

Emerging Technologies Among Digital Reading Interventions

A Research Synthesis

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Introduction

The Educational Problem to be Solved

A report entitled *Early Reading Proficiency in the United States*, commissioned by the Annie E. Casey Foundation (AECF), asserts that, “One of the key milestones along the path to success is learning to read in the early grades” (AECF, 2014, p. 1). Given the aforementioned assertion, the National Assessment of Educational Progress (NAEP) has stated in their summation of the nation’s report card that, “Overall, students have made gains since the 1990s,” with regard to proficiency in mathematics and reading (NAEP, 2013, p. 1); however, when specific focus is given to reading, the same report states that, “Eighth graders made gains in reading, while fourth grade scores remained flat,” when the data from 2013 is considered against the backdrop of the 2011 findings (NAEP, 2014, p. 2). In the same breath, the NAEP discloses that only thirty-five percent of the nation’s fourth graders can read at least proficiently, leaving sixty-five percent of all U.S. fourth graders in underperforming categories of reading achievement (NAEP, 2013, p. 2).

Minimal progress continues to persist even when reading achievement is further broken down into racial and ethnic groups for the fourth grade demographic. Consider Table I below.

Table I. Improvement in Reading Skills by Race/Ethnicity

Racial/Ethnic Group	NAEP Conclusion
4 th Grade Overall	No significant improvement in reading from 2011 – 2013.
4 th Grade – White	1 point increase in reading scale score from 2011 – 2013.
4 th Grade – Black	No significant improvement in reading from 2011 – 2013.
4 th Grade – Hispanic	No significant improvement in reading from 2011 – 2013.
4 th Grade – Asian/Pacific Islander	No significant improvement in reading from 2011 – 2013.
4 th Grade – American Indian/Alaska Native	No significant improvement in reading from 2011 – 2013.

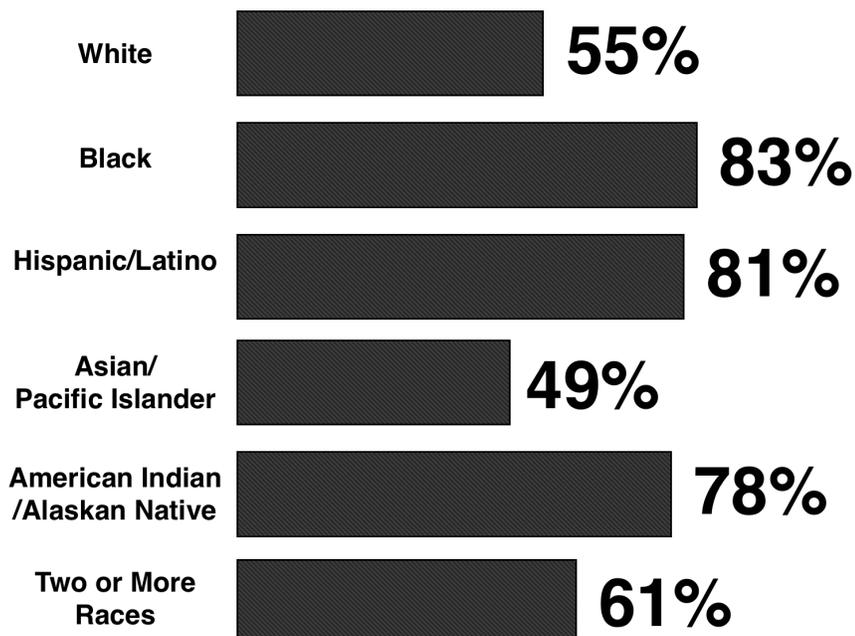
(NAEP, 2013)

The AECF makes a cogent case for why emphasis should be placed on achieving reading proficiency by the fourth grade by pointing out that, “The end of third grade marks the point when children transition from learning to read to using reading to learn other subjects. Children who read proficiently by the end of third grade are more likely to graduate from high school and to be economically successful in adulthood” (AECF, 2014, p.1).

Underachievement in reading strikes low-income students most significantly. Of those fourth graders classified with a low socioeconomic status, eighty percent failed to demonstrate reading proficiency, and seventy-six percent of high poverty schools failed to produce adequate school-wide reading proficiency scores (AECF, 2014). For a detailed breakdown by racial/ethnic group of reading inadequacies, see Figure I below.

Figure I.

Percentage of 4th Grade Students Reading Below Proficient Levels, 2013 (NAEP, 2013)



Furthermore, in an interview with a second grade teacher, Toni Todd of Boston Public Schools, Ms. Todd explained that she often found that those students who had low reading levels also exhibited behavioral problems, and she believed that the behavior was a result of the frustrations surrounding reading deficiency. Ms. Todd found that as students with low reading levels would act out, they would cause greater issues throughout the class, which would impede her instructional effectiveness, essentially causing a domino effect (Toni Todd Lexia Interview – Second Grade, 2016).

Given all these factors, the problem to be addressed can be distilled down into four discrete components: (1) it is essential for students to become proficient readers in their early school years, (2) a large percentage of American students in elementary schools do not read proficiently, (3) low socioeconomic students comprise the largest population of struggling readers, and (4) an inability to read proficiently has further consequences including behavior in childhood and achievement in adulthood.

It stands to reason that what is needed to solve this problem, with regards to an emerging technology, is an intervention targeted at K-5 learners with the capabilities of sustaining and promoting existing proficient readers, diagnosing and closing the reading gaps of inadequate readers, sustaining the interest and engagement of all members of the target audience, and feasibility for integration in high poverty schools and/or with student users of a low socioeconomic status.

Product Description

Given the defined scope and nature of the problem, it should come as no surprise that major educational publishing companies have come to market with numerous reading diagnostic and intervention systems including Fountas and Pinnel's *Benchmark Assessment*

System, Pearson's *DRA2+* and *iLit* programs, McGraw Hill's *Flex Literacy*, and Scholastic's well established *Read180*. While these are all fine programs worthy of consideration, one program distinguishes itself as an emerging technology deserving of exploration thanks to its prioritization of digital characteristics and relatively new arrival on the market: Lexia Learning's *Core5* program.

Lexia, a Rosetta Stone company, has branded *Core5* as an "Adaptive, technology-based, literacy program for students of all abilities in grades Pre-K – 5" (Lexia Learning Video, 2015). Lexia is quick to distance and differentiate *Core5* from more didactic basal programs by identifying their product as, "An essential component of every reading curriculum" (Lexia Reading Core5, 2016). This is key, as the product does not claim to be comprehensive in nature, and *does* require human intervention in some instances that shall be discussed further.

Whereas most similar products begin with a diagnostic test to determine a student-user's reading level before engaging in intervention activities, the most recent iteration of *Core5* sidesteps a testing event with an embedded assessment system the creators call Assessment Without Testing[®], which "Collects students' data from the program with every click of the mouse, providing ongoing progress monitoring for all students" (Lexia Learning Video, 2015). Lexia explains that the data derived from Assessment Without Testing[®] is norm-referenced and, "Highly predictive of outcomes on DIBELS, AIMSweb, MAPS, and other commonly used norm-referenced assessments" (Using Data to Drive Instruction, 2016).

As students engage in the *Core5* program, and data is collected, Lexia's technology creates a personalized learning path within six key areas of reading

instruction: (1) phonological awareness, (2) phonics, (3) structural analysis, (4) automaticity/fluency, (5) vocabulary, and (6) comprehension (Lexia Learning Video, 2015). This personalized learning approach is exactly what makes the program appropriate for all readers of all proficiencies, not just struggling or reluctant readers, which not only addresses facets of the defined problem area, but also incentivizes school adoption since an investment in the program can benefit all students.

According to the manufacturers, “Students begin each level with a choice of two warm up games that engage students while developing speed of processing and automaticity” (What’s New in Core5, 2015). As the level continues, the student has the opportunity to demonstrate mastery of a targeted skill, and if achieved, allows the students to move off of the digital/electronic component of the greater curriculum to enrichment activities where they can, “Further develop automaticity and expressive skills” (What’s New in Core5, 2015). For students who may be having difficulty with concept mastery, the program begins to engage in a guided practice and scaffolding path, where strategies like reduced stimuli and removal of answer choices are used to support the student towards success. When mastery still does not occur, the program goes one step further by drawing upon its embedded instruction which may serve as an effective supplement or companion to a teacher’s whole group or small group instructional practices.

