

Design Principles and Considerations for Technology Integration: A Guide for Implementing Universal Design
for Learning in a Blended Upper Elementary Math Setting

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I. Introduction

This school year, our school is undertaking a Universal Design for Learning (UDL) implementation initiative. With the research provided within the course coupled with prior studies through the Learning Design and Technology program, I feel suffice to say using technology and course design ideas permeate throughout my classroom. With an influx of technology due to the pandemic, classes are now 1:1 with Chromebook access during school hours. Therein lies golden opportunities to reimagine classroom instructional processes and procedures. Our school's initiative for experimentation with UDL practice paired with my research into design has me eager to put research into practice, and help those who may need support.

The response for UDL implementation stems from a Targeted Support and Intervention plan enacted by the state of Pennsylvania in Fall 2019 due to the existing school's underachievement. Test scores linked to this learning population show a clear deficit on grade-level mathematical understanding. According to the Pennsylvania Department of Education's analysis of the school's application for expansion into a cyber charter, the state of Pennsylvania finds that the school's existing population fields a mere 16% of students performing at proficient on advanced levels in math on the Pennsylvania Systems of School Assessment (PSSA).

The setting for my final project takes place within the aforementioned school in a 4th grade classroom. Generally speaking, the learning population is diverse in ethnicity and academic capabilities, lives in predominantly urban settings, come from a lower-SES, and some families of students are English Language Learners. As mentioned above, many students operate on a math level that is below, or significantly below state-level expectations based on beginning of the year diagnostic data, and PSSA data from their third grade year.

I have a direct duty to intervene and work to help students raise their achievement both for themselves and on a school level. In an effort to raise student achievement, satisfy the school's plan for UDL implementation, and use the latest research using technology, this undertaking directly correlates towards my personal and professional goals.

For this project, I'll highlight Universal Design for Learning Guidelines, pair them with my own research into e-learning instructional design and mobile technologies, and provide suggestions for implementation with some of my favorite edtech tools. By aligning these three considerations together, I'll rationalize my educational practices for this struggling learning population. Further, I hope this project can serve as a guide for teachers eager to implement technology and/or UDL into their classrooms, but are unsure where to start.

Students will use a school-provided chromebook in order to access all these activities during school hours. Students are not permitted to take these laptops home, but the content is accessible across a range of devices. Students can login to their school account from a personal device at home and access the LMS.

II. Lesson Planning Process

When sitting down to complete a lesson plan, I like to follow guidelines in line with Backwards Design and ideas from Flipped Learning. Backwards designers begin with assessments and standards, then create learning material aligned to the assessment. This is contrary to traditional lesson planning where the assessment comes as an afterthought. With an assessment and its alignment to the standards in hand, you're ready to plan a sequence of lessons that adequately prepare students for the assessment and to demonstrate mastery of the standard.

By engaging deeply and taking the time to pick apart a standard, effective designers will have a good sense of what they'll want students to be able to do. It's easy getting sucked into teaching content that's not relevant. Analyze standards and refer to the assessments for what students are assessed on. Teach that.

Now that there's standards-aligned learning goals, it's time to compile resources. Refer to your provided curriculum resources for lessons that support your learning goals and objectives. In this context, teachers are encouraged to use supplemental resources to complement the provided curriculum. Research and experience help tremendously when deciding where to look for resources, so building a repertoire takes time. Blooket, Boddle, Classkick, Edpuzzle, Gynzy, Common Core Sheets are a few of my favorites, and they work together to satisfy learning goals.

For each lesson, students have what I refer to as a "Must Do" component. Student Must Do's are a measurable formative assessment for me to see whether students grasped the concept or not. Rather than students completing worksheets with pencil and paper that need to be graded, I look for opportunities to utilize technology to grade and provide feedback whenever possible. After students complete their "Must Do" assignment, they're off to their "Can Do's" which provide student spiral reviews of past skills, on-their-level practice, on grade level practice, and tactile opportunities of engagement. After Must Do assignments are complete and Can Do assignments are underway, circulate to provide feedback and guidance and work with small groups of students who need intervention.

Mobile technology-enhanced flipped learning makes it so students can access the content anytime and anywhere. Using the 1:1 laptops, students access Google Classroom, our learning management system (LMS), where the teacher has preloaded learning experiences for students to complete and interact (See Figure 1, 2 and 3). True flipped learning switches traditional school and home roles. However in this case, students consume new ideas early in class with limited teacher-talk. Direct, explicit instruction paired with aligned formative assessment questions, and then repetitive skill- and- drill practice. Providing course materials on the learning management system ensures that students *could* access content from mobile devices in informal learning settings.

III. Design Principles Chart

Table 10.1. Aligning E-Learning Design Principles and Universal Design for Learning in Upper Elementary Mathematics

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| <p>Multiple Means of Engagement</p> <p>Provide options for Recruiting Interest</p> <ul style="list-style-type: none"> <input type="checkbox"/> Optimize individual choice and autonomy (checkpoint 7.1) | <p>After direct instruction and students complete their “must do” task, students have different <i>choices</i> of how they want to engage deeper with the content tied to the learning objectives. Via the LMS, students are provided guided options for how they want to engage and practice. Both Blooket and Boddle are used for practice that give students instantaneous feedback to help with self-regulation. Both programs are wise choices with learning theories aplenty to use for practice during school hours and at home for extra practice. Sometimes computer games from OER sites get linked... videos and slide shows too. Students also have non-digital options in the class including flashcards, task cards, operation drills with the answer key, and open-invitation to work with the teacher in a small-group setting. This design principle tasks students to carve their own understanding, and interact in ways that help them.</p> <p>By promoting agency and choice, students are responsible for their learning with plenty of opportunities to engage. The onus of responsibility lands on the learner’s plate.</p> <p>In guiding students to seize control over their learning by making choices to help them achieve learning goals, students are engaged in a form of Self-Directed Learning (Garrison, 2003). Garrison highlights that “the foundation of the interest and movement in SDL was a focus on the freedom and responsibility of the individual learner to construct their own learning experiences. It was also a rejection of an excessively teacher-centered traditional educational experience.” (pg. 162). Garrison goes onto mention that “the concept of an educated person as one who has learned how to learn” (pg. 162).</p> <p>The goal of this principle is to push students towards autonomous learning, and self regulation. Students are encouraged and provided opportunities to self-advocate and act in their own best interest.</p> |
| <p>Multiple Means of Engagement</p> | <p>“In an educational setting, one of the most important ways that teachers recruit interest is to highlight the utility and relevance of learning and to demonstrate that relevance through authentic, meaningful activities.” CAST (2018).</p> |

