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A Review of Digital Products for Formative Assessment Uses: Considering the English Learner Perspective

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Abstract

English learner (EL) students are the most rapidly growing student population in the United States. Recent research has suggested that digital and computer-adaptive instructional tools have tremendous potential to engender positive outcomes for these students and their teachers. Against this backdrop, we conducted a review of 30 currently available digital learning and assessment products that could be used for formative assessment purposes. The aims of this review were (a) to identify which technology-enhanced features have currently been implemented in digital materials intended for formative purposes with EL students and (b) to identify areas in which technology-enhanced features could be still further utilized in digital materials to benefit the formative practices of EL students and their teachers. Our findings reveal that a host of potentially useful features are currently being implemented but that these products and their features largely fail to target the particular needs of EL students. The implications of these findings for developing the next generation of digital learning products for formative assessment uses for EL students and their teachers are discussed.

Key words: digital products, English learners, formative assessment, technology

In the U.S. K–12 public education setting, formative assessment has been gaining increasing attention due to the benefits that it readily provides over large-scale summative assessment. This is because summative assessments are implemented after a certain period of instruction, so instructional adjustments to remediate students' deficiencies in real time are unlikely to be achieved (Dixson & Worrell, 2016; Short & Fitzsimmons, 2007). By contrast, the concept of formative assessment centers on ongoing assessment processes to gather learning evidence and provide immediate feedback for both teachers and students while the learning process is taking place (Black & Wiliam, 1998; Council of Chief State School Officers [CCSSO], 2012; Heritage, 2010; Sadler, 1989).

Formative assessment can be particularly beneficial for English learner (EL) students and their teachers, given that EL students' diverse backgrounds (e.g., levels of native language proficiency and English-language proficiency, formal schooling experience, length of residence in the United States, home language, cultural background) result in various learning needs. Ongoing assessment to identify where students stand relative to learning goals and to provide instruction targeted to their individual needs can be a promising strategy for increasing EL students' academic achievement. Through this assessment process during instruction, teachers will be able to identify the specific linguistic and instructional needs of EL students who require support to develop their English-language proficiency to access rigorous content learning and participate meaningfully in the classroom.

Yet research has suggested that in practice, effectively implementing formative assessment is not a simple matter and involves a number of factors (e.g., Alvarez, Ananda, Walqui, Sato, & Rabinowitz, 2014; Ruiz-Primo & Furtak, 2006; Schneider & Gowan, 2013). Key factors include the need to establish and communicate clear learning goals, collect evidence of learning with appropriate methods, act on this evidence (e.g., by providing feedback and adapting instruction), and engage students in self- and peer assessment (Black & Wiliam, 1998; Heritage, Walqui, & Linquanti, 2015). Each of these factors requires deep content knowledge and pedagogical skills from teachers. For example, Schneider and Gowan's (2013) study with a sample of 23 elementary teachers from multiple schools indicated that teachers' abilities were varied in interpreting collected evidence and relatively weak in providing targeted feedback for students. The researchers stressed the importance of professional development regarding the successful implementation of formative assessment.

Professional support for effective formative assessment has repeatedly been pointed out in prior literature (e.g., Alvarez et al., 2014; Heritage, Kim, Vendlinski, & Herman, 2009; Moss, Brookhart, & Long, 2011). As Bailey and Heritage (2008) pointed out, formative assessment can take place through many different methods (e.g., formal tests, classroom tasks, classroom discussions/conversations, and observation) with careful planning. However, the limited time that teachers have to cope with a range of schoolwork also adds to the challenges involved in devising or selecting appropriate methods and successfully implementing them for formative uses. Furthermore, not all teachers are equipped with the knowledge and skills required to support the language development of EL students specifically (Callahan, 2013). To provide the necessary professional support, it is thus important to make available appropriate tools and resources designed specifically for EL students and their educators (Shore, Wolf, & Heritage, 2016; Shore, Wolf, O'Reilly, & Sabatini, 2017).

In recognition of the benefits of and the need for sound resources to support formative assessment practices, a number of commercial companies and nonprofit organizations have begun to develop materials specifically for formative assessment uses. As part of larger research efforts at Educational Testing Service to (a) develop a framework for the formative assessment of EL students and (b) develop resource materials for EL students and their teachers, the present study reviewed existing digital (i.e., computer-, Web-, and mobile device-based) products to identify common features regarding the key characteristics of formative assessment described earlier. The central questions guiding our study are as follows:

1. What technology-enhanced features have currently been implemented in digital materials intended for formative purposes with EL students?
2. In what areas could technology-enhanced features be still further utilized in digital materials to benefit the formative practices of EL students and their teachers?

