Education Perfect Evidence Portfolio: A Literature Review on Foundational Research

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Introduction

This evidence portfolio summarizes the foundational research literature that serves as the empirical basis for Education Perfect. Education Perfect (EP) is a comprehensive digital learning platform (DLP) that provides a full suite of instructional materials and resources for primary and secondary school teachers. Among these resources, EP provides full lesson and unit plans for delivering standards-based content for teachers of every core subject area (language arts, mathematics, social studies, and science) and grade level, a variety of digitized instructional tools aimed at enhancing and differentiating instruction, and in-depth formative assessment tools that allow for highly adaptive practice and personalized teaching to students. As highlighted by the program's developers:

> "Education Perfect (EP) is a leading digital learning platform with product and learning design drawn from evidence-based research into best practice and a user experience informed by teacher and student feedback. EP offers a comprehensive toolkit across a broad range of subjects, including pre-crafted curriculum content, extensive digital instruction tools, an engaging and adaptive learning experience, intelligent assessment tools, and rich data insights." (Education Perfect, 2022)

The instructional materials and resources available through Education Perfect, as well as the overarching design and structure of the EP digital learning platform, borrow from a variety of key pedagogical frameworks in the field of education. Bloom's Taxonomy, Rosenshine's Principles of Instruction, and Black and William's Assessment for Learning framework all play significant roles in informing EP's structure and content. In terms of Bloom's Taxonomy, EP seeks to provide teachers with scaffolded resources that allow students to develop skills and abilities in a complementary manner. Students first work through activities that ask them to remember and understand and then progress to application and analysis activities before concluding with tasks that challenge their evaluative thinking and creative skills (Education Perfect, 2022). Building on this foundation, Rosenshine's Principles of Instruction, including sequencing and modeling of concepts, questioning, scaffolded practice, and review, are then integrated throughout the instructional content delivered through the EP DLP. As it pertains to these areas:

- EP Lessons are broken into small chunks, with instructional material supported by images, videos, and worked examples.
- Frequent checks for understanding are interspersed with instructional material, ensuring students grasp the material before introducing additional information or difficulty.
- Every question has a model answer, and where possible, answers are automatically marked. Mistakes and misconceptions are uncovered immediately, and students progress only once mastery of a set of questions has been achieved.
- EP provides students with a revision game (Dash) once a lesson is completed and provides a gamified review of the material. Through the game, rewards are unlocked in a spaced manner in subsequent days and weeks, providing a pathway to ensure mastery is achieved. (Education Perfect, 2022).

Throughout this instructional process, EP provides teachers with rich formative assessment options that allow for highly data-informed instruction. Each Education Perfect lesson, regardless of content or grade level, adapts to each student's individual progress and assessment data and creates a personalized instructional pathway based on areas of strength and weakness.

In the context of these overarching features, this evidence portfolio seeks to summarize the research that forms the foundation of the Education Perfect theory of action and documents the research support for the primary components embedded within this DLP. This research was conducted by Johns Hopkins University's Center for Research and Reform in Education after consulting with the Education Perfect product team and reviewing the program's instructional materials. In specific, this document aims to summarize the contemporary research related to *eight key areas of instructional emphasis* within the Education Perfect DLP. These include:

- Explicit instruction
- Differentiation
- Adaptive practice
- Gamification
- Timely and specific feedback
- Mastery-based progression
- Formative assessment
- Spaced repetition

In separate sections, we provide an overview of the extant research literature on each of these topics, including the ways that these pedagogical features can be leveraged to the greatest effect on student learning. As appropriate, commentary is also provided discussing the ways in which Education Perfect seeks to leverage best practices in each of these areas, as well as other areas where programming may benefit from refinement. Conclusions and recommendations for future research directions are then provided at the close of this document.

Literature Review: Foundational Research Underlying Education Perfect

Building on the program's theory of action, the following sections summarize the foundational research that serves as the empirical basis for the Education Perfect DLP. Broadly, these sections seek to provide an overview of the research germane to the eight primary instructional components of Education Perfect: explicit instruction, differentiation, adaptive practice, game-based learning, formative assessment, student feedback, mastery-based learning, and spaced repetition of practice and review. Conclusions and recommendations for future research directions are provided at the close of these sections.