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| <p>Provide Options for Recruiting Interest</p> <p><input type="checkbox"/> Optimize relevance, value, and authenticity (checkpoint 7.2)</p> | <p>In math class, students engage with different learning experiences that they are eager, not resistant, to doing. By providing questions from a myriad of sources onto a gamified option, the relevance for students increases. They're eager to "play a game" while the teacher has tactfully made the questions align to the class content. Students interact with the learning material in a way that becomes relevant and authentic to them. Heiser and Ralston-Berg claim game-based learning has theoretical frameworks concentrated in behaviorism, cognitivism, humanism, and constructivism" (pg. 288). The gamified nature of the programs used are developmentally appropriate and relevant with cartoonish figures and an emphasis on earning money.</p> <p>The Horton text devotes 3 solid chapters to Absorb, Do, and Connect activities, and their prevalence in e-learning design. Making learning relevant to learner's lives beyond the classroom is a key feature of Connect activities. Common connect activities include thinking broadly about the subject, asking questions, recall events from their lives, real-world tasks, guided researching, and creating a piece of original work. (Horton, pg 164). The tie between school concepts and real life helps make the learning relevant.</p> <p>In the past, I've provided students with chances to connect our mathematical concepts to the outside world. Notably, students scoured houses and vehicles to connect ideas of place value, addition, subtraction, and value. Students were then able to share their findings with their classmates by copying and pasting links in a discussion post while having jaw-dropping realizations about the world beyond, and what money can buy. Budgeting activities for addition and subtraction as well as a bridge pattern analysis will help to connect geometric ideas.</p> |
| <p>Multiple Means of Engagement</p> <p>Sustaining Effort & Persistence</p> <p><input type="checkbox"/> Heighten salience of goals and objectives (checkpoint 8.1)</p> | <p>Learning experiences need to be designed with the specific standard and associated skills in mind. Analyzing standards and breaking down content into bite-sized consumable lessons for students is an effective way to ensure learning is purposeful. In Pennsylvania, mathematics standards are broken down into eligible content pieces which are sub-skills of the standards. These serve as those bite-sized lessons, or series of lessons which can then get organized to teaching standards, and ultimately units.</p> <p>The standards and eligible content further help solidify the notion of learning objectives and "I can" statements by explicitly providing what students need to be able to do. The language of the learning objectives and the "I can" statements need to mimic the wording of the standard/eligible content. This way, students optimize their time</p> |

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| | <p>by knowing exactly what is expected of them.</p> <p>Standards, Goals, and Objectives are all huge components in learning designs and have vast amounts of research to back up their importance. Learners need not to be strangers to them, but rather embrace them as goals to achieve or as a measuring stick. Students should see learning objectives as they're posted for display in the classroom, receive their own spot on Google Classroom, appear at the beginning of Gynzy lessons, and will notice the standards posted at the top of Classkick Slides.</p> <p>Moore and Kearsley provide numerous considerations for designing a distance learning study guide. Not like a syllabus or a textbook, a study guide is used to "communicate teaching" and can also be viewed as "a tutorial in text" (Moore and Kearsley, pg 105). When assuming the sum of all the parts of the units created on the LMS, I will have, in essence, designed at least a starting point for an online 4th Grade Math Course. The course can be recycled and revised as needed, but comes complete with standards aligned learning experiences, goals, and objectives for the entire 4th grade curriculum.</p> |
| <p>Multiple Means of Engagement</p> <p>Sustaining Effort & Persistence</p> <ul style="list-style-type: none"> <input type="checkbox"/> Vary demands and resources to optimize challenge (checkpoint 9.2) | <p>A Classkick Case Study highlights how an instructional math specialist, Pamela Kent, harnessed the program to accommodate a special education population, but found even more possibilities for differentiating using Classkick. Kent notes "Originally, my goal was to meet the needs of students who need oral administration as an accommodation for assessments. And then as I played with Classkick more, I realized we could differentiate between different groups of students by using the same assignment but scaffolding it differently. "The specialist goes on to say "My original goal has been met, but we have expanded and found more that we can do with Classkick and I am sure that we have not even come close to maximizing what we would could be doing yet. But, we have definitely grown in our usage and found only additional benefits." This quote shows just one feature of Classkick, the audio tool, can have a profound impact on struggling learning population. The audio tool is a helpful, and I've found similar successes using the back and forth audio files.</p> <p>Classkick allows the designer lots of other choices too for how students can show what they know. One premier feature of Classkick is to provide a short-answer box for students coded with the correct response. When students type in their answer, they will be greeted with a green box outline indicating a correct answer and rewarded with a classwork point, or met with a red box outlining signaling an incorrect response and not earning said point on the assignment. This</p> |