As technology-enhanced learning and assessment tools gain increasing prominence in U.S. K–12 classrooms, we were particularly interested in using these questions to frame an examination into the ways in which digital products (a) operationalize formative assessment characteristics and (b) have been designed to facilitate the implementation of formative assessment for teachers and students (e.g., task types, feedback systems, learning management

systems; LMSs). While we reviewed digital products that have formative assessment functions in general, we attempted to examine the extent to which these products address the needs of EL students specifically, in terms of both content and features. We hope that the methods and findings reported herein will offer information helpful for those interested in creating useful resource materials specifically for EL students and their teachers so that they may carry out formative assessment more effectively and systematically.

Methods

Sampling Digital Products

In selecting existing digital products with formative learning and/or assessment features, we first searched online for the Web sites of developers or providers of digital learning and assessment materials in the U.S. K–12 education space. As mentioned, our search encompassed digital products for formative uses targeting either the general K–12 population or the EL-specific population with such key words as formative assessment, formative use, English language learners, and English learners. Products intended for adult learners only were therefore excluded. These efforts led initially to 47 companies and organizations as well as 55 educational applications for mobile devices (apps) being identified. From this list, 30 individual products were selected for inclusion in our study, having met our key criterion of the explicit mention of formative uses in their product descriptions. Table 1 presents a list of these 30 products along with the name of the associated provider and the content areas each product aims to target. Notably, while some of these digital products are assessments in the traditional sense, others are learning products with no outright assessment component, and still others are simply platforms through which formative assessment and learning content can be delivered in a more dynamic, engaging, and user-friendly manner.

Table 1. Products Included in Our Review

No.	Company name	Product name	Content area(s)
1	Amazon TenMarks	TenMarks	ELA (writing), math
2	ATI Online	Galileo K–12 Online	ELA, STEM
3	Benchmark Education	Online Assessment	ELA (writing)
4	Certica Solutions	Navigate Item Bank	ELA, social studies, Spanish, STEM
5	Classkick	Classkick (app)	ELA (grammar, reading, writing), German, social studies, Spanish, STEM
6	CORE Education & Consulting Solutions Inc.	CORE XLR8	ELA, STEM
7	CueThink	CueThink	Math
8	Curriculum Associates Inc.	i-Ready	ELA (reading), math
9	Discovery Education	Discovery	ELA (grammar, writing), social studies, STEM
10	GoSoapBox	GoSoapBox	All content areas (in all education fields not limited to K–12)
11	Imagine Learning	Imagine Learning Program	ELA (grammar, listening, reading, speaking, vocabulary), math, Spanish
12	Knowre	Knowre	Math
13	Learning A-Z	Raz-Plus	ELA (reading, writing, vocabulary), science
14	Lexia Learning	RAPID Assessment	ELA (reading)
15	MasteryConnect	Socrative (app)	ELA, social studies, STEM
16	MasteryConnect	MasteryConnect	ELA, social studies, STEM
17	McGraw-Hill	ALEKS	Math
18	Measured Progress	Formative Content Bank	ELA (reading), math
19	Measured Progress	STEM Gauge	Science
20	Middlebury Interactive	Middlebury Interactive Languages	ELA (listening, reading, writing, vocabulary), foreign languages
21	Naiku	Naiku (app)	ELA (reading), social studies, STEM
22	NearPod	NearPod	ELA (grammar, reading, writing), social studies, STEM
23	NWEA	Measures of Academic Progress (MAP)	ELA (grammar, reading, vocabulary, writing), STEM
24	Quia Web	Quia Web (app)	All content areas (in all education fields not limited to K–12)
25	Quill	Grammar	ELA (writing)
26	ReadWorks	ReadWorks	ELA (reading)
27	Scantron	Performance Series	ELA (reading, writing), STEM
28	Snapwiz	Edulastic	ELA, social studies, STEM
29	Storyworld	Storyworld	ELA (reading, vocabulary), foreign languages
30	Yacapaca	Yacapaca (app)	All content areas (in all education fields not limited to K–12)

Note. Where the product descriptions mention specific ELA domains (e.g., reading), we have included them here. ELA = English language arts; STEM = science, technology, engineering, and math.