Explicit Instruction and Mastery-Based Learning

To begin, explicit instruction and mastery-based learning represent two pedagogical approaches that are heavily emphasized in the Education Perfect DLP. In tandem, these two frameworks ultimately serve as the foundation in which content and skills-based instruction is organized and delivered through EP lessons and units – regardless of subject area or grade level. In both cases, a wide variety of research dating back many decades demonstrates the utility of these approaches in fostering student learning (Marin & Halpern, 2011; Reutzel, Child, Jones, & Clark, 2014; Hughes, Morris, Therrien, & Benson, 2017; Anderson, 1994; Kulik, Kulik, & Bangert-Drowns, 1990).

As it relates to explicit instruction, research has shown rather consistently that instructional techniques falling within this umbrella can be effective at enhancing student learning outcomes across a wide variety of subject areas, including language arts (Reutzel, Child, Jones, & Clark, 2014; Hughes, Morris, Therrien, & Benson, 2017) and mathematics (Darch, Gerten, & Gerten, 1984; Hughes, Morris, Therrien, & Benson, 2017), as well as in a variety of general academic skills including critical-thinking, problem-solving (Marin & Halpern, 2011; Bangert-Drowns & Bankert, 1990), and writing (Hughes, Morris, Therrien, & Benson, 2017). As described by Torgesen (2004), explicit instruction is "instruction that does not leave anything to chance and does not make assumptions about skills and knowledge that children will acquire on their own." Though a variety of instructional models adhere to the principles of explicit instruction in slightly differing ways, this approach consistently involves five key components (Hughes, Morris, Therrien, & Benson, 2017):

- Segmenting complex tasks into smaller "chunks"
- Drawing student attention to important features of the content through modeling and think-alouds
- Utilizing guided practice and scaffolding to gradually develop independence in students with completing tasks
- Providing opportunities for students to receive feedback and respond
- Creating purposeful practice opportunities

By incorporating these collective features, it appears that explicit forms of instruction may be especially effective at reducing cognitive load, as well as the resulting stress this can place on the working memory of learners (Clark, Kirschner, & Sweller, 2012; Smith, Saez, & Doabler, 2016). Thus, this approach can be particularly effective for students who lack background knowledge and/or automaticity in recalling prerequisite knowledge and skills related to what is being taught (Reutzel, Child, Jones, & Clark, 2014). Research has shown that explicit instruction can be a highly effective means of teaching specific thinking strategies and skills, linear progressions of multiple strategies, and processes that involve multiple steps (Reutzel, Child, Jones, & Clark, 2014; Gersten, Fuchs, Williams, & Baker, 2001; Pearson & Dole, 1987). In light of these trends, it is perhaps not surprising that research has also consistently demonstrated the effectiveness of this approach as a guiding pedagogical foundation for instruction in math, reading, and writing (Reutzel, Child, Jones, & Clark, 2014; Graham & Harris, 2009; Graham, McKeown, Kiuhara, & Harris, 2012; Kroesbergen & Van Luit, 2003; Solis et al., 2012; Swanson, 2001; Vaughn et al., 2000).

Within the context of this overarching instructional framework, Education Perfect also heavily emphasizes a mastery-based learning approach. Mastery-based learning refers to an instructional approach where students have to exhibit a certain threshold of competence with a task before moving on to the next. In contrast with more traditional forms of instruction where all students are provided the same amount of time to achieve competence with a given skill before the teacher moves to the next topic, in mastery-based approaches, each student continues to spend time on a skill until they achieve proficiency (Dick & Reiser, 1989). This approach first gained prominence in the 1960s and, in the years since has become one of the most thoroughly researched instructional techniques in the field of education (Anderson, 1994; Saphier, Haley-Speca, & Gower, 2008).

