AN IN-DEPTH EXPLORATION OF MATHEMATICS TEACHING TOOLS: PRACTICAL INSIGHTS FOR EDUCATORS

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Abstract

Over the last decade, math learning environments have transformed dramatically with advances in technology and the incorporation of AI, which now enhances the way these tools support teachers and adapt to students' individual knowledge and performance levels. In this paper, we present findings from a comprehensive exploration of five widely used mathematics teaching tools: ALEKS, Beast Academy, DreamBox, IXL, and Khan Academy. An in-depth exploration and content analysis of these tools was conducted by seasoned educators and educational researchers, leveraging their unique insights and practical experience. Findings are presented in a structured framework that facilitates both direct comparisons across platforms as well as deeper insights into individual tools.

Our exploration covers both logistical considerations (such as pricing, technical requirements, and accessibility) as well as practical guidance on how and when to leverage these platforms effectively. By highlighting lesser-known features and comparing the strengths of each tool, we provide educators with valuable perspectives to help in selecting and integrating resources that best meet the diverse needs of their student populations. The inclusion of educator perspectives and feedback supports educational decision-makers as they evaluate and navigate options available for enhancing classroom practices. The information we provide is positioned to be useful to educators across stages of resource adoption, whether they are selecting tool(s) to incorporate into their practice or looking to learn more about the nuances and capabilities of tools already in use.

Keywords: education, K12, mathematics, instructional tools, resource use

1 INTRODUCTION

In recent years, escalating with the onset of the COVID-19 pandemic, there has been a shift to the ways in which mathematics educators and students approach learning. Until recently, online teaching resources were engaged with less consistently than they are now [1], [2]. This shift began when schools started prioritizing active learning, seeking ways to increase student engagement, promote flexible access to instruction, and move away from calculation toward a focus on "mathematical thinking" [2]. Currently situated within what Borba et al. [2] refer to as the "third phase" in the development of digital technology usage in mathematics education, advances in instructional methods are being realized through the leveraging of the internet to assist in developing "blended learning" environments. Blended learning may take many forms but always features the hybridization of traditional classroom designs and e-learning in one or more forms [3]. In contrast to online learning, which typically involves moving standard in person instruction to digital format (e.g. teleconferencing), blended learning is conceptualized as an integration of digital resources to enhance the quality of instruction. It has been shown that these approaches are effective in bolstering student interest, engagement, academic performance, and higher-order cognitive processing [3].

Mathematics educators can currently make use of these tools in various ways, through leveraging of mobile devices in the classroom (e.g. iPads, Chromebooks), subscriptions to Massive Open Online Courses (MOOCs) such as Khan Academy, and use of online resource libraries [4]. The emergence of these new technologies also brings with them the challenge of understanding and implementing ever-evolving online resources. As Attard & Holmes [1] note, "integrating digital technologies effectively into mathematics teaching and learning is a complex task requiring the consideration of many elements including pedagogy, content, and student learning. Uses of digital technologies in mathematics can be ineffective, distracting, or even dangerous when not integrated into the learning process in meaningful ways." To assist with instructional integration of these technologies, this paper aims to offer educators a comprehensive review of features offered from five widely utilized mathematics teaching tools to assist in thoughtful implementation.

2 METHODOLOGY

This study was conducted in two phases, both designed to provide educators with actionable insights into five widely used online mathematics learning platforms: ALEKS (Assessment and Learning Knowledge Spaces), Beast Academy, DreamBox, IXL, and Khan Academy. The process combined systematic information gathering with educator-informed analysis to ensure a practical and comprehensive understanding of each tool.

The first phase focused on the collection of detailed information from publicly available sources and direct interaction with each platform. To ensure consistency across platforms, the team developed a series of graphic organizers that served as structured templates to guide data collection. These included sections for platform logistics (such as pricing models, device compatibility, and technical requirements), instructional design (such as scope and sequence, lesson format, assessment strategies, and pacing), and support features (including student progress tracking, teacher dashboards, and classroom integration tools). Each platform's official website and supporting documentation were carefully reviewed, and data were recorded systematically using the graphic organizers. In addition to this external review, educator accounts were created for each platform to explore features from a user's perspective.

In the second phase, the collected information was reviewed and analyzed by a team of educational researchers with expertise in mathematics education curriculum evaluation. This stage involved a content analysis of the collected data, looking across platforms to identify recurring themes, distinctive features, and potential gaps. The analysis was informed by both the structured data and the qualitative input provided by experienced educators. Researchers synthesized this information to highlight key use cases, clarify the intended instructional purposes of each platform, and illuminate features that might be particularly beneficial or underutilized.