As shown in Table 1, our sample includes 26 products offering content for English language arts (ELA) or language development; 24 products offering content for science, technology, engineering, and mathematics (STEM); and 11 products offering content for social studies. Of the ELA products for which clear information was available regarding target language modalities (e.g., reading, writing), six cover reading skills only; four cover writing skills only; five cover both reading and writing skills; one covers reading, writing, and listening skills; and one covers reading, listening, and speaking skills. Finally, regarding standards alignment, 21 products were explicitly described as being aligned with the Common Core State Standards.

Creating a Coding Protocol

After identifying which products to include in our study, we set out to devise a coding protocol for categorizing each product's formative assessment features in a systematic way. The categories included in the protocol were intended to identify major formative assessment features as described in this research memorandum's introduction and to summarize common features as well as notable features in technology-enhanced products. These categories and their attendant definitions are summarized in Table 2. Given the diversity of the 30 products reviewed (e.g., assessments, platforms, learning products), we purposefully left most of the categories as open sets to allow for qualitative description as needed, rather than constraining each with a closed set of predetermined values that must be adhered to in all cases.

Table 2. Coding Protocol to Categorize Features of Digital Products for Formative Uses

Category	Description
Product description	A brief qualitative description of the product and any sample materials available
Delivery modes	The method by which the product is administered to students (e.g., desktop/laptop computer, mobile device)
Assessment purposes	The assessment purposes for which the product is designed, if any
Item/task types	The item/task types used for any assessment components; item/task types to elicit student learning evidence
English learner–specific features	Features that are designed specifically to focus on English learners
Feedback features	The ways feedback is provided
Learning management system features	A description of any learning management system for teachers and/or students, including instruction/less planning, item banks, item creation, score report, and progress tracking features

For each product included in our study, information for as many of the preceding categories as possible was systematically collected on the basis of what was available online. It should be noted that not all categories applied equally to all products. For instance, instruction-only products lacking an assessment component may not have information about item types. Similarly, many products have no LMS so that category naturally does not apply to such products. There were also instances for which a category presumably applies (e.g., delivery/administration mode for a formative assessment product) but for which no statements could be found online explicitly clarifying the relevant information. In all of the cases, no information was coded for the affected categories. Because of this conservative approach to classifying products with a paucity of information online, our findings likely underspecify information about these products in the coding categories for which little or no information was available.

Procedures and Analysis

Four researchers, all of whom were involved in creating the coding protocol, divided up the 30 products under review and classified each according to the coding protocol. It is important to note at the outset that the coding procedure sought merely to catalog each product's feature set, not to evaluate a product's merits or overall quality as an educational tool.

Coding was done primarily by reading information about each product on its Web site and paying particular attention where applicable to any sample materials accessible online. These sample materials came in the forms of formative assessment items, book chapters, example score reports, and other sample materials each product's developer made freely available online. When no sample materials were provided, the researchers were limited to prose descriptions in the products' marketing literature as well as occasional product reviews also provided online. Where applicable, screenshots of any available sample material were also collected, with the goal of providing concrete examples to guide subsequent qualitative analyses and discussion. Given the diverse and open-ended nature of this coding task, we endeavored to be liberal in our collection of information, with the goal of providing as much material as possible for subsequent analysis. We regularly met to discuss our use of the coding protocol and information collected online. After collecting all the information we could find about the 30 products, we discussed common and otherwise notable features observed across these products. We also discussed further areas of development based on the features available in the sampled products we reviewed.

Findings

In this section, we present the findings from our exploratory review and coding analysis. This section is divided into a number of subsections, each dealing with a single category or subcategory from our coding protocol. While the findings in each subsection are discussed in aggregate across all products included in our review, where applicable, we also go into further detail about specific products deemed worthy of highlighting or emphasis. However, a significant caveat in interpreting our findings, as mentioned, is that many products do not have full information available online from which to draw conclusions about each category in our coding protocol. As a result, the findings reported in the following subsections are necessarily not exhaustive and may underspecify the information in certain categories.