Broadly, the goal of mastery-based learning is to develop students' automaticity with basic subskills that make up larger, more complicated tasks (Brandt, 1998; Marzano, Pickering, & Pollack, 2001). When automaticity is developed with a skill or concept, students can utilize it with little or no conscious thought, thus placing minimal strain on working memory (Marzano, Pickering, & Pollack, 2001). Put differently, by mastering the foundational "subskills" that makeup more complicated tasks, students are better able to learn more complex skills because they are able to focus their attention exclusively on the more advanced portions of the task while not extending their attention to the foundational pieces.

A bevy of research has demonstrated the positive impacts the use of mastery-learning techniques can have on students (Anderson, 1994; Kulik, Kulik, & Bangert-Drowns, 1990). Research has found that students taught through mastery-learning are often more satisfied with the instruction they receive and have more positive attitudes towards the content they are taught compared to students taught through other methods (Anderson, 1994; Kulik, Kulik, & Bangert-Drowns, 1990). The approach has been found to improve students' academic self-concept (Anderson, 1994; Guskey & Pigot, 1988), proclivity to stay "on-task" (Anderson, 1994; Duby, 1981), and has also been found to engrain students with certain aspects of growth mindset (Anderson, 1994; Duby, 1981; Dweck, 2006). When utilized in a whole-class setting, this approach has been found to help decrease the amount of variability in aptitude between students (Anderson, 1994; Kulik, Kulik, & Bangert-Drowns, 1990). Given these benefits, it is perhaps not surprising that mastery-based approaches to instruction have been found to substantially enhance students' ability to retain their learning long-term (Kulik, Kulik, & Bangert-Drowns, 1990).

As it pertains to explicit instruction and mastery-based learning, Education Perfect incorporates a variety of key strategies. EP lessons begin with an introduction section that provides learning objectives outlining to students what they will be learning. New information is presented in small chunks, with supporting images, audio, and videos, to ensure that learning is multi-modal and differentiated. Worked examples are incorporated throughout each lesson and are followed by systematically scaffolded questions for students to complete. Questions are automatically graded through the DL platform, and students are presented with model answers and specific explanations. Once a set of information and questions has been mastered by students, new material is introduced, and the process is repeated. Throughout this process, interleaving strategies, as well as questioning and feedback strategies, are provided. Lessons then conclude with a review of the content covered in relation to the period's learning objectives (Education Perfect, 2022).

Pertaining to mastery-based learning specifically, EP lessons are scaffolded, and content is strategically chunked. Instructional material is interwoven with questioning, and students are provided with immediate targeted feedback through the DLP portal. If a student answers formative assessment questions incorrectly, then the question and feedback cycle continues until mastery is established. As further summarized by the program's developers:

> "Supporting this focus on mastery, completing an EP lesson requires a student to answer every question correctly eventually. Alongside the student completion measures, our learning analytics monitors time spent and records student responses, including specific errors or areas of difficulty. This enables the teacher to provide targeted support to students that need it, further enabling mastery of the learning material by every student." (Education Perfect, 2022)

Deliberate Practice and Spaced Repetition

Within this broader context of mastery-based learning, research points strongly to the importance of practice and repetition as it relates to skill development and learning. In particular, research highlights the value of deliberate and adaptive forms of practice, as well as spaced repetition of review, as mechanisms that can and should be incorporated within mastery-learning environments to enhance student success. Indeed, to become an expert in any content area, it has been suggested that it takes at least 10,000 hours of practice (Ericsson, 2008). Beyond this, however, researchers argue that deliberate practice (DP) of specific tasks is necessary and that expert performance does not rely solely on practice of specific tasks but on the "intentional modifications and adjustments" to make this practice increasingly more difficult (Ericsson, 2006). Failure to do so, in fact, may result in an unchanging plateau of skill level. Ericsson (2008) analogizes this to a child playing a sport or a musical instrument; after extensive practice, most children will become adept at a given skill, but the children with potential to become experts in these areas might be encouraged to seek out more professionalized coaching "to reach a higher target performance, which had been previously outside the range of their performance ability." Deliberate practice must be designed to become increasingly difficult for the learner, and this requires nimble responsiveness from an adaptive program.