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| | <p>heightens the degree of difficulty, but also adds to the satisfaction of accuracy. From my experiences and observations, students are likely to seek out help in order to clear up misconceptions if their box doesn't respond green. Students are persistent to earn all their classwork points.</p> <p>Classkick also allows students to respond to multiple choice questions with the same green and red indicators. The program features drag and drop items as well as access to a pen tool, highlighting tool, line tool, text box tool, and many more. Each of these features also include a choice of color.</p> <p>My experiences and attitudes towards the program and its ability to aid in a range of student and teacher needs echo the specialist's interview responses. It's ease of use and potential for raising student achievement make it a no-brainer in class. I can confidently claim I would struggle to teach without it.</p> <p>Other programs like Boddle are able to be scaffolded to student's math abilities too. With a range of skills assignable by grade, students receive specific attention to their needs on their level. This differentiation supports struggling learners and challenges the higher-achievers.</p> |
| <p>Multiple Means of Representation</p> <p>Provide Options for Perception</p> <ul style="list-style-type: none"> <input type="checkbox"/> Offer ways of Customizing the Display of Information (checkpoint 1.1) <input type="checkbox"/> Offer alternatives for auditory information (checkpoint 1.2) <input type="checkbox"/> Offer alternatives for visual information (checkpoint 1.3) | <p>The role of the learning management system (LMS) in UDL implementation, and integration of technology into the classroom cannot be understated. Research conducted through LDT 832 - E-learning Design drove a lot of the decisions to permanently implement the use of a LMS. After using an LMS in emergency circumstances, researching their benefits, and reflecting on past usage, my Google Classrooms are now true works-in-progress.</p> <p>Even in the blended setting, I'm leaning on e-learning design principles. In Moore's work, "Designing the study guide," the authors lay out 14 considerations for a course <i>study guide</i>. All of the considerations are available through the use of a LMS which serves as the study-guide. The article goes on to state, "information and activities ... should be organized into self-contained lessons or units." (Moore, pg 105). In response to this quote, I've created 5 Google Classrooms, one for each subject taught (Homeroom, Math, ELA, Science, Social Studies). By doing this, I'm able to create topics within each class that coincide with the units taught, down to the lessons and consumable content students see. The 4A Math Google Classroom currently has 6 topics: Place Value, Rounding, Addition, Subtraction, and Geometry. Beneath each topic are learning</p> |

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| | <p>experiences designed to work towards mastery in those topics. These include instructional videos, links to different activities, questions, slideshows and more. I've gone on to add more to the LMS after completing the place value unit for LDT 832.</p> <p>The display and layouts of the year-long course is now “malleable and customizable” (CAST, 2018). The presentation of materials shifts from static print to a more adaptive course layout. Utilizing Google Classroom as the ever-adaptable filter for digital resources that work to satisfy the unit’s learning goals is optimal.</p> <p>During what Moore refers to as “absorb activities”, students are actively engaged with consuming new content. Students are taking in all the necessary information crucial to satisfy learning goals. Slide shows, Demonstrations, informational videos, readings, stories by a teacher, and even field trips all work towards planting seeds in the learner’s mind. Technology affordances allow for students to absorb the necessary information in multiple ways, rather than a static teacher perceived as the keeper of knowledge. Offload some of the teacher-talk onto explicit, consumable media complete with some visual and audio pizzazz.</p> <p>“If Absorb activities are the nouns, then Do activities are the verbs of learning.” (Horton, pg 129). Students are able to transmit what they’ve learned from the absorb activities and begin practicing. Practice with the new content helps learners fine-tune their understandings while getting immediate feedback in the process. Do activities work to bring information out of a student, whereas Absorb activities push knowledge in.</p> <p>The activities added to the LMS work to guide students through Absorb, Do, and Connect activities. The focus becomes the transmission of knowledge in, knowledge out, and then connecting to the outside world. Students interact with Edpuzzles, Gynzy slides, Discussion Posts, Blooket games, Boddle quests, computer games and other OER to help teach a variety of concepts. With Classkick, Google Classroom, Boddle, and Blooket as well as many other programs, students are never short on activity to complete.</p> <p>NOTE: The Place Value unit within the 4A Math Google Classroom satisfied LDT 832’s final project requirement and was peer-reviewed by Dr. Jaclyn Dudek.</p> |
| <p>Multiple Means of Engagement</p> | <p>By using Blooket, Boddle, and Classkick, I’m able to provide students with learning experiences that give them instantaneous,</p> |

Provide Options for Self Regulation

- [Promote expectations and beliefs that optimize motivation \(checkpoint 9.1\)](#)
- [Develop self-assessment and reflection \(checkpoint 9.3\)](#)

immediate, and corrective feedback by the use of technology.

With Bloocket, I load the game with predetermined multiple-choice questions aligned to specific concepts. These questions and their content are directly related to whatever learning goal students are currently working towards. With these locked and loaded questions and a link, students are able to quiz themselves and their understanding of the material countless amounts of times. Students are immediately notified of correct and incorrect answers. Questions are recycled through, and pop up again. At the end, students are provided with a detailed report of their performance, and the teacher receives analytical data too.

With Boddle, the program comes preloaded with their own question banks directly aligned with Common Core Math Standards and other state standards. There are slight disparities between PA Core and Common Core, but most standards overlap and compliment each other well. The teacher creates assignments linked to the standards, and students interact with questions assigned to that standard. Again, the computer optimizes the feedback aspect. Students are immediately notified if they're correct or incorrect through animation. Boddle tracks this data, and provides it to the teacher on the backend.

Again, with Classkick the teacher can code boxes beforehand to accept recognizable short answer solutions. With this tool's capability and the change of a quick toggle button, students are able to self- assess themselves by the color of the box. This tool came in handy for students practicing multi-digit addition or subtraction. Rather than waiting for teacher feedback and building misconceptions, the immediate feedback slyly keeps students motivated and engaged to earn classwork points. Students don't want to feel like they don't know what they're supposed to be able to do, and if they're consistently answering questions incorrectly, they're likely to seek help to clarify misconceptions.