Delivery Modes

We were particularly interested in the extent to which mobile devices (e.g., smartphones or tablets) were utilized to deliver materials to be used for formative purposes in the classroom, because mobile devices can utilize technology-enhanced features more readily than desktop/laptop computers. We therefore saw a product's delivery mode as an essential piece of information to capture when investigating the prevalence of various technology-enhanced features. Among the 30 digital products we reviewed, 17 products were delivered on desktop/laptop computer only, 5 products were delivered on mobile devices only, and 8 products were delivered on both computer and mobile devices.

Features of Item/Task Types

When classifying the products for formative assessment uses, one category of particular interest to our study was the item/task types they employ as well as whether any of the products offer special features of relevance to the creation or presentation of these items/tasks. Our intent for this category was to categorize and quantify various assessment methods to shed light on innovative, tech-enhanced ways of eliciting student learning evidence for formative purposes.

From those products for which the relevant information was accessible, both selected-response and constructed-response items/tasks were available. For products offering selected-response items, these include multiple-choice (both single and multiple answer), true/false, matching, and vocabulary drag-and-drop items. For products offering constructed-response items, these include short-answer, extended-response, essay, and fill-in-the-blank items. Many of

the products with these item/task types also offer technology-enhanced features, including multimedia embedding, drag-and-drop functionality, drop-down menus, rollover and pop-up contextual menus, text highlighting, internal dictionaries, note taking, text-to-speech functionality, configurable color coding, and the ability to provide teacher or peer feedback/annotations on learners' work (e.g., directly within a product's LMS). A reasonably diverse spread of item types and features was therefore observed among the products we reviewed, extending beyond the traditional dichotomy of selected-response versus constructed-response types.

Our review yielded two notable item/task type features in terms of innovation and the potential for enhancing learning. The first notable feature lies in adaptive content (available in Curriculum Associates's i-Ready, Imagine Learning, Lexia Learning's RAPID Assessment, McGraw-Hill's ALEKS, NWEA's MAP, and Scantron's Performance Series). That is, these products automatically adjust the content of upcoming learning or assessment tasks based on a student's past performance to maximally hone in on that student's current knowledge or abilities. This function was observed to be feasible only in products that are mostly desktop/laptop computer-, Web-, or mobile device-based, as traditional paper-based formats tend to be too rigid to allow for highly tailored content at the level of individual students. We see such adaptive content functionality as being worth highlighting because, given formative assessment's focus on the recursive processes of assessment and feedback, the efficacy of any product at improving outcomes for individual students will likely be improved if its content can be tailored to students' individual needs. Moreover, given the particularly diverse backgrounds of EL students, the ability to adapt task content to these students' correspondingly diverse learning needs presents obvious benefits for both EL students and their teachers.

The second notable feature we observed in this category is the ability for teachers to create their own new content directly within each learning product's associated platform (available in Classkick, CORE XLR8, CueThink, Learning A-Z, MasteryConnect, Nearpod, Quia Web, Snapwiz's Edulastic, and Yacapaca). According to the product descriptions and sample materials accessible via each product's Web site, this feature tended to come in the form of an option within a product's digital interface for teachers to draft their own lesson plans or assessment items within predefined templates set out for each product. Such an arrangement allows for flexibility of content yet also for continuity with a product's existing aesthetic and

other features. For example, if a teacher creates new assessment items and administers them to his or her class, performance metrics can be generated at a number of different resolutions and displayed via the product's LMS, if it has one. The teacher can then either pass these metrics along to students for their consideration or else use them to adjust lesson plans according to the needs of the class in a formative fashion. In this way, we believe the ability to create new content within a product's existing structure can confer great benefits to EL students and their teachers.

English Learner–Specific Features

Among the 30 products reviewed, only 6 (i.e., Amazon's TenMarks, Imagine Learning Program, Learning A-Z's Raz-Plus, Middlebury Interactive Languages, NWEA's MAP, and Storyworld) were found to have been designed expressly for language learners either in full or in part. What is more, our coding analyses revealed that this subset generally offered only a handful of EL-specific features. One of these features is the provision of first-language (L1) support. Given the large population of Spanish-speaking EL students in K–12 schools, L1 support typically means that only Spanish-language versions of the product are available in addition to the default English-language versions. While this is useful, the implementation of L1 support in this way is not particularly nuanced or dynamic, as it does not interact with the English-language versions and entirely neglects other minority language groups. The exception to this was the Imagine Learning Program, which offers interactive language support in the form of clickable glossaries with translations.