Tabibian et al., (2019) argue that optimal learning is derived not from randomly spaced and deliberate practice but from a carefully curated algorithm that adapts to the individual learner and his or her ability. This algorithmic model (titled MEMORIZE) accounts for learner forgetfulness and the probability of mistake-making and suggests that the most beneficial review schedule varies by learner and is adjusted for learner performance. In other words, an adaptive learning approach to practice can be more effective than a seemingly random practice, especially when the adaptive learning is differentiated and is increasingly more difficult over time. Or, as stated by Ericsson et al. (2007), "It is only by working at what you can't do that you turn into the expert you want to become." Answering fewer, more difficult questions is more effective than answering many, shallow questions that require memory retrieval but are not challenging (Becker-Blease & Bostwick, 2016).

Studies have shown that adaptive practice in quizzing and on practice tests has led to more positive effects on learning outcomes (Greving et al., 2020; Heitmann et al., 2018; Heitmann et al., 2021). Additionally, the deliberate practice of material over time in conjunction with the adaptiveness of the program to present appropriately difficult practice questions has been shown to reduce extraneous cognitive load and increase motivation for the learner (Heitmann et al., 2021). The effectiveness of deliberate practice on any skill is intensified by using adaptive questioning that is responsive to the learner's understanding and ability and achieves the delicate balance of rigor.

Building on these findings, repetitive practice has been shown to be essential for increasing the learning performance of any skill in any subject area. This concept is widely understood and often echoed in the refrain, "Practice makes perfect." Indeed, practice has been shown to be even more effective when it is spaced out or distributed. In educational studies, researchers use the terms "spaced practice" and "distributed practice" to refer to a "repeated encounter" with instructional content that is deliberately spaced out temporally between interactions (Kang, 2016). The result is an efficient memorization technique that concretizes the material for the learner over a series of repeated practice. An authentic example of spaced practice would include an elementary school student using flash cards or an online program to memorize the multiplication table, where the learner repeatedly – and over time – revisits the math facts to re-activate and recall the knowledge in order to strengthen and expedite the retrieval process. In other words, the repeated practice of recalling multiplication facts over time solidifies the learning and becomes quicker and more automatic.

Kim and Webb (2022) performed a meta-analysis of studies related to spaced and distributed practice and identified several heuristics for optimal learning conditions. Importantly, repetitive spaced practice yields the largest gains in learning on tasks with low-complexity (like declarative knowledge in mathematics and language-learning) compared to high-complexity tasks (like grammatical rules and pronunciation). Other variables also contributed to the effectiveness of the spaced practice technique, including learner characteristics, activity types, and feedback (Kim & Webb, 2022). Regarding feedback, Nakata (2015a) found a positive effect for "expanding spacing" between instances of providing feedback, where the learner experiences progressively longer spacing between receiving performance feedback. Nakata (2015b) also studied the differences between providing immediate and delayed feedback on learner performance, where feedback was either provided immediately after each repeated practice (immediate) or at the conclusion of the repeated practice (delayed) but found no clear advantage for either condition.

Relatedly, the meta-analysis could not conclude an optimal number of repeated practice sessions for effective learning.

Researchers also have studied the effects of spaced practice on learner confidence. Emeny et al. (2021) examined the spacing effect on mathematics, specifically, and found that when practice is distributed over time, learner achievement scores improved and learner calibration (the ability to accurately predict performance on a test) was more accurate, compared to learners who did not space out their mathematics practice sessions. Notably, “massed practice”, which is the opposite of spaced practice, actually yielded overconfident learners, whereas those who engaged in repetitive, spaced practice were more attuned to their understanding of the material (Emeny et al., 2021).

Collectively, research indicates that spaced or distributed practice over time benefits learning in several ways, but there are some caveats for its use. Spaced practice is most beneficial when it centers on low-complexity tasks, uses expanded spacing over time, and provides performance feedback to the learner. To increase its effectiveness, spaced practice also should account for learner differences and performance, which might be accomplished best through adaptive learning.