Technology that provides students with immediate, instantaneous and corrective feedback leads students to self-reflect and self-assess their own progress and understanding at a rate much faster than teachers are able to provide by grading papers.

Boddle's gamified aspects include that of digital badging, coin rewards, and creating a customizable avatar. Assignments that teachers assign appear to students as "Quests." Students are thrust into a little micro-world where they're answering math questions to earn coins, and then spending those coins on cosmetic items for the

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| | <p>avatar, or spent in the arcade with bonus games. These digital badges nudge students in the way of going back for more. By using self-guided assessment for learning, students are taking ownership over their own learning and are encouraged to self-regulate. By promoting agency in class, I'm working towards developing self-aware and autonomous learners.</p> |
| <p>Multiple Means of Representation</p> <p>Provide options for Language & Symbols</p> <p><input type="checkbox"/> Illustrate through multiple media (checkpoint 2.5)</p> | <p>By utilizing multiple medias, teachers take the burden of acting as the all-knowing keeper of information off their shoulders. Instead, they should focus part of their efforts on curating strong media as a means for students to engage in Absorb activities. Rather than providing one static means to teach a concept, a learning designer will provide as many options as possible to communicate the same information...a buffet-style of choices as opposed to only black coffee.</p> <p>UDL Guidelines call for alternative forms such as illustrations, dances, diagrams, tables, models, videos, comic strips, storyboard, photographs, animations, and physical/virtual manipulatives. (CAST 2018). Horton's list of common absorb activities include "presentations, readings, stories by a teacher, and field trips." (Horton, pg 68). Not all of these suggestions are necessary for every skill, but sprinkling a few onto the LMS helps to diversify how students acquire knowledge.</p> |
| <p>Multiple Means of Representation</p> <p>Provide Options for Comprehension</p> <p><input type="checkbox"/> Guide Information processing and visualization</p> | <p>The idea of using videos in class isn't necessarily new or groundbreaking. But the affordances of Edpuzzle to move static videos towards more interactive ones sets it apart. With Edpuzzle, instructors can find or upload their own video and then embed questions directly into it. Students are not able to skip ahead in the videos until the questions have been answered. Multiple choice and short-answer questions can be embedded and the program can automatically grade multiple-choice questions for the teacher. The teacher decides if they prefer students to watch the video and answer questions on their own and at the own pace, or if the teacher wants to utilize "Live Mode" to display the video and have questions pop up on student devices with live feedback.</p> <p>Edpuzzle videos are easily implementable for a range of grade level and concepts across the K-12 spectrum, Edpuzzle also boasts its own growing library of original videos that explicitly teach grade-specific content .</p> <p>Professionally designed interactive videos encapsulate various different learning theories including self-regulated learning, learner-centered environments, opportunities for self-reflection,</p> |

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| | <p>metacognition, agency, immediate and instantaneous feedback, and others. Strategically made Edpuzzle videos aligned to standards and learning goals can serve as valuable learning experiences for students and data-piece for teachers. On the backend, Edpuzzle collects detailed analytical data such as percentage of video watched, correct/incorrect multiple choice responses, and student responses for short answer questions. The teacher then uses this formative data piece to help drive their instruction.</p> |
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IV. Graphics