Of the six products listed in this section, the one that stood out from the rest in terms of EL-specific focus and features was Storyworld, which is a collection of digital bilingual books designed to help young students learn English, Spanish, and Chinese. Given this product's particular focus on language learners, features of interest include the automated reading aloud of whole sentences or individual words in two languages, with learners able to toggle between the languages at any time; word- and phrase-level translation support; and postreading activities in learners' native languages (e.g., multiple-choice vocabulary questions whose stem is in the native language but whose options are in the target language). This was the only product so fully featured specifically for language learners. Although the product lacks an explicit description of how it could be used for formative purposes, it is not difficult to imagine how a teacher might integrate Storyworld into instruction in a formative manner, and these features are worth noting to understand what technology-enhanced language support is currently available for EL students.

Features of Feedback

Given that feedback is a critical component of formative assessment, we were also interested in exploring how feedback is presented in the products we reviewed. In identifying features of feedback, we utilized Shute's (2008) feedback categorization scheme of *verification* and *elaboration*. Verification feedback is any which informs learners merely of the correctness of their responses (e.g., using check marks, showing the overall percentage correct). By contrast, elaboration feedback is any which provides more detailed explanations as to why a response is correct or incorrect, varying from hints to scaffolded assistance to detailed instruction. Among the 30 products reviewed, we found that 5 provide verification feedback, while 6 products provide elaboration feedback. The remaining products do not describe the implementation of feedback, precluding any inferences regarding what types of feedback are provided, or how.

For the products we reviewed, verification feedback about response correctness is offered only in the context of selected-response items and is provided immediately rather than following a delay. Such products include Snapwiz's Edulastic, Quia Web, Benchmark Education's Online Assessment, and the Scantron Performance Series. By contrast, the types of elaboration feedback we observed consisted of error analysis, instructional material reviews, and misconception explanations and are delivered either by the teacher, by a student's peers, or automatically via a product's LMS. For example, in some products, students can provide feedback to one another by way of annotations directly on a peer's work (e.g., CueThink). In others, elaboration feedback on work can be bidirectional between both students and teachers (e.g., Naiku). In still others, automatically generated feedback could be provided immediately regarding the correctness of an answer as well as possible issues a student could fix to arrive at the correct answer (e.g., McGraw-Hill's ALEKS and Quill's Connect, Diagnostic, Grammar, and Proofreader).

Features of Learning Management Systems

For this study, we have adopted Watson and Watson's (2007) and Szabo and Flesher's (2002) conceptualization of LMSs as platforms on which educators administer instructional and assessment content, assess and report performance, track ongoing progress, and manage learning documentation generally. The functionality and usability of LMSs are of vital importance to an effective online learning experience. Watson and Watson (2007) identified a list of features that developers in the K–12 context should consider including in their products' LMSs, such as instructional methods, data management, assessment, and performance reporting. In this study,

we explored LMS features designed specifically for teachers. In particular, we examined how instructional suggestions, assessment practices, and performance reporting systems are implemented in the products under review, because these features can reinforce formative assessment practice efficiently. In this section, we begin by quantitatively reporting the distribution of the various LMS features we identified across these products, and then we go into more detail about each feature specifically.

The results show that of the 30 products under review, fully 20 appear to offer LMSs as defined herein, though some are more fully featured than others. Of course, this figure is likely a lower-bound estimate, because it may be that for some of the remaining 10 products, LMS-like functionality does exist but was simply not referenced in the product samples or marketing materials we used for our review. Figure 1 depicts the distribution of the teacher-oriented LMS features identified from these materials during our review. These features include the provision of diagnostic information for further instruction, lesson planning, item banks, item creation, score reporting, and progress tracking. For instructional methods, 12 products' LMSs convey to teachers which areas need further instruction based on classroom-level performance results, and 3 provide explicit lesson-planning suggestions, indicating that some products do cater to teachers' instructional needs rather than focusing exclusively on the needs of students. To help teachers customize assessments that are suitable for their students, seven products' LMSs provide item banks from which teachers can choose items, while six allow teachers to create and even share their own items with others directly within the LMSs. Finally, in terms of reporting students' performance results, 16 products' LMSs allow teachers to generate score reports at either the student, classroom, grade, school, or district level, and 12 provide capabilities for long-term progress monitoring.