As it relates to these strategies, Education Perfect seeks to include a variety of features aimed at providing opportunities for student practice and skill repetition. During Education Perfect lessons, students complete questions that build from simple recall and comprehension of newly presented material through scaffolded practice. As students engage in these activities, they are provided with immediate and detailed feedback through the DLP portal. Subsequent questions dynamically adjust so that students are provided variants that build toward mastery. Through the program’s “Quiz Tool” students receive additional targeted practice questions that are responsive to student answers and provide additional scaffolds that aim to help build fluency and automaticity with the content at hand. As it pertains to repetition of these practices, the program incorporates additional components – including its “Dash Review Game” and other game-based learning features -- that encourage the spaced review of the learning material that has been covered in earlier curricular units (Education Perfect, 2022).

Differentiation and Gamification

Within the broader context of this explicit, mastery-based learning framework, the Education Perfect DLP seeks to provide a variety of instructional tools to enable teachers to build student engagement and better reach diverse groups of learners. In particular, a bevy of EP resources are available for teachers to provide differentiated instruction to students, as well as provide opportunities for students to engage in game-based learning.

A variety of research has explored the ways that instructional strategies related to differentiation and gamification can impact student engagement and learning. Engagement-oriented program features such as these are indeed important. Research has consistently found that students who are interested in a task or activities engage longer, demonstrate greater effort, and demonstrate more productive learning behaviors, including self-regulation and problem-solving, as well as better learning outcomes than those experiencing less engagement (Lipstein &

Renninger, 2006; Harackiewicz et al., 2008; Renninger & Hidi, 2002; Renninger & Shumar, 2002). As it relates to digital learning curricula such as those supplied through Education Perfect, research actually points to features in these areas being among the most immediate advantages that these programs can have over more analog forms of instruction. Indeed, one facet that differentiates blended learning from traditional forms of instruction is the flexibility that digital modes have with regard to presentation. A key advantage of digital forms of curricula is that they are not bound by some of the inherent limitations of print-based materials, as digitized versions can offer options for interactive presentations, videos, audio, and other multi-modal means of teaching (Clark, 2002; Sankey, Birch, & Gardiner, 2010). Much research points to the value of teachers leveraging features such as these. Research on pedagogical approaches such as differentiated instruction (Tomlinson et al., 2003) and Universal Design for Learning (Rappolt-Schlichtmann, Daley, & Rose, 2012; Rose, Meyer, & Hitchcock, 2005) have demonstrated the utility of using strategic, multi-modal types of teaching. The positive impact of differentiated instruction on student learning is well-established in education science (Chamberlin & Power, 2010; Firmender, Reis, & Sweeny, 2013; Tomlinson et al., 2003; Tulbure, 2011; Johnsen, 2003). Students benefit, in terms of both engagement and achievement, from receiving content that is tailored to their skills, interests, and needs. Moreover, a growing body of literature has found support for an instructional approach that differentiates modes of instructional presentation, provides multiple entry points for students to engage with content, and is flexible in terms of how students demonstrate learning (Rappolt-Schlichtmann, Daley, & Rose, 2012; Rose, Meyer, & Hitchcock, 2005). The use of non-linguistic representations of information, whether they be through images, graphic organizers, or videos, have long been found to be an effective means of helping students to form a deeper understanding of concepts as well (Beesley & Apthorp, 2010; Dean, Hubbell, Pitler, & Stone, 2012; Marzano, 2007; Medina, 2008). Importantly, the affordances of instructional technology facilitated through programs like Education Perfect appear to make flexible, multi-modal forms of teaching such as these easier and more robust (Dean, Hubbell, Pitler, & Stone, 2012; Sankey, Birch, & Gardiner, 2010) thus saving teachers valuable time that can instead be spent on other instructional behaviors (Hunter, Jordanna, Sonneman, & Joiner, 2022). In addition to enabling content to better adapt to student's individual needs and performance, digitized instructional features can help teachers distribute differentiated content quickly and discreetly to students. This may include differentiated problem sets and instructional activities, as well as opportunities for small group instruction and individualized tutoring.