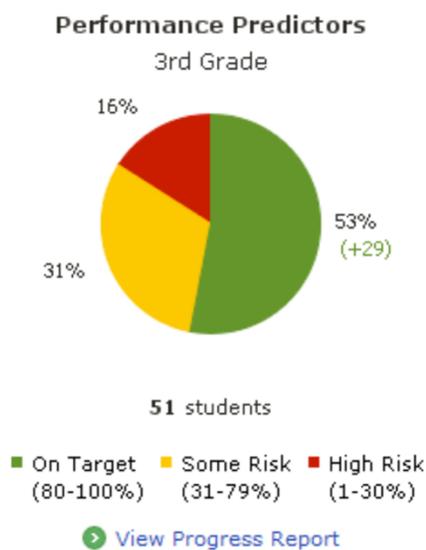
With regard to offline instruction, *Core5* is transparent about the role teachers must play in order to achieve maximum efficacy with the product. When student-users reach certain thresholds, the program notifies the teacher that the student needs an

offline lesson (whether for enrichment or for remediation beyond the scope of the embedded direct instruction). *Core5* provides the teachers with digital and print resources to conduct the offline instruction; however, a great deal of input and discretion is required of the teacher.

Lexia's proprietary data reporting tools do empower teachers to guide instructional practices with up-to-date metrics that can be segregated by student, class, grade, school, and district. According to the company, "Data drives recommended program use," and the, "Data can be viewed through simple reports and teacher dashboards" (Lexia Learning Video, 2015).

Core5 differentiates itself from competitors with a predictive tool that tells teachers how likely a student is to achieve their end-of-year benchmark goals, and essentially allows educational professionals to "triage" pupils, and determine who needs and would benefit from the most instructional time. See Figure II and Figure III below for two examples of these predictive measure reports.

Figure II.



(Using Data to Drive Instruction, 2016)

Figure III.

School	Students	Performance Predictors ▼		Grade Level of Material On or Above	Meeting Usage
		On Target	Monthly Change		
Park Community School	255		57% +29	82%	 75%
Kennedy Elementary School	313		51% +32	76%	 60%
Reagan Early Childhood Center	59		46% -11	100%	 85%

(Using Data to Drive Instruction, 2016)

Additional key features of the *Core5* program include flashcards, an embedded picture glossary, a device agnostic platform, offline support for students who may not have in-home internet access, and the option to push out instructions in a student's native language including Spanish, Mandarin, Haitian Creole, Arabic, Portuguese, and Vietnamese.

Students' engagement with the *Core5* platform is garnered through a combination of elements. The student dashboard (seen below in Figure IV) appears to be a new component of the most recent iteration of *Core5*, and according to creators at Lexia, the dashboard, "Enables students and parents to track progress towards personalized goals and promotes awareness and ownership of performance and progress" (What's New in Core 5, 2015). Furthermore, the six-year program is structured in such a way that student-users digitally journey around the world encountering different characters and characteristics of distinct geographical and cultural regions. Users are permitted to select what skills and concepts they want to focus on (within their custom created pathway), and can choose where they want to

journey to in their digital learning world, drawing upon tenants of self-determination theory and motivation.

Figure IV. Student Dashboard



(What's New in Core 5, 2015).

Lexia continues to distinguish itself as worthy of consideration among the more established product lines by aligning its program to both Common Core and state-specific standards, and claims to be, “The only research validated literacy program available on tablets” (Mobile Technology and Research, 2016).

On the whole, Lexia’s *Core5* program appears to be a worthy emerging technology deserving of any reading educator’s consideration.

Potential for Substantial Improvements in Learning

In order to fully appreciate *Core5*’s actual potential for substantial improvements in learning (i.e., how *Core5* can actually solve the problem to be addressed), certain features and

functions of the product must be considered in the context of the problem to be solved, and linked to tangible solutions for an associated discrete component of the problem.

Discrete problem component 1: becoming proficient readers in early years. As established earlier, children must become proficient readers in their early years, particularly by the end of third grade, as this marks the threshold where reading skills must be leveraged towards comprehension of content across core subject areas. *Core5* addresses this need head on by specifically targeting students in the Pre-K through fifth grade age ranges. Furthermore, *Core5* surpasses more traditional previous efforts by other products in the field by existing not only as an intervention tool capable of closing reading gaps, but also existing as a robust supplement to more comprehensive, basal reading programs, ultimately creating utility for all readers, whether reluctant, struggling, proficient, or accelerated. Every child in every grade, Pre-K through five, will become a more proficient reader by engaging in the prescribed use of the program.

Discrete problem component 2: high percentages of American elementary students struggle to read proficiently. Recall earlier that the NAEP reported in 2013 that sixty-five percent of fourth graders cannot read adequately (NAEP, 2013). This is not a trend limited specifically to fourth grade. In order to solve this problem, the reading gap must be closed for those students who are not reading at least on grade level. This problem area is addressed most effectively by *Core5's* intervention nature. As aforementioned, the program engages users in initial gaming and activities to essentially determine the child's reading level without a direct test. For those students the program identifies as needing intervention to close a gap, the program offers them options about what they want to study and when. As a user grapples with new or frustrating concepts, the program engages in a strategic and scaffolded approach to intervention. Upon first signs of frustration, the program removes stimuli (e.g., music, backgrounds, certain graphics), to encourage the user to focus more effectively.

Continuing frustration will prompt the removal of some answer choices in an effort to narrow the scope. If frustration persists, *Core5* activates an embedded direct teaching lesson to cover the concept, and if this is still not effective, the reporting tools alert the classroom teacher that the child needs an offline, direct, face-to-face intervention, and then provides the teacher with the lesson plans and materials needed to conduct that session.

Such vigorous intervention methods present great potential for improving learning for this particular problem area.

Discrete problem component 3: low socioeconomic students comprise the largest population of struggling readers. It should be stated up front that Lexia's *Core5* program is not intended to close the poverty gap in any way; however, the product does have some features that may be able to uniquely serve some segments of the low socioeconomic student population, specifically those who are learning English as a foreign language.

According to the American Psychological Association, "SES and race and ethnicity are intimately intertwined" (American Psychological Association, 2014). The National Center for Education Statistics (2015) found that there were 4.4 million students in U.S. public schools classified as English Language Learners in the 2012 – 2013 school year. The Center for Public Education (2008) reports that's two-thirds of ELLs have a low SES status, seventy-nine percent of all ELLs speak Spanish, two percent speak Vietnamese, one percent speak Chinese, and slightly less than one percent (0.9%) speak Haitian Creole or Arabic. Given this information, it might be reasonable to conclude that the act of supporting some of the needs of English Language Learners simultaneously meets some of the needs of the low socioeconomic population. Furthermore, ELLs have the added obstacle of not only potentially needing to close a reading gap, but also having to learn to read, write, and speak in English before they can even begin to address said reading gap.

Core5 has potential to improve learning outcomes in this problem area by offering scaffolded directions and support in a student's native tongue. By offering these resources, student autonomy is increased, most notably in the digital participation portion of the product, and the student is able to begin a lesson simply by having a firm understanding of what is expected of them.

Anecdotally speaking, a third grade Boston Public School teacher, Dina Zampine, reported in an interview that she had one student who came to her class mid-year with a low SES status and absolutely no background with the English language. Through his dedicated use of the product, the student in question was able to complete the entire Lexia program in less than a year, mastered the English language, and surpassed his peers. Furthermore, Lexia offered to give licenses to the parents of the student as well, for free, so that they may use the product for their own personal acquisition of English language skills (Dina Zampine Lexia Interview – Third Grade, 2016).

Ultimately, *Core5* was not created specifically to serve the needs of the low SES population; however, it does have some secondary benefits that serve that community well, demonstrating even more potential for learning improvements beyond the initial intents for the product.