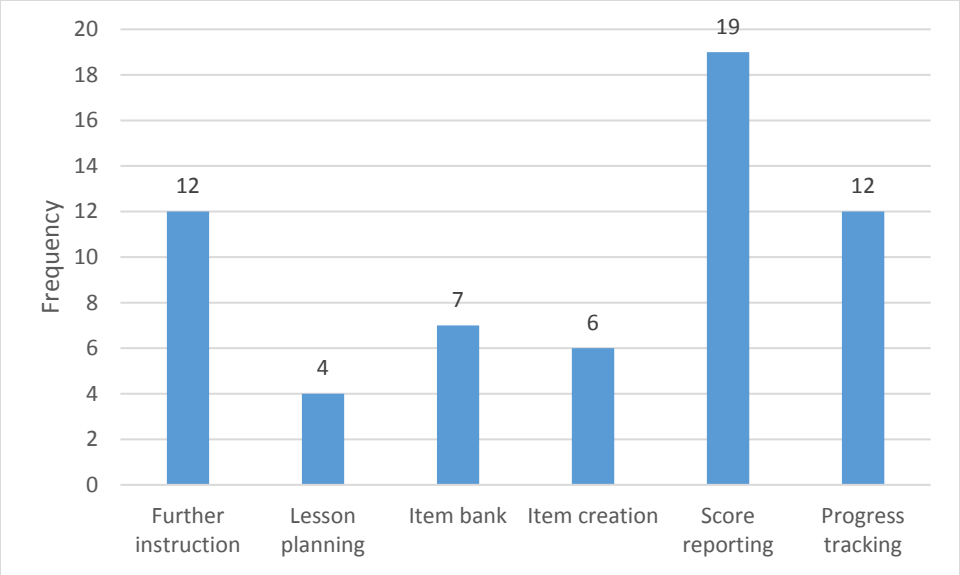

Figure 1. Number of products that include specific learning management system features.

Both because the conceptualization of the features in Figure 1 may not be self-evident to all readers and because variation was observed within each feature such that presenting our findings only in aggregate may gloss over further important findings, we now discuss each of the LMS features in Figure 1 in greater individual detail.

Diagnostic information for further instruction. We observed several interesting features concerning providing suggestions for further instruction with a product's LMS. For example, some (e.g., Lexia Learning's RAPID Assessment) provide detailed diagnostic reports for each student—sometimes including information down to the level of individual subskills—to help educators group learners for instructional planning and address skill weaknesses collectively. Others (e.g., Curriculum Associates's i-Ready) further this approach by using these diagnostic profiles to then generate a detailed action plan and resources for differentiated instruction, including a breakdown of which skills students have mastered versus which skills should be prioritized in subsequent instruction.

Lesson-planning template. The implementation of this feature, namely, the ability to plan lessons within a product's LMS, was found to be comparatively less diverse than the others for the products we reviewed, as shown in Figure 1. Aside from the automatically generated suggestions for subsequent instruction discussed in the previous subsection, lesson-planning

capabilities within an LMS generally take the form of prefabricated curricula from which educators can select (e.g., Amazon's TenMarks, Classkick).

Item banks. Although several products offer access to item banks by way of their LMSs, little novelty was observed in how this access is implemented. In general, the item banks are simply large numbers of prefabricated items (usually 10,000+) that educators can access directly through a product's LMS and incorporate into their lesson plans. Such access is typically provided for free, but in select cases, it is provided at an additional cost beyond that of the product itself. Finally, many developers were at pains to point out whenever their products' item banks are aligned to standards, which was the case for the majority of products.

Where the various item banks primarily differ, then, is in the degree to which the items are technology enhanced, as well as whether they are tagged with task-relevant metadata. The degree to which the items in a product's item bank exhibit technology-enhanced features was generally observed to be a factor of the role of technological enhancement within the product itself. That is, if a product offers technology-enhanced features, such as pop-up contextual menus, text highlighting, note taking, drag-and-drop functionality, or time limits, these features will likely also be incorporated into the items in that product's item bank. As for the tagging of metadata, a particularly fully featured example is Certica Solutions's Navigate Item Bank, which provides per-item estimated difficulty levels, Bloom's revised taxonomy levels (Krathwohl, 2002), Webb's (1999) depth of knowledge levels, distractor rationales, and even passage metadata for passage-based items (e.g., text category and subcategory, gender/ethnicity of main character/subject, text organization, Flesch–Kincaid readability level, Lexile measure, approximate word count, topic key words). Detailed information such as this is intended to help teachers insert only the most appropriate items into their curricula according to the needs of their particular students. This level of metadata was found to be uncommon overall among the products with item banks that we reviewed, however, with most simply providing items, keys, and target ages or grade levels.