Special attention was given to contextualizing the tools for different classroom environments and teaching styles, with the goal of providing educators with a clear, comparative understanding of how each tool might align with their instructional goals. In this way, information gathered can benefit educators looking to choose a tool to use as well as educators already using one.

3 RESULTS

The sections that follow present a detailed examination of each of the five online mathematics learning platforms included in this study. Drawing from both structured data collection and the practical insights of experienced educators, we describe the unique features, instructional models, and potential classroom applications of each tool. To provide a foundational comparison, Table 1 outlines core logistical factors for each platform. These high-level considerations often play a critical role in school and district-level decision-making. This overview is followed by in-depth profiles of each tool, offering educators a comprehensive look at how each resource functions in practice and how it may align with various instructional goals.

Table 1. Logistical Comparisons At-a-Glance.

	Suggested Grades	***Applicable Uses***		***Access***			
		Comprehensive Curriculum	***Curricular Supplement***	***Language***	***Desktop Browser***	***Mobile Browser***	***Mobile App***
ALEKS	3-12	X	X	English, Spanish	X	X	
DreamBox	K-8		X	English, Spanish	X	X	X
Khan Academy	PreK-College		X	50+ Languages	X	X	X
IXL	PreK-12		X	90+ Languages	X	X	
Beast Academy Online	1-5	X	X	English	X	X	

3.1 ALEKS (Assessment and Learning Knowledge Spaces)

ALEKS is an adaptive online platform, with comprehensive and supplemental classroom learning opportunities for students. This tool maintains a frustration-free learning environment by leveraging AI diagnostic tools, providing real-time data and insights to individualize instruction, close learning gaps, and support standards-aligned teaching. It was initially designed for integration into classrooms with High School students but now offers programming as early as third grade. Unlike other comparable services, ALEKS avoids the use of avatars and game-like features, instead prioritizing a clean interface and a workspace designed to mimic a more traditional response environment. This vision is reflected in ALEKS's streamlined layout that feels like a virtual workbook. ALEKS also provides students with the use of on-screen digital tools (e.g. graphing tools, a virtual pencil/ruler/compass, special notation keys for expressions, and table/proof building tools) that are commonly found in math classrooms. Programming avoids multiple-choice questions, instead prioritizing typed answers to challenge students to rely more on their critical thinking and problem-solving skills.

An initial "knowledge check" is conducted prior to students starting, comprised of 20-30 questions to help determine their current knowledge level and to personalize instruction. As students complete topics within a course, their progress is tracked using a pie chart which updates in real time. Mastery is shown in color on this chart, with grey areas indicating remaining learning opportunities. Students are also provided with intermittent diagnostic "knowledge checks", which apply adaptive questioning to calibrate students' "knowledge state" by considering recent learning. ALEKS then adjust the content presented to match the students' abilities. Leveraging these AI-integrated features, ALEKS maintains students at the "boundary of their current knowledge", striving to ensure they are appropriately challenged.

ALEKS also offers flexibility for educators and institutions to prioritize their own learning sequencing, which can be used to address knowledge gaps. Educators may choose to allow ALEKS' diagnostic features to guide sequencing or can assign a specific course. Additionally, a fact fluency program referred to as "QuickTables" is available to help students master basic addition, multiplication, and division. In these ways, ALEKS allows for flexible learning in which students and educators can choose the style of instruction that best suits their needs through a mixture of personalized learning, assessment options, and instructor-assigned work. ALEKS also contends that their programming is aligned to state standards for all 50 states and is set automatically for most courses. Common core standards are also available for application to facilitate targeted learning.

3.2 Beast Academy Online

Beast Academy Online is a web-based math learning platform created for students in grades 1-5, offering comprehensive programming that promotes the use of deep conceptual understanding and problem-solving skills. Beast Academy Online may be used to supplement classroom instruction or as a standalone curriculum, and targets a younger student population, applying a graphic novel, story-based format for lessons. The learning environment differs from traditional online platforms, instead of taking on the feel of a gaming adventure. Students enter different "worlds" (classrooms), collecting stars and trophies as achievements. Collecting enough of these will move the student closer to a final test, after which they will unlock the next level of learning. Learning options are broad, and opportunities include reading graphic novel lessons, watching problem-solving modelling in videos, and solving practice problems. There are also options available on screen to access tools such as a pencil/eraser, to gain help completing a problem, and a book button to re-connect the student with the associated graphic novel lesson. After answering a problem correctly, a screen appears that explains two strategies that could be used to solve the problem. This feature can be helpful in broadening student thinking. While the default structure is self-paced, the program is designed for lessons to be taught and reviewed by educators. For an additional cost, online instruction is also available.