Discrete problem component 4: ramifications of reading inadequacies. While *Core5* is not intended to address the problems outlined with regards to achievement in adulthood, it does have some features that can potentially alleviate the anecdotally described behavioral problems that may be associated with reading inadequacies. Both teachers who were interviewed as Lexia users described behavioral problems among many students with low reading proficiencies, and felt that the inability to read might cause the behavioral problems. It should be noted that both teachers expressed this conclusion in their opinion and experience, and were not expressing this opinion as a matter of fact based on empirical data.

Regardless of the foundations of this claim, both teachers also agreed that student engagement would likely solve the behavioral problems.

Lexia's ability to deliver on the student engagement forefront can be seen in the following unique characteristics/features:

- Student Dashboard, which provides self-monitoring of progress and autonomy
- Self-paced, self-selected lessons, which provides agency for the student
- Game-like nature of the program, which avoids didactic experiences that feel like lessons or formative or summative evaluations
- World journey format that allows the student to choose where on the global map they want to study, providing a variety of experiences and settings for the learning to occur
- Award certificates to celebrate the accomplishments of students who reach specified achievement levels

Overall potential. Given *Core5's* ability to meet the needs, at least to some degree, within each of the discrete problem categories, the product should be regarded as having high potential for improving learning outcomes for users.

***Core5's* Transformative Nature**

Lexia's *Core5* program impact should be considered transformative, but to fully comprehend why, the program's transformative elements should be broken down individually and juxtaposed against the format of previous efforts to reveal the progress. See Table II below for a presentation of this information. For the purposes of this synthesis, the information expressed in the "Format of Efforts of Previous Products" column is a general amalgam based on personal experiences with products like *Read180*, *iLit*, *DRA2+*, and Fountas and Pinnel's *Benchmark Assessment System*.

Table II. Transformative Nature of *Core5*

Goal of Product	Format of Efforts of Previous Products	Transformative Format of <i>Core5</i>
Publish program materials in a manner appropriate for teachers and students	Materials published traditionally in print, with some recent iterations including some digital components	Heavy dedication to an almost entirely digital experience, teachers moving offline only for the most pronounced of intervention needs
Determine a student's initial reading level prior to program use	Manual running records, paper and pencil tests, or electronic tests	Adaptive gaming experience that uses data collection to avoid a formal test
Monitor student growth throughout program use	Teachers administer formative evaluations, tests, and running records throughout the year to obtain updated reading levels	Teachers can view reports in real time that show every bit of progress, no matter how small, at any given time
Intervene with struggling or reluctant readers	Teachers draw upon outside training, supplements, or possibly provided program print materials to provide 1:1 interventions with students	Technology takes a scaffolded approach to digital interventions, and teachers are called upon to deliver 1:1 interventions in fewer instances, at which time the program provides the lesson and materials to the teacher.
Serve needs of students who are identified as proficient or above level	Proficient or accelerated students usually not served by traditional programs	Proficient and accelerated students receive a custom pathway so their reading progress may continue.
Use technology to improve user experiences	Newer iterations of traditional products include apps, digital running records, and some online student activities.	Heavy digital instruction, game like nature for students, device agnostic, adaptive, and identical experience regardless of device used
Provide agency and engagement for student users	Some programs allow students to choose between two and three different books to read, some online games, and some rewards for achievement	Students pick which lessons, how long to work, where in the world to work, digital dashboards for progress monitoring, and certificates for achievement
Provide actionable data for teachers and administrators	Teachers generate reports after manual tests, electronic tests deliver static, summative data, data available after testing events	Up-to-date reports available in real time, all the time, alert notices for teachers when a student struggles, predictive analytics for end-of-year achievement

As exemplified by Table II above, *Core5* has a very transformative impact in the educational ecosystem thanks to its heavy reliance on technology and digital integration initiatives, as opposed to the manual efforts required of previous products. The technology behind the program has allowed the product to achieve all the benefits of more traditional programs and transcended their offerings with increased efficiency and depth of coverage, which in turn gives the product a better chance of being implemented with efficacy and fidelity.

Overview of What is to Come

Given that a solid foundation of this emerging technology has been established through a contextualized problem in the American educational marketplace, a thorough description of the product and its format, a discussion of its potential for change, and its transformative nature, this investigation and synthesis shall now take a deeper dive into the product to properly analyze and discuss its functions. What is to follow includes: (1) a look into the self-determination theory and empirical frameworks present in *Core5*, (2) the independent research findings exploring the program's efficacy and a comparison of those findings to the claims and product promises of the manufacturer, (3) a look into and comparison of the findings supported by research as compared to the claims made by those who advocate for the product, (4) what is known about the strengths and limits of the *Core5* technology, (5) a personal account of the user experience and linear walkthrough of a lesson, (6) summaries of two teacher-user interviews, and a discussion of their experiences as compared to the claims made by the technology creators, and (7) summative comments evaluating the overall strengths and limits of the technology, barriers to widespread adoption, and the likely impact of the program and its potential for evolution in future iterations.

Theoretical and Empirical Framework

Theories of Learning and Teaching Exemplified in *Core5*

While there may be numerous learning theories threaded through the *Core5* program, the creators at Lexia name self-determination theory as the foundational framework for the most recent iteration.

Self-determination theory. Self-determination theory, according to *The Handbook of Theories of Social Psychology*, is, “An empirically derived theory of human motivation and personality in social contexts that differentiates motivation in terms of being autonomous and controlled” (Lange, Kruglanski, Higgins, 2012, p. 416).

In an article written for the American Psychological Association, author Johnmarshall Reeve states, “Applying self-determination theory (SDT) to educational settings has proven to be a productive undertaking. The theory explains why autonomously-motivated students thrive, and it explains why students benefit when teachers support their autonomy” (2002, p.1). He goes on to state, “While the effort to learn how to integrate students' motivational resources such as self-determination into the school curriculum requires asking teachers to develop new skills and brave the waters of conceptual change, the benefits for students of doing so are many” (Reeve, 2002, p.1).

Self-determination theory in *Core5*. Self-determination theory and the closely related elements of autonomy manifest themselves in three distinct components of the *Core5* program: (1) the students' ability to select which geographic region, within their online world journey, they want to navigate to learn in next, (2) the students' ability to select which skills and concepts they want to work on, and (3) the ability to determine how long to work on the program within a given sitting.

Benefits of Self-determination theory in Core5. The benefits of self-determination theory in *Core5* are best expressed by the teachers who use the program in their anecdotal accounts. Toni Todd explained that the program, “Promotes independence among the children,” (Toni Todd Lexia Interview – Second Grade, 2016) and the autonomy derived from that independence lead Dina Zampine to state that *Core5*, “Basically runs itself,” because the students are so engaged with their own decision making (Dina Zampine Lexia Interview – Third Grade, 2016).

When asked to discuss examples of where she saw the tenants of self-determination theory coming to life in her classroom use of *Core5*, third grade teacher Dina Zampine replied that students are, “Required to get sixty minutes a week on the computer, and the love the computer piece! When they get bored, they choose another component to work on. They like the feel of competition, and they make a big deal about handing out the achievement certificates” (Dine Zampine Lexia Interview – Third Grade, 2016).

Second grade teacher Toni Todd offered additional insight in this matter by stating, “Lexia was difficult at first, because it was just one more thing teachers had to learn; however, it really helps with child buy-in and engagement. Sometimes it’s too engaging! I have to tell some kids to get off of the computer and go outside and play! The kids really think Lexia belongs to them, and they want their achievement certificates – in fact, they want Lexia to put our school mascot on the certificates!”

