34	14.6	Emerging	2	Average	-0.20	Comparing Quantities 2
	38	14.8	Emerging	2	Average	-0.21	Last In Line
	176	14.9	Accomplishing	4	Average	-0.22	Measurement 4
	232	15.5	Emerging	2	Average	-0.29	Number Sequencing 2
	184	16.0	Accomplishing	4	Average	-0.34	Classification and Data 4
	162	16.2	Accomplishing	4	Average	-0.36	Ice Cream Truck Shape Puzzle
	228	18.4	Intermediate	3	Easy	-0.59	Subitizing 3
	51	19.2	Intermediate	3	Easy	-0.67	Comparing Quantities 3
	233	19.4	Intermediate	3	Easy	-0.68	Number Sequencing 3
	153	22.1	Intermediate	3	Easy	-0.93	Shape Asteroids
	247	22.9	Emerging	2	Easy	-1.00	Subitizing 2
	31	23.6	Emerging	2	Easy	-1.06	Set Counting 2
	120	25.5	Beginning	1	Easy	-1.22	Patterns 1
	133	27.1	Emerging	2	Easy	-1.34	Measurement 2
	113	28.7	Intermediate	3	Easy	-1.46	Spatial Relationships 3
	18	29.7	Beginning	1	Easy	-1.53	Set Counting 1
	107	29.8	Beginning	1	Easy	-1.54	Classification and Data 1
	101	31.1	Emerging	2	Easy	-1.64	Matching Simple Shapes 2
	20	32.0	Beginning	1	Easy	-1.70	Comparing Quantities 1
	98	32.8	Emerging	2	Easy	-1.76	Spatial Relationships 2
	169	34.9	Intermediate	3	Easy	-1.90	Camping Trip
	26	37.6	Beginning	1	Easy	-2.09	First In Line
	246	39.0	Beginning	1	Easy	-2.19	Subitizing 1
	117	43.3	Emerging	2	Easy	-2.47	Classification and Data 2
	56	47.6	Beginning	1	Easy	-2.75	Direction Words
	65	48.1	Beginning	1	Easy	-2.78	Matching Simple Shapes
	231	50.2	Beginning	1	Easy	-2.91	Number Sequencing 1

Note. n = 48,766. **Bolded and italicized** games may represent mismatch between intended and empirical difficulty.

Table 15
Difficulty Levels for Games within Literacy

	Game ID	% Passed first attempt	Skill Level		Difficulty Level	Game Difficuly	Game Name
Literacy	85	0.8	Intermediate	3	Difficult	3.51	Print Directionality
	109	1.7	Accomplishing	4	Difficult	2.67	Blending Onsets & Rimes
	173	1.8	Proficient	5	Difficult	2.64	Letters or Words?
	88	1.8	Proficient	5	Difficult	2.60	Lowercase Space Letters
	80	2.1	Accomplishing	4	Difficult	2.45	Lowercase Letter Jellies 2
	122	2.2	Accomplishing	4	Difficult	2.38	Identifying Book Features
	146	2.4	Proficient	5	Difficult	2.29	Blending Simple Words
	241	2.6	Proficient	5	Difficult	2.18	Alphabet Knowledge 5
	27	2.6	Proficient	5	Difficult	2.18	Letter Jellies
	254	2.7	Proficient	5	Difficult	2.14	Key Ideas and Details 5B
	172	2.7	Proficient	5	Difficult	2.11	Teddy Bear Rhyme
	73	3.3	Accomplishing	4	Difficult	1.85	Segmenting Words
	255	3.4	Proficient	5	Difficult	1.81	Key Ideas and Details 5C
	180	3.5	Proficient	5	Difficult	1.77	Key Ideas and Details 5A
	245	4.2	Proficient	5	Difficult	1.52	Letter-Sound Correspondence 5C
	49	4.3	Accomplishing	4	Difficult	1.51	Uppercase Space Letters 2
	244	9.1	Proficient	5	Difficult	1.42	Letter-Sound Correspondence 5B
	44	4.5	Proficient	5	Difficult	1.34	Letter Sounds 1
	115	4.8	Proficient	5	Difficult	1.30	Segmenting Simple Words
	52	4.9	Accomplishing	4	Difficult	1.23	Lowercase Letter Jellies
	23	5.4	***Emerging***	***2***	***Difficult***	***1.17***	Magic Hat 2
	121	5.4	Proficient	5	Difficult	1.14	Sorting Words By Onset
	163	5.5	Accomplishing	4	Difficult	1.06	Words That Don't Rhyme
	102	5.8	Accomplishing	4	Difficult	0.98	Isolating Onsets
	253	6.2	Accomplishing	4	Difficult	0.90	Key Ideas and Details 4C
	39	6.5	Intermediate	3	Difficult	0.64	Magic Hat 3
	438	8.1	Proficient	5	Difficult	0.56	Comprehension - Fiction 5
	171	8.9	Accomplishing	4	Average	0.41	Key Ideas and Details 4B
	33	9.3	Intermediate	3	Average	0.34	Segmenting Compound Words 2
	87	10.0	Accomplishing	4	Average	0.21	Letter Sounds 3
	82	10.8	Emerging	2	Average	0.09	Combining Two Words
	165	11.0	Accomplishing	4	Average	0.06	Key Ideas and Details 4A
	252	11.3	Intermediate	3	Average	0.00	Key Ideas and Details 3C
	46	11.4	Intermediate	3	Average	0.00	Uppercase Space Letters 1
	83	12.4	Accomplishing	4	Average	-0.16	Letter Sounds 2
	106	12.6	Intermediate	3	Average	-0.18	Combining Syllables
	149	12.8	Intermediate	3	Average	-0.21	Matching Rhyming Words
	13	13.2	Emerging	2	Average	-0.27	Segmenting Compound Words
	8	14.6	Beginning	1	Average	-0.46	Segmenting Sentences
	251	14.7	Intermediate	3	Average	-0.47	Key Ideas and Details 3B
	91	16.0	Emerging	2	Easy	-0.63	Do These Words Rhyme?
	440	16.8	Intermediate	3	Easy	-0.73	Letter-Sound Correspondence 3
	59	17.0	Beginning	1	Easy	-0.75	Completing Compound Words
	152	19.7	Intermediate	3	Easy	-1.05	Key Ideas and Details 3A
	142	22.4	***Accomplishing***	***4***	***Easy***	***-1.32***	Writing Development 4
	70	29.0	Beginning	1	Easy	-1.91	Book Orientation
	250	40.2	Emerging	2	Easy	-2.79	Key Ideas and Details 2C
	240	41.3	Emerging	2	Easy	-2.87	Alphabet Knowledge 2
	189	51.2	Emerging	2	Easy	-3.57	Key Ideas and Details 2B
	19	54.9	Beginning	1	Easy	-3.84	Magic Hat 1
	89	66.6	Emerging	2	Easy	-4.70	Key Ideas and Details 2A
	249	69.3	Beginning	1	Easy	-4.91	Key Ideas and Details 1C
	11	70.4	Beginning	1	Easy	-5.00	Rhyming
	248	83.1	Beginning	1	Easy	-6.17	Key Ideas and Details 1B
	71	85.7	Beginning	1	Easy	-6.48	Key Ideas and Details 1A

Note. *n* = 50,480. **Bolded and italicized** games may represent mismatch between intended and empirical difficulty.

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