Beast Academy applies diagnostics in the forms of "are you ready for" assessments and a cumulative test at the end of each "chapter", to gather information about the learner's readiness. These tools can be used by educators to gauge student performance, and to make changes to assigned programming. In this way, Beast Academy is less autonomous than some other programs (requiring more educator insight into progress) but may afford educators additional flexibility when initially selecting a student's starting placement. Other features such as "trophy problems" and "upstairs/downstairs" activities offer enrichment opportunities for learners who want to further challenge themselves.

3.3 DreamBox

DreamBox is an online learning program designed to supplement K-8 instruction, offering a wide range of math skills for students to practice. There are 10 “mathematical domains”, including counting, comparisons and ordering, addition and subtraction, place value, measurement, multiplication, and division, geometry, ratios and proportions, expressions and equations, and functions. Domains each include a list of “learning units”, which are standards aligned concepts and skills that fall within each category. Learning units are then organized by grade level (grades K-2, 3-5, 6-8), each featuring gamified, standards-aligned instruction. Lessons may be independently completed or specifically assigned by an instructor.

Students are initially placed within their grade level, with DreamBox’s software actively monitoring student performance and adjusting learning within-unit. Short-term assigned work will appear to students with a star, while other longer-term goals will appear with a calendar icon. Once lessons within a long-term goal are completed, the assignment will be removed. Educators can also assign short term (1 week), and long term (2 month) assignments based on NWEA MAP scores, Bridges Math Units, or Dreambox’s CCSS aligned sequencing. In 2024, DreamBox implemented “launchpad”, a premium service which provides additional assessment opportunities to assist in proper student placement. This assessment takes 15-45 minutes and is an alternative to instructor-assigned grade level. Educators can monitor assigned work and overall student progress toward mastery. Additionally, a messaging feature allows both educators and students to send personalized notes, allowing for added personal guidance and student assistance.

3.4 IXL

IXL is an online learning platform for students in grades preK-12, providing math skills instruction alongside real-time diagnostics and teacher analytics. IXL is organized by grade level for PreK-8, with higher level math courses available by subject name (e.g. Algebra 1 & 2, Geometry, PreCalculus, Calculus). The program takes on the feel of a virtual workbook, without many visual distractions. A variety of problems are offered for each grade level and course, with a mixture of traditional problem types and frequent incorporation of visual models and tools used in math classrooms. IXL provides space on the screen for pencil and paper calculations by clicking on the drawing tool, with answers typed into a provided space. Special keys, such as square root, straight fraction/division symbols, and exponents are made available on problems that require them. Student work is organized by topic or by content, with each lesson featuring a skill within the specified learning area. When working in IXL, one problem presented at a time. Question formats include multiple-choice and fill the blank, with some problems requiring students to answer two questions before moving on.

Student progress is tracked using an onscreen marker, which moves along a trajectory towards scores of 80 (“proficiency”), 90 (“excellence”), and then “Challenge Zone” (increasing for correct responses, moving backwards for incorrect responses). Students reaching the "Challenge Zone" will typically have to answer 7-9 questions, which upon successful completion will indicate mastery of the skill. Awards are also earned throughout movement within a skill, beginning at a score of 70 students will receive a different color “ribbon” for every subsequent 10 points until mastery. Students are also offered “badges” which appear on a grid and are used to track progress through a grade level.

IXL skills build on one another, so it is recommended that students proceed in sequential order. However, the built-in diagnostic feature or an instructor may recommend practicing different skills for targeted practice or to complement what is being covered in class. IXL’s initial diagnostic feature includes 55-70 questions, designed to create a personalized action plan for each learner. Scores from this diagnostic align with the students’ knowledge-based grade level (e.g. 100s being 1st grade, 200s being 2nd grade, etc.). Educators can track student progress and diagnostics in real-time and can input external student testing information (e.g. NWEA MAP results) to prepare learners with more targeted skills practice. IXL also features a “Summer Learning Adventures” series, supporting students entering Kindergarten through 8th grade with 20 days of themed activities designed to reinforce learning. Additional seasonal programs including “Summer Boost,” “Fall Power Up,” and “Weekly Boost” are available throughout the year for K–8 and higher-level math courses (Algebra 1 & 2, Geometry, Precalculus, and Calculus), supporting continued development.