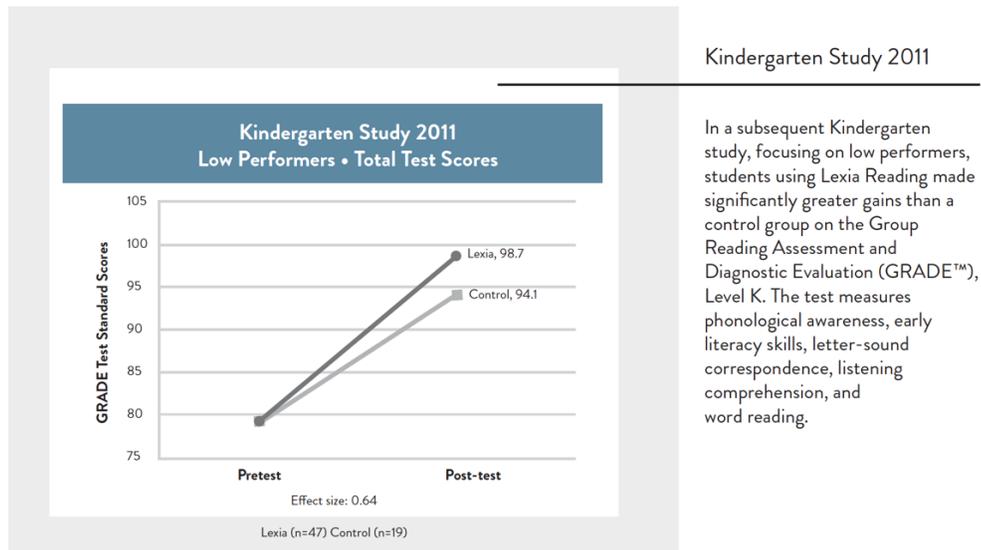
Direct and Related Research Findings

Core5 Research Findings. Extensive scientific studies have been conducted and published with regards to the efficacy of Lexia’s product. According to the company, such scientific research studies have been published in *Reading Psychology*, *The Bilingual Research Journal*, *The Journal of Research in Reading*, and *The European Journal of Special Needs*

Education. Lexia published a synthesis of these studies in their report *A Summary of Published Research*, where the following four key findings were enumerated:

1. The Lexia Reading Program improved reading scores for students in preschool, elementary, and middle schools.
2. The lowest performing students benefited most from using Lexia Reading (See Figure V below.).

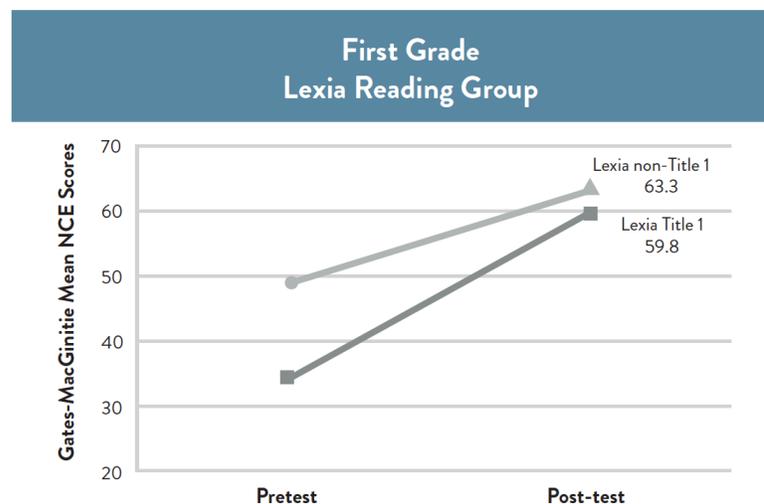
Figure V.



3. Title I students using Lexia Reading closed the reading gap after only six months of intervention (See Figure VI below).

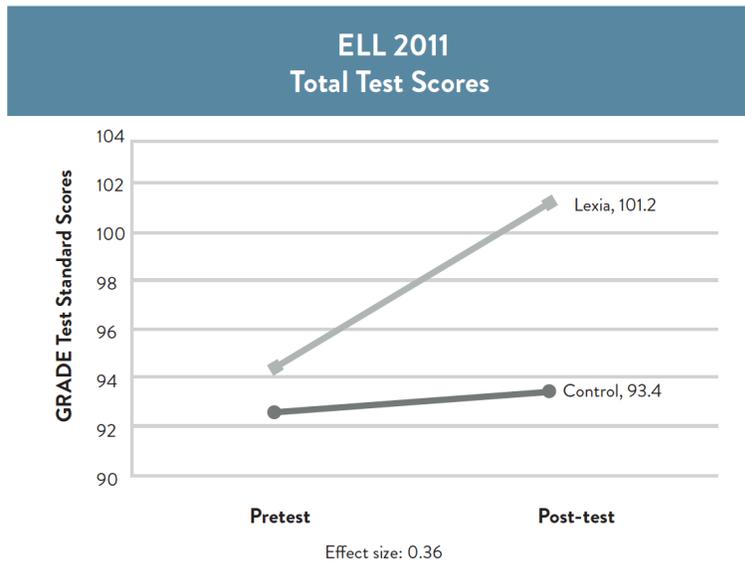
Figure VI.

Moreover, Title I students in the Lexia Reading group closed the performance gap when compared at post-test to non-Title I students in the Lexia Reading group.



4. ELL students using Lexia Reading showed gains in early reading skills (See Figure VII below.).

Figure VII.



Students who used the Lexia Reading program in addition to core reading instruction showed greater gains than a control group in overall reading, phonological awareness, and word reading. The Group Reading Assessment and Diagnostic Evaluation (GRADE), Level K, was used as the reading measure.

(Lexia Learning Research, 2014, pp. 3-8)

Read180 Research Findings. To offer contrast and context to the Lexia findings, research was conducted on the leading product in the marketplace, *Read180*, and key highlights of their findings are offered below as drawn from their report *Compendium of Read180 Research* (2013, pp. 1 - 95):

- The program has existed for fifteen years, and consequently has a great deal of research evaluating the efficacy.
- Of the studies conducted on *Read180*, eleven of the studies meet evidence standards and seven were peer reviewed.
- Four studies support the effectiveness of the product among economically disadvantaged students.

- Nine studies support the effectiveness of the product among English Language Learners.
- Seven studies support the effectiveness of the product among diverse ethnic and racial groups.
- Nineteen studies support the effectiveness of the product among students with disabilities.
- 1,600,000 students are reported to have benefitted from the use of *Read180*.
 - Nineteen percent were elementary school students
 - Forty-nine percent were middle school students
 - Twenty-eight percent were high school students
 - Four percent came from other educational settings

It is clear that the long life lifespan of *Read180* has contributed to the abundance of research available, and perhaps the density of the research makes it difficult to distill out just a few salient points as Lexia has done in their compendium. Research published by Scholastic and Houghton Mifflin and Harcourt on *Read180*'s efficacy is not presented in such a way as to facilitate a direct comparison between the two products; however, it may be reasonable to conclude that they achieve similar results, and the ability to distinguish one as more efficacious than the other is difficult without deeply exploring the minute nuances of their research.

Core5 Research Findings Compared to Advocate Claims. Advocates, or stakeholders like satisfied teachers and product development teams, of Lexia's *Core5* program have made numerous claims about the high level of efficacy the product can provide; however, those claims should be held up to the light of research to evaluate their veracity and reliability. In order to compare these claims to empirical research findings to assess accuracy and validity, the stakeholders/advocates must be identified alongside their claims, and then analyzed against

the findings of independent research. Table III below offers an overview of this information, and previews the discussion to follow.