Within this broader context of differentiated forms of instruction, a fast-growing body of research has demonstrated the effectiveness and benefits of game-based learning (Budhai & Skipwith, 2017; Connelly et al., 2012; Hamari et al., 2016). In fact, recent research has found that educational video games can be an effective means of increasing engagement in learning, can facilitate deep immersion or “flow states” with an instructional activity, and can enhance both learning outcomes and long-term interest in the subject matter at hand (Hamari et al., 2016). Additional research suggests that game-based learning can indirectly cultivate skills such as problem-solving, lateral thinking, and concentration (Budhai & Skipwith, 2017). Other research points to the particular value of game-based learning that integrates specific reward mechanisms and allows for collaboration with peers, as these features have been shown to enhance students’ persistence with solving problems and propensity to engage in other learning driven behaviors (Sailer & Homner, 2020; Clark et al., 2016; Sun, Chen, & Chu, 2018). Of particular note, burgeoning research suggests that many of the features of effective games overlap with the features of effective instructional experiences:

> "In an ideal educational game setting, students learn how to solve complex problems. The problems within a game typically start off easy and then progressively become more difficult as players' skills develop. Players are motivated to learn, in part because learning is situated and occurs through a process of hypothesizing, probing, and reflecting upon the simulated world within the game. In addition, the goals are clear, and information becomes available to players at just the time that it is needed to reach each goal. Making sense of that information becomes a goal intrinsic to gameplay." (Hamari et al., 2016)

In light of these research findings, differentiated instruction, as well as that which incorporates elements of game-based learning, can certainly serve as a beneficial component within a broader digital curriculum. In this vein, Education Perfect appears to incorporate a variety of features and components in service of these particular instructional strategies. As outlined by Education Perfect (2022):

> "EP provides several efficient methods for targeting learning material to individual student needs. Teachers can assign lessons to different groups or individuals within a class and can easily assign specific sections of lessons to target specific skills or difficulty levels better. Teachers can also customise resources or create their own using EP's integrated content editing features, providing further tailoring to meet the unique needs of their students….In addition to tailoring and targeting learning material, teachers can use EP's assessment functionality to identify student strengths and weaknesses, and automatically generate recommended next steps to create a unique learning pathway for each student."

In addition to these features for differentiation, Education Perfect incorporates a variety of key gamification elements designed to enhance student engagement. Of note, in completing EP lesson activities, each question answered correctly earns students a "point," contributing to their annual score and placing them on a scoreboard alongside their classmates as well as those from across their school. Students can earn points through effort-based (as opposed to performance-based) activities as well, and can also earn various stickers, certificates, badges, and other prizes through the program by completing EP lessons. This "points" system serves as the basis for annual competitions that Education Perfect hosts where students and schools can compete against other EP users worldwide (Education Perfect, 2022).

Formative Assessment: Timely and Specific Feedback

As a final key component of the Education Perfect theory of action, the program utilizes an explicit formative assessment cycle that serves to inform instruction and aims to drive the student learning experience. Education research has consistently demonstrated the value of formative assessment, and more specifically, the ongoing feedback it elicits for students, as highly influential drivers of learning. Assessment, particularly ongoing formative types of assessment, has been found to be a crucial feature in predicting the success of individualized learning environments (Lee, 2014). Ideally, assessments should be criterion- as opposed to norm-referenced (Lee, 2014), should be tied to student learning goals, and should be based on well-communicated performance standards (Saphier, Haley-Speca, & Gower, 2008). Perhaps most importantly, assessments need to be leveraged in a way that fosters feedback and helps modify student learning. Frequent error analysis on behalf of the teacher, as well as self-analysis of errors on behalf of the student, are important components of assessment -- particularly so for mastery-based learning (Saphier, Haley-Speca, & Gower, 2008).

The feedback that students receive as a result of formative assessment is arguably the most important predictor driving the success of students as they engage in learning frameworks such as those leveraged through Education Perfect. In fact, some research suggests that academic feedback may be among the most strongly and consistently impactful behaviors teachers can engage in to raise achievement (Bellon, Bellon, & Blank, 1997). As a general rule, more feedback is better than less for students engaged in mastery-based learning (Kulik, Kulik, & Bangert-Drowns, 1990; Brandt, 1998). A great deal of research has shed light on the mechanisms in which feedback functions best for students. Broadly, feedback should be:

- ***Matched to a criterion.*** Feedback that provides students with information about where their performance is in relation to a certain mastery threshold is generally more effective than feedback that tells them where their performance is in relation to other students (Marzano, Pickering, & Pollack, 2001; Crooks, 1988; Wilburn & Felps, 1983).