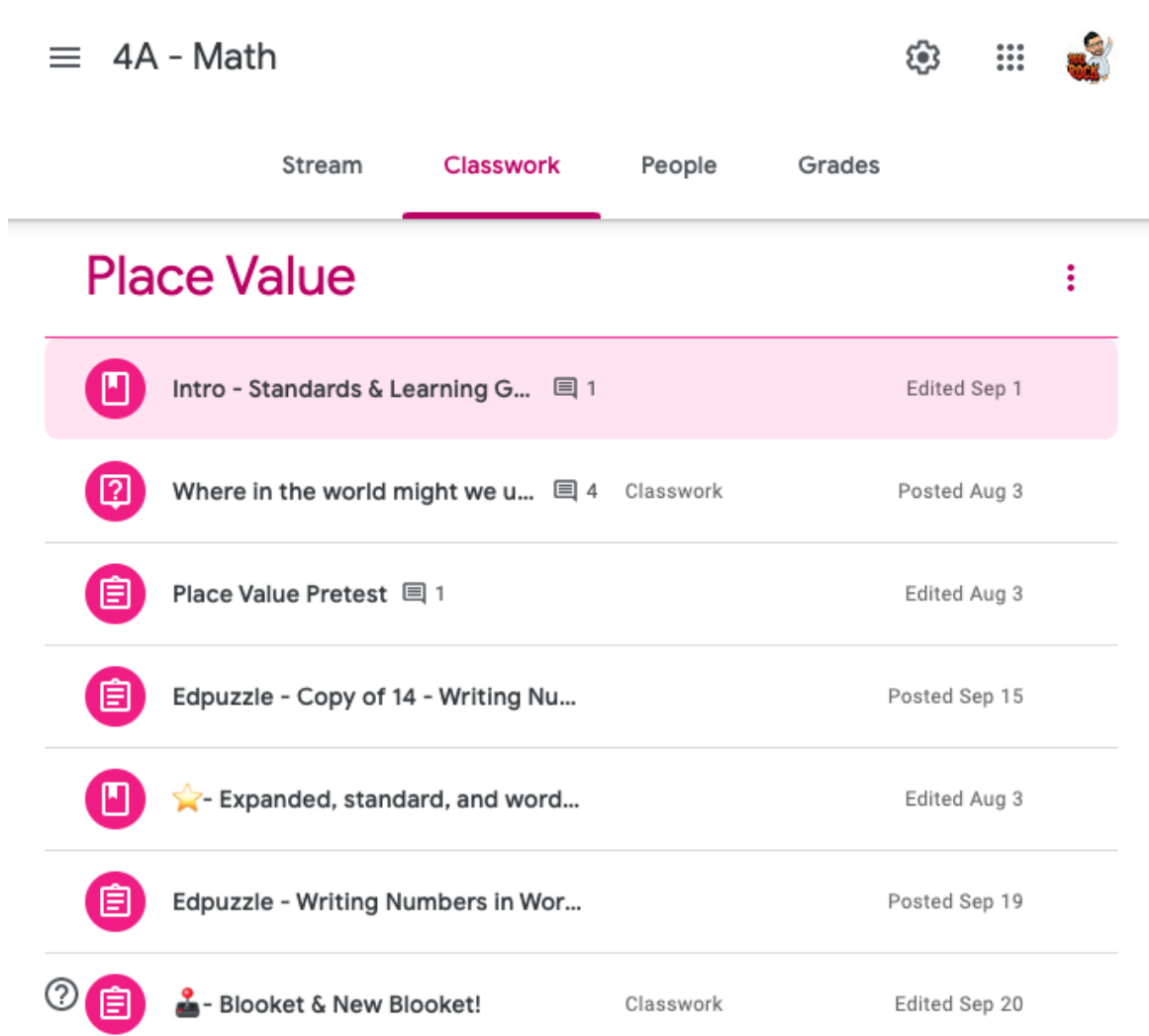


Figure 1: Unit Design in LMS - Place Value

4A - Math

Stream **Classwork** People Grades

Subtraction

- AnswerGarden - What is Subtraction... Posted Nov 7
- LIVE MODE! - Edpuzzle - Subtraction wit... Classwork Edited Nov 7
- You Do - Edpuzzle - Subtraction with Re... Classwork Due Nov 10, 3:00 PM
- LIVE MODE - Edpuzzle - Subtracting acr... Classwork Edited Nov 7
- You do! - Edpuzzle - Subtracting Across ... Classwork Due Nov 12, 3:00 PM
- Edpuzzle - Key Words in Addition and Su... Posted Nov 14
- ★★★★- Subtraction Classkick Classwork Edited Nov 7

Figure 2: Unit design in LMS - Subtraction

4A - Math

Stream **Classwork** People Grades

Geometry

- Must Do's and Can Do's Edited Nov 23
- Edpuzzle - 4th Grade Geometry Review Posted Nov 22
- 😊- Lessons 1 & 2 Help Videos Edited Nov 23
- ✍️ - NUMBEROCK & Khan Academy Vide... Edited Nov 23
- Edpuzzle - Classifying Angles Posted Nov 23
- 📄 Geometry Classkick Classwork Posted Nov 23
- 🎯- Geometry BLOOKET Edited Nov 23
- Measuring Angles Practice Posted Dec 7