Table III. Claims vs. Findings

Advocate/Stakeholder	Claim	Comparison to Research
Lexia Learning Company	<i>Core5</i> accelerates reading skills development.	Research supports this claim; however, research suggests that certain populations, chiefly struggling reader populations, accelerate faster.
Lexia Learning Company	<i>Core5</i> is beneficial for students of all abilities PK-5.	The research conducted seems to suggest that <i>Core5</i> is more appropriate for lower achieving students and for ELLs. There is not much research to suggest that it is the best choice for proficient or accelerated readers, but it probably is not detrimental to these populations either.
Lexia Learning Company	<i>Core5</i> uses games to engage students.	Research did not assess students' engagement, so this claim cannot be substantiated with empirical findings.
Lexia Learning Company	<i>Core5</i> effectively supports ELLs.	This claim is proven and substantiated by scientific research studies.
Lexia Learning Company	<i>Core5</i> improves oral language development and reading comprehension.	Research suggests that these gains may be most pronounced among ELLs as they acquire basic English skills.
Lexia Learning Company	<i>Core5</i> supports effective blended learning.	Research does not evaluate or substantiate this claim.
Teacher Using <i>Core5</i>	<i>Core5</i> is effective for small group and station-based instruction.	Quantitative research does not evaluate this claim; however, anecdotal accounts from personal research does support this claim.
Teacher Using <i>Core5</i>	<i>Core5</i> allows students to engage in the program autonomously.	Quantitative research does not evaluate this claim; however, the foundations in self-determination theory

		make this claim quite evident to the layman evaluator.
Teacher Using <i>Core5</i>	Some students close the gap faster using <i>Core5</i> than others.	This claim is substantiated by research. Specifically, students classified as Title I students are those making the fastest gains, according to independent studies.
Teacher Using <i>Core5</i>	<i>Core5</i> is effective for differentiation	This claim is not directly substantiated by research; however, this might be a reasonable conclusion to draw based on the four major findings of independent research studies.

Discussion of Claims Compared to Research. Table III, above, presents interesting findings worthy of deeper investigation. It appears that claims made by the manufacturers appear to fall into two distinct domains: (1) those claims that can be empirically evaluated, and (2) those claims that cannot be empirically evaluated, but seem to be reasonable conclusions based on the findings of the scientific studies. Perhaps there are additional studies that could substantiate some of the more reasonable claims, but such studies do not seem to be available to the public. Four of the six claims the company made can be substantiated by research, and two cannot be substantiated. Claims made by teachers, however, seem to be mostly anecdotal; therefore, difficult to evaluate with research. While three of these four claims may not be able to be supported by research, research may not be necessary as long as the consumers feel that the product is solving a problem or need that they deem significant.

What Is Known and Unknown About *Core5*'s Strengths and Limits

What is known and unknown about the strengths of *Core5*. The strengths of Lexia's *Core5* program are very evident and clear: (1) engaging for students, (2) promotes student autonomy with usage, (3) highly effective for ELLs, (4) effective for students with significant reading gaps, (5) there is utility for the product beginning with early childhood learners all the

way through middle school, and (6) the use of technology makes instruction efficient and effective. As mentioned, some of these claims can be scientifically proven, while others seem to be only qualified with personal user accounts; regardless of the evaluation methods, many users seem to be satisfied with the product.

While much is known about the strengths of the *Core5* program, there are opportunities for additional discovery. It seems that the product could benefit from independent studies evaluating the level to which student-users find the program engaging. The engagement of the product seems to be a flagship element that the company champions in their marketing and sales materials, and many teacher-users seem to agree that the product is engaging to students, in their opinion, but it does not appear that any of these stakeholders have asked the most important stakeholders – the children themselves. If the product is indeed as engaging as advocates seem to claim it is, then the product could only stand to benefit from a scientific study evaluating that claim.

One chief finding from the company's report was that English Language Learners made, "Gains in early reading skills" (Lexia Learning and Research, 2014, p. 7). While this is a known, established fact, perhaps the content creators should ask what types of gains, if any, are being made beyond early reading skills? Many of these ELL students using the product need to close large reading gaps that transcend simple early literacy skills, so perhaps some modifications to the program, that do not compromise the chief mission, could help ELL students gain even more utility from the use of the *Core5* product.

Furthermore, the company stated in their research report summary, "The Lexia Reading program improved reading scores for students in pre-school, elementary, and middle schools" (Lexia Learning and Research, 2014, p. 2). It should be noted that the company also advertises their program as being most appropriate for Pre-K through fifth grade settings, so the advantages of use of *Core5* in middle school settings are secondary to the original design.

Given that Lexia heavily advertises their student engagement piece as a reason to purchase, the question must be asked: do middle school users find the product as equally as engaging as the Pre-K through fifth grade audience, and should adjustments be made to make the product more developmentally appropriate for an older market that seems to have need for using *Core5*?

What is known and unknown about the limits of *Core5*. While there are numerous strengths to Lexia's *Core5* program, which far outweigh the limits, there are still limits that need to be explored: (1) the program may not be the best choice for proficient or accelerated students, (2) the program does not exist comprehensively within electronic technology, and still requires some paper and pencil intervention techniques, and (3) the program is a supplement, or component, to a complete curriculum, which means that to be entirely effective, a school district would have to purchase the *Core5* product in addition to acquiring and learning a comprehensive basal programing like Pearson's *Reading Street* or Houghton Mifflin Harcourt's *Journeys*.

With regard to what is unknown about these limits, it can be said that it has been scientifically established that *Core5* has high efficacy in meeting the needs of those student-users with pronounced reading gaps; however, there is no empirical data to suggest that *Core5* is the best choice for proficient or above-grade-level readers. Lexia makes no mention of how engagement techniques are differentiated for these students, and since the product is intended for Pre-K through fifth grade users, it is not hard to imagine a scenario where a gifted fifth grade student might find themselves unchallenged by the program if the child in question had a reading capability equivalent to seventh or eighth grade levels. Lexia might stand to benefit from further investigating the needs of these proficient and above-grade-level readers in order to add characteristics and features that serve them better, thus making the product well rounded and more robust.

Even though Lexia appears to be mostly contained within and proctored by electronic technology, some student-users may find themselves in certain scenarios where the technology is no longer sufficient to meet their needs, and a face-to-face intervention is required with the teacher. This may come as a surprise to some users, seeing as how Lexia makes great mention about their embedded direct teach component that helps struggling students. However, when a student does not seem to be benefitting from the coping strategies built into the program, *Core5* will alert the teacher that the child needs a live teaching session, and the program will then provide the teacher with instructional materials. To further understand the limitations of scenarios like these, it would be worthwhile to investigate how frequently students are requiring offline interventions, and in what particular domains or concept areas, and then use that data to revise and improve the embedded direct teach lessons contained on the digital platform.

Perhaps the most pronounced limit of the product is the fact that it is indeed just a supplement for literacy teachers. This is problematic, because user accounts suggest that to implement the product with fidelity requires a significant amount of time that may be just as much time, if not more, than standard instruction in a basal reading curriculum. To learn more about this limitation, the product should be evaluated to determine how far off it is from being a viable basal curriculum (i.e., How many more instructional standards would need to be covered before it was comprehensive of Common Core or state-specific standards?). Perhaps *Core5* could be adapted into a basal program with intervention and enrichment woven organically throughout the curriculum to reduce costs for districts and logistical obstacles to implementation for teachers.

Experiences with Use

Personal Experiences & Commentary About Suitable Learning Nature

In order to have a full appreciation of the product, limited demo access was obtained for the third grade student-facing version of the *Core5* program. What follows is a linear account of the product use, along with figures that represent the visuals presented on the screen for the student.