- ***Specific and precise.*** Descriptive feedback that provides students with information on specifically what was right about what was done correctly and what was wrong about incorrect work is particularly valuable (Saphier, Haley-Speca, & Gower, 2008). It is important that feedback of this type be direct and viewed by the student as credible (Saphier, Haley-Speca, & Gower, 2008).

- ***Timely.*** Ideally, feedback should be provided as quickly as possible following an assessment. This helps shape student learning and increases the likelihood that students will be able to modify their learning behavior in ways that are meaningful. Giving feedback immediately after a test-like situation appears to be ideal. Research has found that, in general, the more time delay in giving feedback, the less improvement there is in achievement (Bangert-Drowns, Kulik, Kulik, & Morgan, 1991; Marzano, Pickering, & Pollack, 2001).

- ***Corrective in nature.*** Feedback appears to be most effective when it provides students with information on how to modify their work so that their performance can improve. As Marzano, Pickering, and Pollack (2001) highlight: "The best feedback appears to involve an explanation as to what is accurate and what is inaccurate in terms of student response." It is important that feedback of this type is provided in a way that maximizes student understanding of the corrections that need to be made (Saphier, Haley-Speca, & Gower, 2008).

- ***Opportunities for self-reflection***. Student self-reflection, where students review their previous work and consider ways in which it could be improved, can be highly impactful

(Marzano, Pickering, & Pollack, 2001; Trammel, Schloss, & Alper, 1994). Having students review each other's work and provide feedback to one another has also been well-established as beneficial for student learning (Saphier, Haley-Speca, & Gower, 2008).

In the context of these best practices, to accompany a robust system of assessment and student feedback, research points to the importance of mastery-based learning programs tracking student progress on an ongoing basis and then using this information to modify learning plans as needed. Ideally in these learning environments, each student should work with the teacher to help create a personalized learning plan (Lee, 2014). These learning plans should include goals, pacing guidelines, and specific strategies the student can use to achieve these outcomes. As students complete work and progress through content, research has clearly highlighted the importance of both the teacher and student tracking progress toward achieving goals and mastering the content at hand (Lee, 2014; Marzano, Pickering, & Pollack, 2001; Saphier, Haley-Speca, & Gower, 2008).

As part of a broader, school-level model of student progress monitoring, Multi-tiered Systems of Supports (MTSS) have been shown to provide a highly useful framework for making data-informed decisions regarding student intervention. Within this framework, student assessment data is utilized to make decisions regarding how to best provide targeted instruction to students based on their level of needed support. Typically, these tiers consist of Tier I, where students are provided instructional programming that is appropriate for all students, Tier II where students are provided additional interventions that target key skill areas, and Tier III where students are provided an intensive series of interventions. This framework is well-situated in the contemporary research on response to intervention (RTI) (Kincaid & Batsche, 2016; Ziomek-Daigle & Heckman, 2019), and research suggests that this approach provides an accessible and practical framework that can help educators address the needs of students who are not responding to universal interventions (Ziomek-Daigle & Heckman, 2019). Research has also found that this systemic instructional approach can have both short- and long-term benefits for student learning across a variety of subject areas (Grapin, Waldron, & Joyce-Beaulieu, 2019; Burns, Appleton, & Stehouwer, 2005). Of particular note, MTSS and RTI approaches have been found to improve student academic achievement (Grapin, Waldron, & Joyce-Beaulieu, 2019), enhance student equity (Mercado, 2018), and decrease the likelihood that students will require special education services (Burns, Appleton, & Stehouwer, 2005).