Figure 3: Unit Design in LMS - Geometry

bc Library

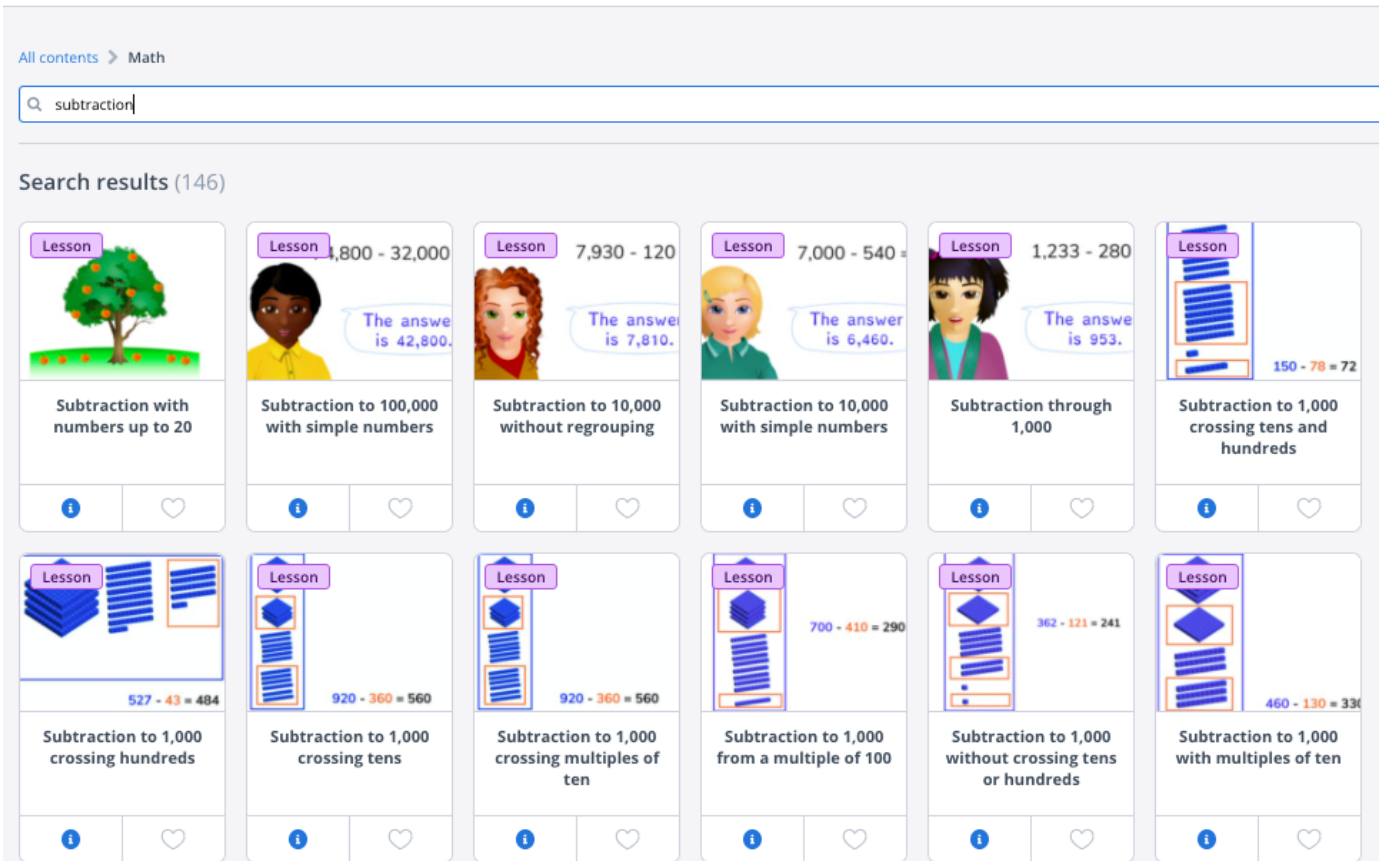


Figure 4: Gynzy library of subtraction-based slide decks.

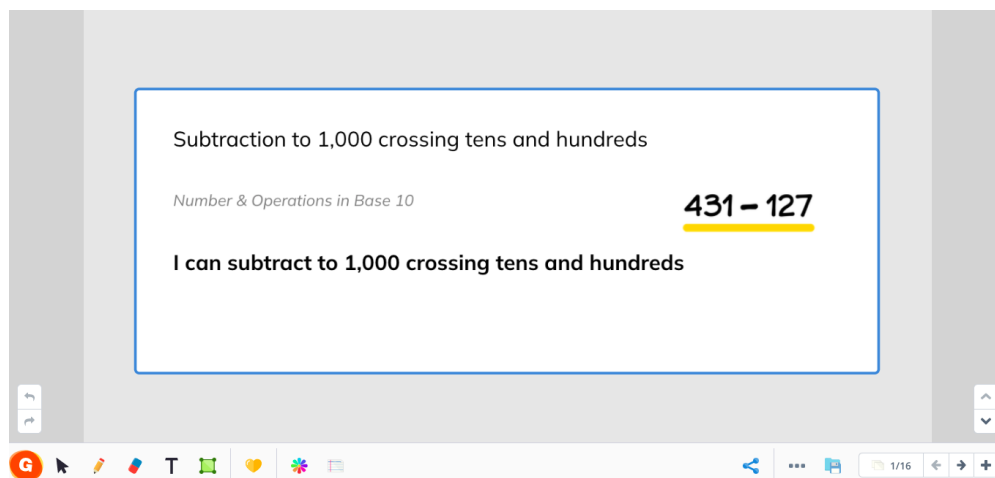


Figure 5: Professionally created slide decks from Gynzy with an upfront learning objective. Subsequent slides gradually build background knowledge and work towards developing new understandings. Slides are linkable to Google Classroom with an easy copy and paste.

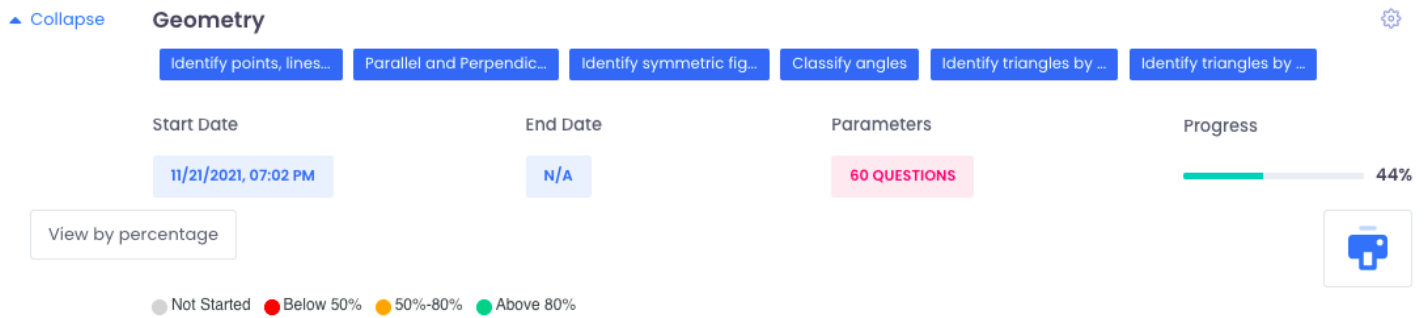


Figure 6: A Boddle Quest containing 6 skills all linked to Pennsylvania Core Math Standards and eligible content. Mastering these concept satisfies the standard and student learning goals. Students have 60 possible questions to demonstrate mastery with adaptive and automated question release to support student needs.