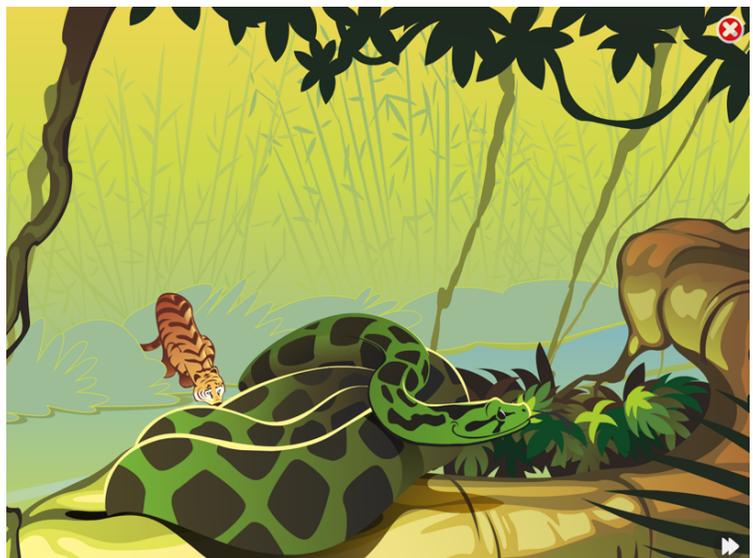
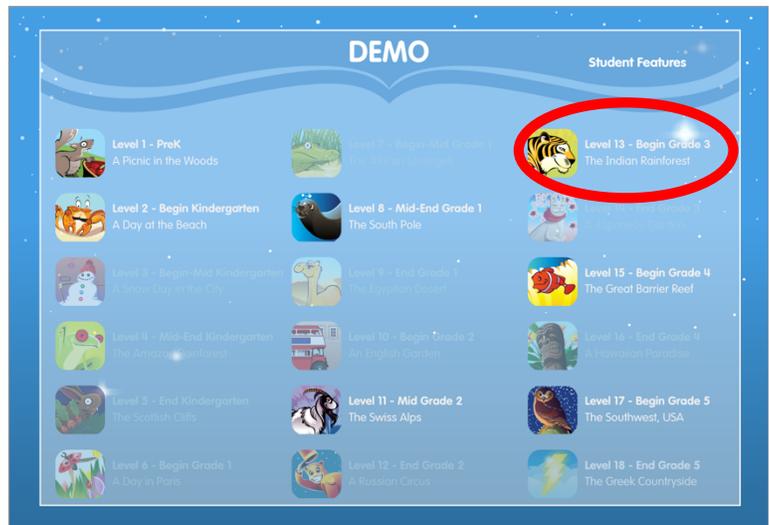
Step 1: The third grade level was selected from the home screen, which indicated that the user experience would be set in the Indian Rainforest.

Commentary: From the beginning, the student is given autonomy to choose which location they would like to travel to, giving the student-user a sense of buy-in and control over their own learning.

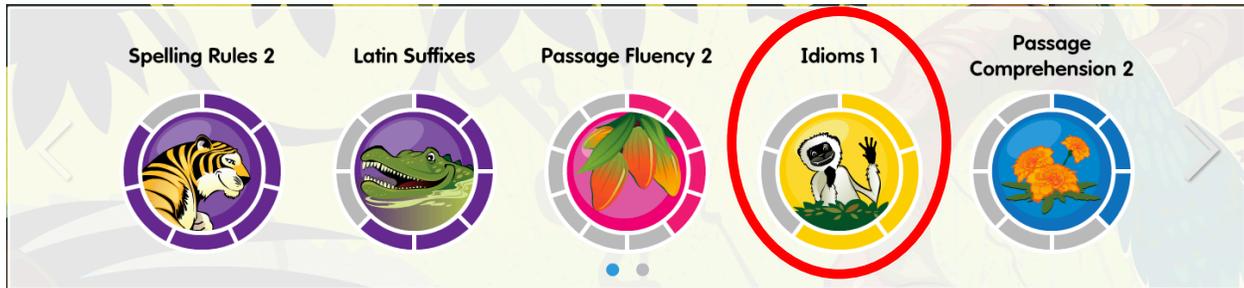
Step 2: An engaging and dynamic animation sequence played that set the scene and context for learning amid the creatures of the Indian Rainforest.

Commentary: From a student

engagement perspective, it may be worth noting that students might consider this more classical style of animation to be dated, and might distance the student-user from full engagement since



most contemporary animated games, movies, and television shows employ more computer animated aesthetics.



Step 3: Following the animation, a second dashboard of five different concepts was presented (seen above), and the user was allowed to select whichever concept appealed to them most.

Commentary: Idioms were selected, for the purposes of this experience, since idioms would be something that would provide both the experience of a native English speaker and a notable added obstacle for an English Language Learner.

Step 4: A sub-menu was displayed for the user which enumerated the targeted standard for the lesson. In this instance, the identified standard from the Common Core was,

“Demonstrate an understanding of idioms and deduce the meaning through sentence-level context clues (L.3.5a).” The user is asked to select

which lesson in the ten-lesson sequence he or she desires.

Commentary: It is unclear what the benefit is for calling out the instructional standard on this student-facing screen. Phrases like, “... deduce the meaning through sentence-level context clues,” seems a bit sophisticated for a third grader who, theoretically, is struggling with reading.



Level 13



Idioms 1

Vocabulary
Demonstrate an understanding of idioms and deduce the meaning through sentence-level context clues.
L.3.5a

Part 1 Recognition
NA



Part 2 Recognition
NA



Step 5: A verbal explanation of an idiom was given for the user, and a static image was shown portraying the very literal interpretation of the idiom.

Commentary: This particular step seems like the ideal place for instructions to be offered verbally in the user's native tongue, though that may prove somewhat challenging in this lesson since idioms are cultural, and often do not have direct translations that preserve intent or meaning. It may be beneficial for the

It's raining cats and dogs.

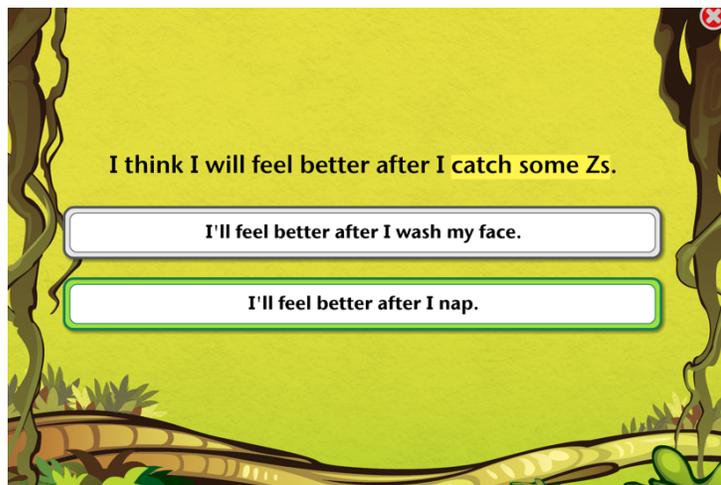


user to have the definition of what an idiom is written on the screen so that the concept is reinforced verbally and in the written word. Furthermore, this very literal depiction may be effective for English Language Learners to make the transition from one language to the next; however, students who grew up hearing these phrases may find the literal depiction to be confusing, since it is so disconnected from its cultural/contextual meaning. From a user experience perspective, there is no "back" button feature on the screen, so if the user wanted to return to this screen to hear the definition and explanation of an idiom again, he or she would have to logout of the system entirely, and start over, which doesn't seem like the most efficient approach.

Step 6: Following the short embedded lesson on idioms, the program proceeded into the more game-style format of learning. A different idiom was presented with the same literal depiction and verbal narration of the sentence.

Step 7: After the new idiom and static illustration were presented, the screen transitioned, a sentence was presented with the idiom reconciled into context, and the student was asked to identify the correct meaning of the idiom by selecting one of three answer choices under the sentence. If the incorrect option was selected, verbal narration stated, “Not quite,” and that incorrect answer choice was removed from the screen, and a negative sound tone was played. The verbal narration offered a

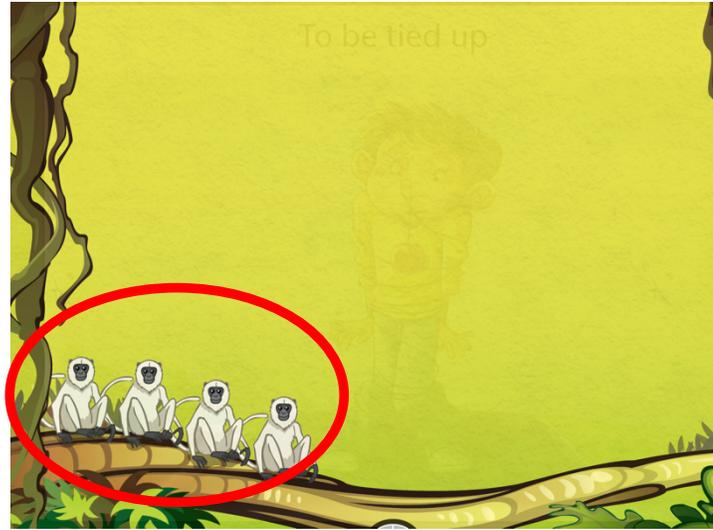
To catch some Zs



reiteration of the idiom, and the idiom itself was highlighted with a yellow bar to draw user focus specifically to the portion of the sentence that contained the idiom.