As outlined, the Education Perfect DLP utilizes an explicit formative assessment cycle that seeks to form the basis of instructional decisions made by program users. Through the platform, users are provided with an existing bank of assessments spanning each subject area as well as the full elementary-secondary grade span. Teachers are also provided tools to quickly create and customize assessments of their own. Using these resources, users engage in an assessment cycle that involves:

- Pre-testing to diagnose the current knowledge base and skillset of each student
- Automated and individualized next steps for each learner based on their pre-test results
- Post-task testing to gain an updated measure of student knowledge
- Analysis and actionable insights into student learning growth based on progression between pre- and post-task tests (Education Perfect, 2022)

Through leveraging assessment data generated through these resources, the EP platform is able to provide ongoing and actionable feedback to students in a variety of ways. As summarized by the program's developers:

> "As students progress through a lesson, many questions are automatically graded with model answers provided, allowing for continuous feedback as they move through the learning. This ensures students progress to mastery at a pace and level of guidance that suits each individual….Lessons also contain extended response questions that require more involved student answers and are not automatically marked. Example answers and grading criteria are provided, and students self-review their responses and can improve on them. Teachers can view and provide feedback on these extended response questions via text or recorded verbal feedback. Additionally, these feedback features are available for use in peer review, an anonymous, teacher-mediated student-to-student feedback tool." (Education Perfect, 2022)

Conclusion

In light of these findings, Education Perfect appears to be a digital learning platform and curriculum solution with distinct potential to enhance learning outcomes for students across a variety of subject areas and grade spans. The instructional materials and resources made available to Education Perfect users, as well as the overarching design and structure of the EP DLP, borrow from a variety key pedagogical frameworks in the field of education and appear well-supported in contemporary research.

As discussed throughout this evidence portfolio, the research literature related to the program's core components – explicit instruction and mastery-based learning, adaptive practice with spaced repetition, differentiation and game-based learning, and the use of formative assessments to provide timely and specific feedback to students -- is quite supportive and is suggestive of the potential benefits this overarching approach may yield. Importantly, program components across each of these areas appear embedded with key instructional strategies aligned with research-based best practices. Grounded in an overarching pedagogical framework that emphasizes a combination of explicit instruction and mastery-based learning, EP lessons appear well-designed to minimize cognitive load in learners (Clark, Kirschner, & Sweller, 2012; Smith, Saez, & Doabler, 2016) and well-positioned to develop students' automaticity with basic subskills that make up larger, more complicated tasks (Brandt, 1998; Marzano, Pickering, & Pollack, 2001). As students participate in these forms of instruction over time, research indeed suggests that long-term learning can be enhanced across a variety of subject areas (Reutzel, Child, Jones, & Clark, 2014; Graham & Harris, 2009; Graham, McKeown, Kiuhara, & Harris, 2012; Kroesbergen & Van Luit, 2003; Solis et al., 2012; Swanson, 2001; Vaughn et al., 2000), and students can better retain mastery of the knowledge and skills they learn (Anderson, 1994; Saphier, Haley-Speca, & Gower, 2008). Instructional strategies embedded within this overarching framework, most notably the use of highly adaptive practice with spaced repetition, appear to potentially strengthen the program's ability to enhance and reinforce student learning and skill development (Ericsson, 2008; Greving et al., 2020; Heitmann et al., 2018; Heitmann et al., 2021; Kang, 2016). The incorporation of resources to help teachers more efficiently differentiate instruction and provide game-based learning opportunities also appear to be well-grounded in instructional best-practices research, particularly as it relates to enhancing student engagement (Tomlinson et al., 2003; Rappolt-Schlichtmann, Daley, & Rose, 2012; Rose, Meyer, & Hitchcock, 2005; Budhai & Skipwith, 2017; Connelly et al., 2012; Hamari et al., 2016). As importantly, the program's cycle of formative assessment and feedback serves to potentially provide for a data-informed and highly personalized learning experience for students. These features have also been highlighted in the extant literature as serving many key instructional benefits (Bellon, Bellon, & Blank, 1997; Saphier, Haley-Speca, & Gower, 2008; Lee, 2014).

In the context of this research base, Education Perfect appears well-positioned to positively influence instructional practices in schools and potentially enhance learning outcomes for students. As the program continues its ongoing development and expansion, evaluation research that examines teachers' and students' experiences with the program, as well as its impact on explicitly fostering these learning outcomes, is warranted. Indeed, given the breadth of foundational research supporting the program's foundational approach and instructional methods, Education Perfect represents a potentially highly efficacious learning management and curriculum solution for schools, as well as a distinctly promising research target for future investigation.

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