3.5 Khan Academy

Khan Academy boasts free math learning opportunities for students grades PreK through early college, offered through a variety of video instruction and question-based math skills training. The website takes on the feel of a virtual workbook, with simple interfacing and minimal distractions on problem pages. Khan Academy is organized by grade level from PreK-8, with higher level math courses organized by subject name (e.g. Algebra 1 & 2, Geometry, Trigonometry, Precalculus, Statistics, AP Calculus). Beginning with second grade, each grade level or math course is organized by units with accompanying lessons. Units include the content or topic, and lessons detail specific skills within the topic. Students may choose units or specific lessons to work on themselves and may decide to start from the beginning of a unit or can take a test to see which concepts are already mastered. Within every unit there are video and written lessons, accompanied by practice problems. Students may opt to skip the videos and written lessons, focusing solely on practice problems. Practice problems for each skill vary in number, often involving between 4-7 questions each taking approximately five minutes to complete. Quizzes are introduced periodically, which include at least five questions related to skills practice within a lesson and can take 10-20 minutes to complete. Space is provided for pencil and paper calculations by clicking the scratch pad tool located on the bottom of the screen. Students submit answers by clicking on the provided answer box, which will also allow them to access numeric keys, special keys (e.g. square root, straight fraction/division symbol, exponents).

Khan Academy awards “mastery points” by completing problem sets, quizzes (provided periodically), and unit tests. Each skill is worth 100 mastery points, with students moving up or down towards 100 based on performance. A score of 50 indicates the student is “familiar” with the topic, 80 reflects “proficiency”, and 100 represents “mastery”. Mastery is not easily learned, which is intentional to keep students working hard to achieve deeper understanding. Content is updated several times a year and should students’ mastery level be impacted by new or revised content; they will receive an alert within the course with additional skills they may need to complete. Khan Academy also includes some game-like features, by tracking “energy points” (awarded for watching videos, practicing problems, and completing tasks), and “badges” (given for desirable behaviors, such as earning points, achieving mastery, or learning something new). Students also choose an avatar/character to represent themselves on the platform. Students may unlock other avatars as they earn energy points.

“Course challenges” are diagnostic tools provided for each course. These challenges are more time intensive than individual skills, with about 30 questions estimated to take approximately 45 minutes to complete. This awards mastery points for content the student already knows, and helps the platform determine remaining skills gaps within a course. Students are able to view visual reports which provide information on their level of understanding. Educators have access to “activity overview” reports for students, including learning time and skills worked on for both assigned and individually completed coursework. Educators can also access the “breakdown of skills worked on”, in which educators can see skills that were attempted, familiar, proficient, and mastered.

4 DISCUSSION

This review of five widely used online mathematics platforms highlights their unique features and strengths and is a reminder that the effectiveness of any platform depends significantly on how well it is matched to the specific goals, context, and student population of a classroom. Educators selecting or implementing digital tools should be attentive not only to the instructional design of each platform, but also to the nuances that affect engagement, accessibility, and usability for both students and teachers.

Across all platforms, adaptivity is a major theme. Whether through initial diagnostics, ongoing performance-based adjustments, or educator-controlled assignments, each tool offers ways to personalize learning paths. However, the degree of adaptivity and transparency around how content is adjusted varies. Some platforms, for example, automatically adjust difficulty levels or content sequencing, while others require more hands-on input from educators. Teachers should be prepared to understand and monitor how adaptivity functions in each system and be aware that in some cases, dashboard data may not make these adjustments fully visible.

Each tool was initially designed to target a specific student population, as well as with different aims for supporting learning. An understanding of these goals and their real-world applicability is important when determining which tool will fit best for blended learning opportunities. Some tools were created to serve as supplements to classroom instruction, with others offering more comprehensive standalone curricula options for total learning. Being aware of these differences when planning for blended instruction will assist teachers in finding a platform that will best serve their students’ learning preferences, as well as their own teaching style.

The visual and interface design of platforms also plays a central role in usability and accessibility. Some programs are highly visual and emphasize conceptual understanding through models and animated feedback, while others adopt a more traditional, workbook-like structure. Educators should consider their students' needs as well as the approaches used during classroom instruction to ensure that a supplemental digital platform complements, not complicates, learning. For instance, platforms that heavily rely on visual models without accompanying clarification may frustrate students; similarly, more text-heavy or formal environments may lack the variety needed to keep certain learners engaged. Educators should be aware of how the tools they use present information and supplement them as needed.

Finally, diagnostic and placement tools are powerful but require time and attention. In many cases, initial assessments can be lengthy or cognitively demanding for students. Educators may want to consider breaking these sessions into smaller parts or using them selectively. Additionally, an understanding of how diagnostics are tied to course placement (and if and how those placements can be modified afterwards) is important for maintaining flexibility and equity, especially for students working significantly above or below grade level.

5 CONCLUSION

As digital tools continue to play an increasingly central role in mathematics education, educators are faced with a growing array of options, each with their own strengths, features, and implementation considerations. This review offers a grounded, educator-informed discussion of five commonly used platforms to assist instructors in developing their own frameworks for blended learning. While there is no one-size-fits-all solution, understanding how each tool functions (both technically and instructionally) can empower educators to better select options to meet their needs, as well as be more effective and intentional with tools they are already using.

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