Commentary: According to Lexia, this is an actual gaming element of the *Core5* program. The use of the word “game” seems a little liberal in this instance, as this activity feels less like a game and more like a well formatted and dynamically presented standardized test question. This may feel game-like to some of the younger users; however, it may be likely that older users find this style slightly alienating.

Step 8: This process repeated several times, and the same idioms were used numerous times and inserted into different sentences to reinforce context recognition. For each segment of the lesson the user successfully completes, a monkey is rewarded on the status bar (the branch). When the branch is full of monkeys, the section has been successfully completed.



Concluding commentary from personal user experience. Overall, the lessons (games) seemed to be visually stimulating, developmentally appropriate, and pedagogically sound. However, there were several instances where students might be confused because of the bias of the content creators.

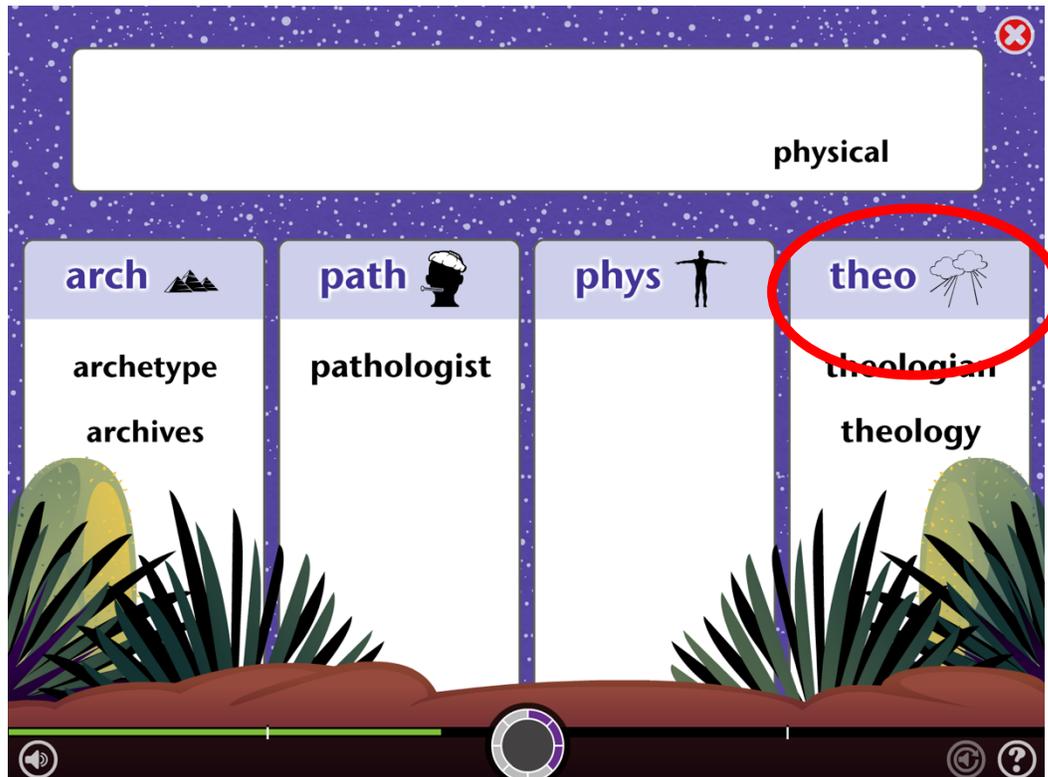
In Figure VIII below, a fish is seen, and the idiom “off the hook” is presented. The intended meaning for this idiom is to understand that someone was relieved of responsibility for something they likely did not want to do (e.g., The teacher assigned a lot of homework, but the student was able to get off the hook, because he had a homework pass.). There is the potential for significant confusion here, seeing as how the slang version of the same phrase, off the hook, is used to describe something that is particularly exciting or engaging (e.g., The birthday party was so wild and amazing, it was off the hook.). Since the visual representation of the idiom is literal, and the fish looks happy, it is not unreasonable to assume that a student-user who had previous experience with this phrase in the slang vernacular might default to that interpretation as opposed to the intended interpretation.

Figure VIII. Off the Hook

In different lessons throughout the program, the disconnect between visual images and intended meanings seemed to persist. One lesson on Greek combining forms seemed to pose a particular issue. In Figure IX below, users were expected to associate the root phrase of “theo” with the concept of God, and the concept of God with heaven, and the concept of heaven with clouds and sunshine. Any breakdown in this association model would likely have caused the student to answer questions incorrectly. This seems to be a bias mistake, on the part of the content creators, that assumes prior knowledge that users may not have upon entering the program. This type of bias is akin to the example of bias seen in a recently retired version of the Iowa Test of Basic Skills, where students were presented with an image of a rotary phone and asked to associate that image with the word “phone.” Many students struggled with

success in this instance because the contemporary visual interpretation of a phone would be more synonymous with a cell phone.

Figure IX. Association Bias in Greek Combining Forms



User Experiences & Thoughts on Suitability for Learning

To gain a more well-rounded view of the user experience, two separate interviews were conducted with two teachers who are actively using the Lexia *Core5* program in their classroom with their students. Summaries of the respective interviews are presented below.

Second Grade Teacher Interview. Toni Todd, a veteran teacher of eighteen years, teaches second grade in a low-income school district, and identifies most of her students as individuals in high need of reading intervention. Ms. Todd was first introduced to the Lexia product two years ago when her campus reading specialist presented the literacy team with the idea, and backed it up with a great deal of research. At first, she admits, that the product was not being used to its full capacity, and there was some pushback from teachers because this

appeared to be one more program for teachers to learn. There was fear that this would be prematurely taken away, like many other programs, when administration did not see immediate results and got cold feet. She explained that as teachers became more impressed with the *Core5* program, chiefly the reporting tools, they began pushing for more rigorous integration of the product into daily instructional time. Ms. Todd is now at one-hundred percent usage of the program among all her students.

Ms. Todd discussed how Lexia's product has structured the blended model of teaching and learning that drives her classroom forward, and she instructs whole and small groups on topics that data reports as most needed, ensuring that her teaching time is efficient and utilitarian. She particularly likes how the program contains components that are easily broken down so that she can create stations in her classroom, which further allow her to segment her class into reading level groups. Ms. Todd spent a great deal of time expressing her love of the data reporting tools, and explained that teachers can look into their data dashboard and see where any child is on the achievement scale at any given time, and they can take that data with them to team meetings and discuss how to support struggling students. She mentioned that at first it was quite overwhelming to be presented with so much data, especially because it was the first time she was able to quantifiably see just how pronounced the reading gaps were among her students. Closing those gaps seemed like a daunting task. However, she credits the simple presentation format that Lexia uses as the reason she is able to quickly and easily digest the wealth of information. Of all the dynamic elements of data reporting contained in the data dashboard, Ms. Todd likes the predictive measure the most; the predictive measure is a tool that gives a projection of where any one particular student is likely to end the year provided they continue developing at their current pace.

While she is thrilled to be using the product, and firmly believes in its effectiveness, she did cite some concerns that were not necessarily the fault of the product. Ms. Todd discussed

the fact that even though *Core5* has been highly effective in her classroom, it is still difficult to be one teacher to twenty-four students, and she typically finds herself having to perform individual interventions with the same group of students, which means decreased face time with proficient or advanced readers. Furthermore, she made mention of the fact that the software is at the complete mercy of the available hardware. Often days their old computers break or do not perform effectively enough to support the program with fidelity. Furthermore, her low-income students do not all have internet access at home, so their only exposure to the program happens at school.

Overall, Ms. Todd is an advocate of the *Core5* program, and believes that it is effective, engaging, and realistically capable of closing at least one year's reading gap in a single academic year (Toni Todd Lexia Interview – Second Grade, 2016).