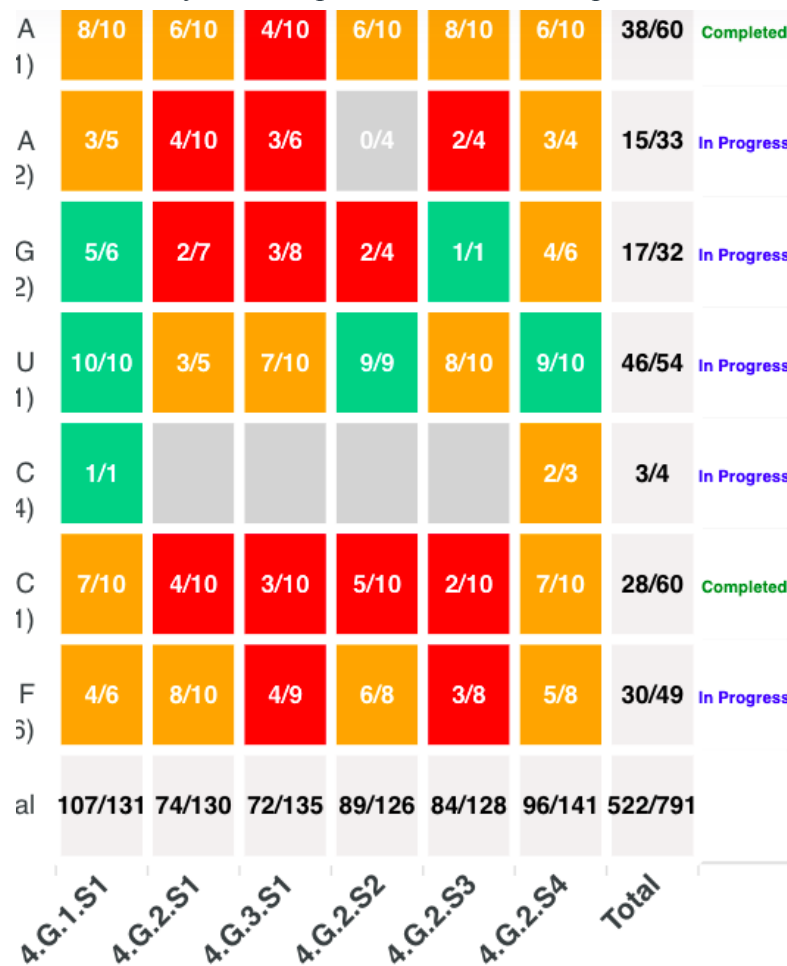
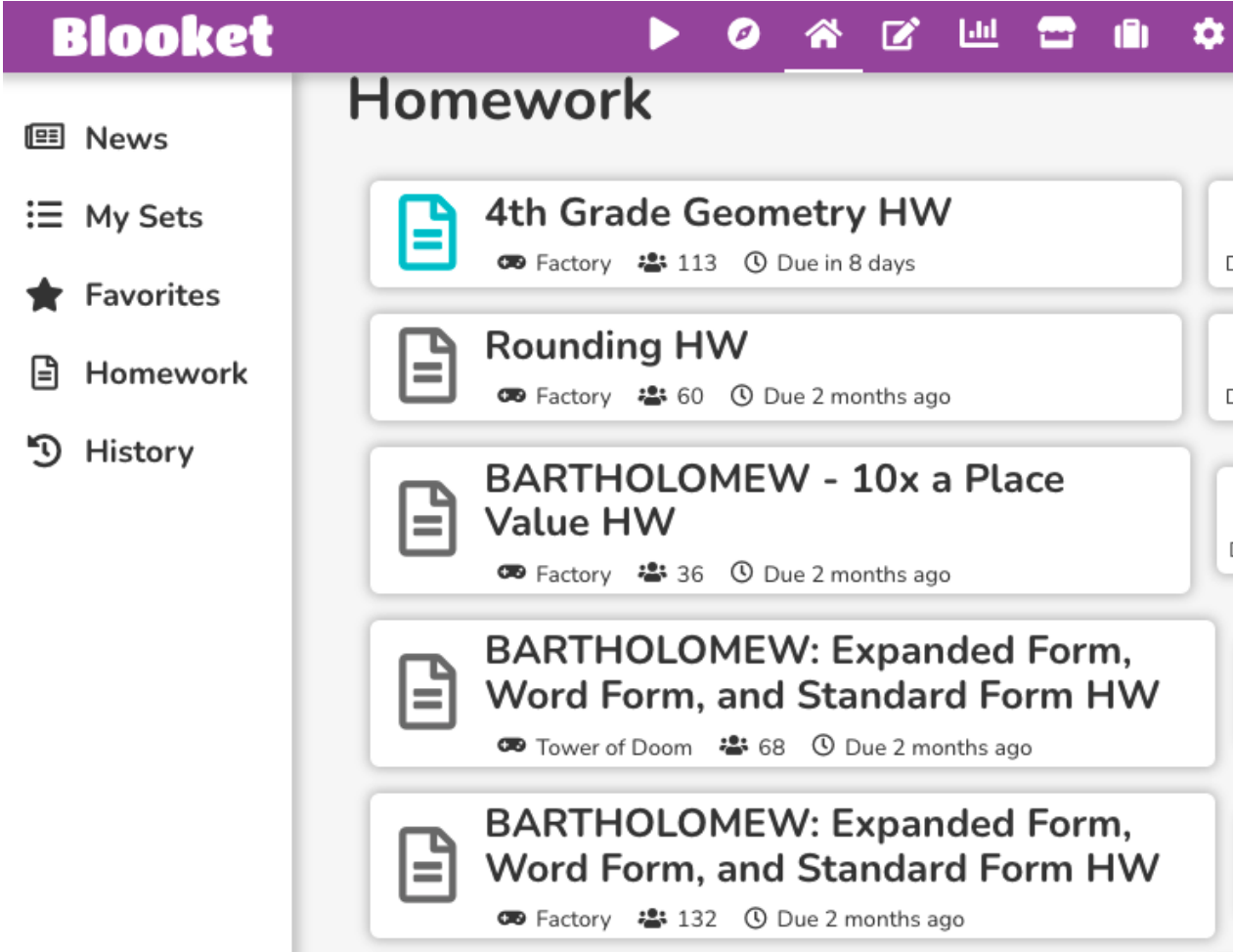


Figure 7: This graph from Boddle highlights student progression on the geometry skills assigned in Figure 6.



The screenshot shows the Blooket interface with a purple header bar containing the logo and navigation icons. A left sidebar lists 'News', 'My Sets', 'Favorites', 'Homework', and 'History'. The main area is titled 'Homework' and displays a list of assignments:

- 4th Grade Geometry HW**: Factory, 113 players, Due in 8 days.
- Rounding HW**: Factory, 60 players, Due 2 months ago.
- BARTHOLOMEW - 10x a Place Value HW**: Factory, 36 players, Due 2 months ago.
- BARTHOLOMEW: Expanded Form, Word Form, and Standard Form HW**: Tower of Doom, 68 players, Due 2 months ago.
- BARTHOLOMEW: Expanded Form, Word Form, and Standard Form HW**: Factory, 132 players, Due 2 months ago.