Third Grade Teacher Interview. Ms. Dina Zampine is also a veteran teacher working in a third grade classroom in an urban school district with mostly low SES students who are classified as ELLs with a background speaking Haitian Creole. Ms. Zampine began using Lexia's *Core5* program when her campus reached out to the company and obtained permission to conduct the program as a pilot in their school. She is now in her third year of the pilot, and finds herself mostly trying to close reading gaps with the product, which she reports can be anywhere from one to three years behind grade level.

Prior to the pilot program, Ms. Zampine was simply using her district's core basal reading program, Pearson's *Reading Street*, which she described as very paper and pencil based, manual, and entirely burdensome on the teacher. Now with the Lexia product, the program practically runs itself, in her opinion, and offers great student engagement with graphics, sounds, animation, certificates, games, and competitions.

Ms. Zampine has structured her classroom in such a way that students are placed into small groups, and each group rotates around to stations, and each station is a component of the

Core5 program. In addition to the computer-based instruction, which she said her students love, she makes significant use of the offline portions of the program as well. Ms. Zampine has created individual binders for all her students that are filled with their specific activities that Lexia has recommended (based on achievement data), and students know to independently rotate to stations and complete their work. She was quite specific to point out that in order to effectively close the student reading gaps, she had to make use of all the elements of the program, not just the digital computer piece.

Students in Ms. Zampine's class are required to amass sixty minutes of online participation in *Core5* a week, which mostly happens in the classroom environment, because her economically disadvantaged students do not often have access to the internet at home. In addition to the built-in engagement pieces present in *Core5*, Ms. Zampine incentivizes online student participation by allowing students to use other digital programs, like SuccessMaker and Stride Academy, only when students have achieved their weekly participation minimums. This has proven to be an effective model as students advance through the program, because more sophisticated topics are not presented in a game format in *Core5*, especially reading comprehension, so students advancing at a rapid pace may become bored or frustrated when the more exciting elements are phased out. Furthermore, the ability of the *Core5* program to present activity instructions in a student's native language has been particularly advantageous for Ms. Zampine's students, since, as mentioned, she serves a very high population of Haitian Creole speakers.

Much like Ms. Todd, Ms. Zampine echoed her statements about the robust and powerful nature of the data reporting tools. She feels constantly in tune with where the children are, and appreciates the monthly and weekly status updates and projections. She likes that she is provided with line graphs that visually represent student growth, as well. She feels strongly that the program is closing student reading gaps in her classroom; however, some students are

improving more rapidly than others, but would agree that the average growth in a school year is one year/one full reading level.

Ms. Zampine went on to include that she has been very satisfied with the experience she has had with the Lexia company, and that the professional development was wonderful; however, she is concerned that the product will be taken away after the pilot program has ended, because *Core5* is very expensive to purchase (Dina Zampine Lexia Interview – Third Grade, 2016).

Experience vs. Claims from Advocates

Generally speaking, it would appear that the claims Lexia makes about the powerful and robust nature of *Core5*'s capabilities seem to be mostly substantiated in user experiences.

Consider that Lexia markets the program with heavy focus on its student engagement, and both teachers made significant mention of the student engagement effectiveness in their interviews. Personal experience with the program led to questions about the game nature of some elements, since some activities that were called games did not feel very game-like, and the graphics and animation were often static and dated. That aside, from what teachers are saying, these elements do not appear to alienate students (though no students were interviewed).

The claims the company makes about the powerful nature of their reporting tools are clearly substantiated by both user accounts, though not scientifically evaluated specifically by an independent study. The addition of the new predictive tool and the delivery of instructions in a student's native language also seemed to be well received and critical features in achieving product efficacy, according to these teacher accounts.

Lexia does not make specific sales promises or ballpark figures about how much growth a student can expect through sustained use; however, both teachers seemed to agree students

could grow their reading proficiencies by about one grade level through proper use of the program throughout a school year. This anecdotal finding seems to be consistent with the data reported in the independent studies of the product, as well. Furthermore, Ms. Zampine's mention of some students closing reading gaps faster than others colloquially validates the empirical finding that Title I students closed reading gaps in about six months, while other students may take longer.

Overall, teacher-user experiences seem to validate almost every claim Lexia has made about the *Core5* program.

Overall Assessment

Strengths & Limits

The strengths of the *Core5* program far outweigh the limits, and can be seen in numerous characteristics like: (1) the browser-based publication format, which keeps the program device agnostic and uniform across devices, (2) effective differentiation for each student through the use of personalized learning pathways and the delivery of activity instructions in a student's native language, (3) the elements of autonomy that allow students to choose what they want to learn, where they want to learn, and when they want to learn, (4) the robust data reporting tools that offer teachers surgically precise information about a student's intervention needs and predictive analytics about where a student will likely end the year, and (5) the ability of the product to achieve its promises.

The limits of the *Core5* program are narrow, but nonetheless are important to acknowledge. There are still some concerns about the game-like nature of all activities (a conclusion substantiated by Ms. Zampine's account of some students getting bored with reading comprehension questions), and the student engagement could likely be increased by including updated graphics and dynamic animations consistent with contemporary styles, much like the

animation found in products like iStation, SuccessMaker, and RM City. Also, while Lexia advertises *Core5* as a program beneficial to all readers of all abilities, not much focus has been given to the experience had by those readers who are proficient or above-grade-level, which may mean that there are more advantageous alternatives on the market for these students. Money and time are of some concern as well; however, these are best explored as barriers to widespread adoption.

Barriers to Widespread Adoption

As mentioned, time and money are going to be the biggest barriers to widespread adoption of this highly efficacious program.

Time. Use of the *Core5* program takes a great deal of classroom time to be conducted with fidelity, and it still requires instruction in a basal curriculum. To properly implement this program into a school setting, it appears that it would benefit best from a dedicated reading interventionist teacher who had a daily standing block of time to work with students in need; however, that might mean that students are missing out on other instructional courses (e.g., physical education, music, art, etc.) that make the school day well rounded.

Time as a barrier to adoption can be seen in the logistical obstacles presented with proper training and professional development in the *Core5* program. Both teacher-users discussed being initially hesitant with unbridled adoption of the program, because they felt it would take a great deal of time to learn and implement. This is a sentiment likely shared by many other consumers in the teacher demographic.

Money. Ms. Zampine alluded to the fact that full adoption of the *Core5* program was expensive, and if *Core5* is priced similarly to its competitors, it could likely cost tens-of-thousands of dollars to acquire the program for even one grade level, and potentially hundreds-of-thousands of dollars for an entire district (maybe millions, depending on district size).

Consider still that this is simply to purchase just the Lexia software, and makes no consideration of the costs of acquiring the needed hardware and associated upkeep. Research suggests that the schools most in need of a product like *Core5* are those who are stricken with poverty, which means they cannot afford to purchase the program. What's more is that those affluent districts who can afford to purchase the product might not have a need for its use. If the price issue is not addressed, Lexia, among other publishers, may have essentially created "a rich man's solution to a poor man's problem."

Likely Impact and Evolutionary Path

As Lexia continues to iterate and evolve *Core5*, it is reasonable to think that they will address some of the few shortcomings the current version demonstrates. The company has made mention of making some of the digital components available offline, so that students can download the software directly to a device and participate at home, even if they do not have internet access.

Continued evolutions will likely see an improvement in the student engagement pieces, with particular regard to the games and graphics. Visual images and animation seem to be characteristics that date almost anything, from comics, to television shows, and movies. As animation software becomes more sophisticated, Lexia will need to evolve to keep up with modern visual standards to retain student engagement.

Furthermore, student-stakeholders who are proficient or advanced readers stand to gain something if future iterations evolve to meet their needs more effectively. The future of *Core5* will likely include enrichment activities that can convert proficient readers to advanced readers, and take advanced readers on a deeper dive into rich texts that are developmentally appropriate.

Regardless of the evolutionary path the product takes, it is clear that the likely impact of Lexia's *Core5* program is profound. If widespread barriers to adoption can be mitigated, this program stands a chance at significantly addressing the pronounced reading gap problem that is so ubiquitous among early learners in American schools.

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