Figure 8: Blookets can be assigned asynchronously with a link to the LMS. Find or create your own game relevant to learning objectives, and allow students to play as they wish. This is a perfect “Can Do” activity that builds a community of players among classmates.

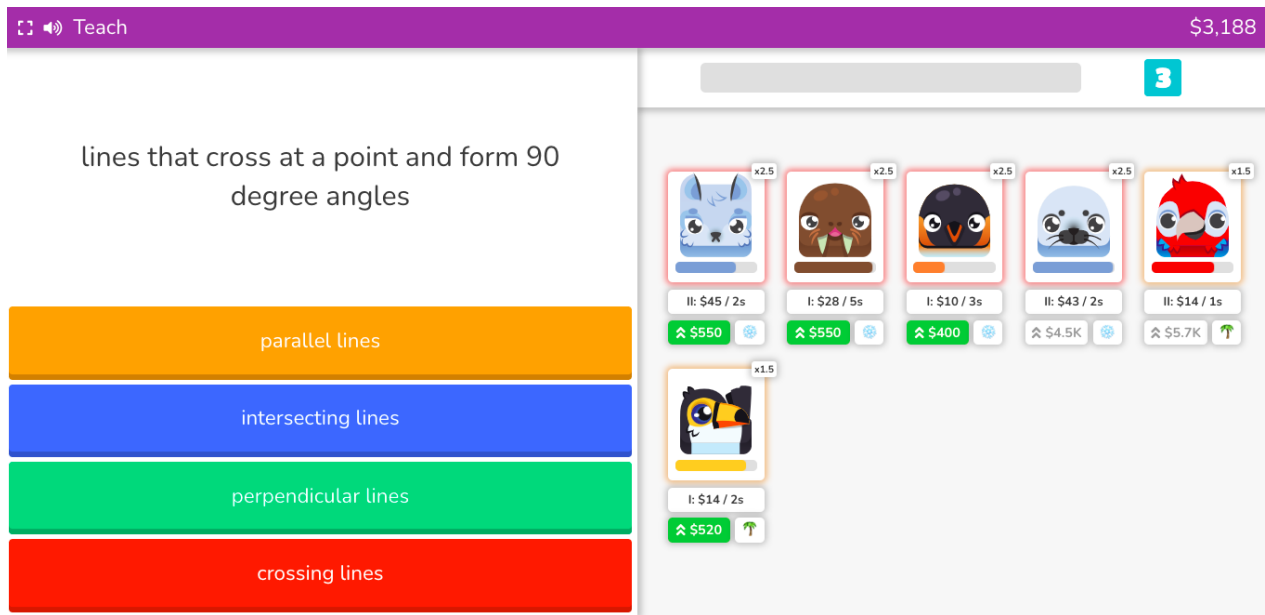


Figure 9: In Factory, students work to answer questions correctly and earn blocks that earn the player money over time. Students are motivated to answer questions rapidly to acquire more blocks and upgrade the existing ones for more money. BlooKet’s fast-paced, competitive, motivating gameplay has students eager to play.

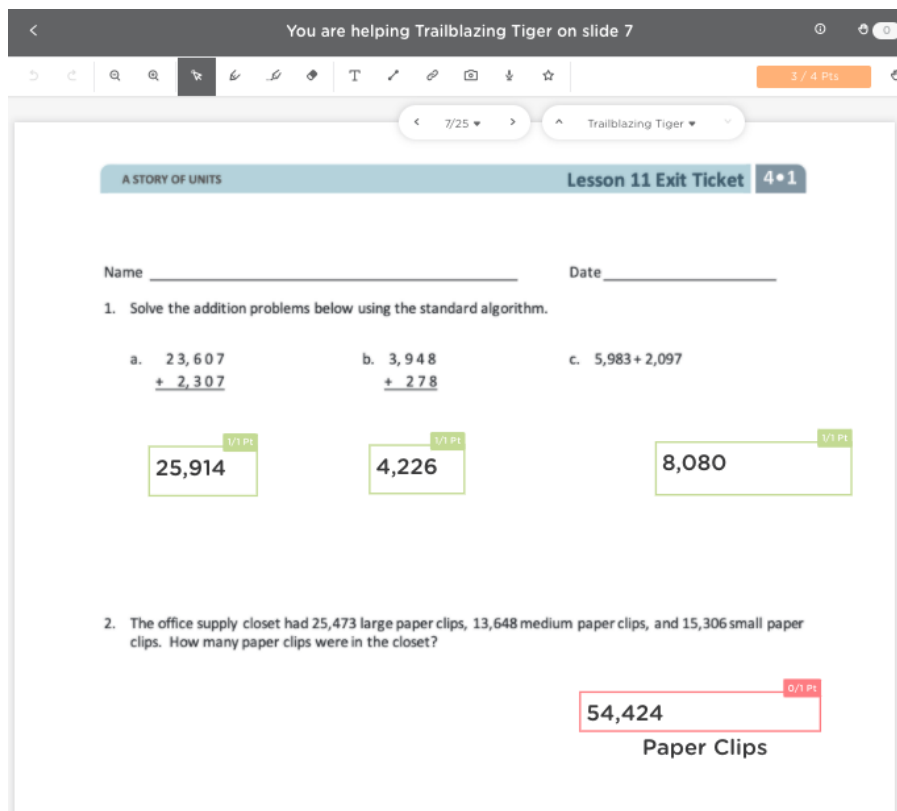


Figure 10: A Classkick slide designed to accept specific short answer responses. This student shows competency in rote arithmetic, but failed to answer the word problem correctly.

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