Item creation. The ability to create new items was discussed at a high level in the earlier section on item/task types and noteworthy features. However, while some of these products offer this feature as a core part of their overall platform, others provide it as a feature specific to their LMSs. In these products (e.g., CORE's XLR8, Quia Web), the LMSs generally provide one or more templates or blueprints specifying the general outline that all items must follow for

seamless integration into the product's overall platform. This structure also helps ensure that all items are formatted properly so as to take advantage of a product's technology-enhanced features, in addition to maintaining the product's overall aesthetic.

Score report. Of all the LMS features observed across the products we reviewed, score reporting was the most frequent and highly developed. Correspondingly, the LMS capabilities for reporting students' performance and associated scores were observed to offer some of the most comprehensive and innovative feature sets. Although formative assessment does not necessarily involve formal score reporting, it is worthwhile to enumerate the score reporting features of the products we reviewed for potential formative uses:

- interactivity (i.e., computer-based features that allow teachers to customize the student performance information on display, providing as little or as much information as is needed for their diagnostic goals; e.g., Curriculum Associates's i-Ready, Lexia Learning's RAPID Assessment)
- wide array of innovative and interactive options for plotting students' performance graphically (e.g., stacked/unstacked pie charts, stacked/unstacked bar graphs, line graphs, pyramid graphs, sunburst graphs, histograms), many of which can update information dynamically according to teacher's selections
- extensive use of color coding to facilitate teachers' prompt understanding of highly information-dense score reports
- automatic scoring and score report generation (e.g., MasteryConnect Quia Web, Smart Response)
- performance self-reporting (i.e., where students report self-evaluations of their own confidence levels and set periodic learning goals on the basis of these self-evaluations, e.g., Naiku)
- performance reporting at several different resolutions (i.e., by student, teacher, classroom, school, district, test item, subskill, or standard, e.g., Benchmark Education's Online Assessment, Curriculum Associates's i-Ready, Lexia Learning's RAPID Assessment, NWEA's MAP)

- provision of data normed to standards to facilitate comparisons between individual students (e.g., Curriculum Associates's i-Ready, Imagine Learning Program)
- automatic highlighting of areas where a particular student may be having trouble (e.g., Imagine Learning Program, Quia Web)
- provision of lesson plan recommendations targeted for individual students based on their performance on diagnostic assessments (e.g., Curriculum Associates's i-Ready)
- information about which specific standard or standards a student has mastered or is currently struggling with (e.g., Curriculum Associates's i-Ready)
- recommendations for next steps based on what a student has already mastered (e.g., McGraw-Hill's ALEKS)

Progress tracking. Similar to score reporting, various products' LMSs also offer features specifically tailored to tracking students' progress over time. Such capabilities aim to help teachers identify ongoing problems in students' learning, assisting them in adjusting lesson plans to target the needs of students in an ongoing fashion. Noteworthy features to this effect include the ability to compare students' progress longitudinally at a number of different resolutions, such as at the student, school, or district level (e.g., Curriculum Associates's i-Ready, Learning A-Z, Lexia Learning's RAPID Assessment, NWEA's MAP, Scantron's Performance Series, Snapwiz's Edulastic), and the ability to see progress broken down by content area, learning goal, or academic standard (e.g., Imagine Learning Program). Another feature common across many products' LMSs which we believe should enhance progress tracking is the extensive use of diverse, interactive graphical displays of student data (e.g., various types of pie charts, bar graphs, line graphs, histograms, and other less common yet easy-to-understand types of graphs). Such a wide variety of options for plotting students' performance graphically should help to clearly communicate trends in performance, even to teachers without significant graph literacy.

Discussion

In this study, we reviewed a sample of digital products which include features of relevance for formative assessment. Our review focused specifically on identifying the types of features designed to facilitate the efficient practice of formative assessment using technology enhancement. In particular, the types of features specifically designed for EL students and their

teachers were our key interest. The products reviewed were observed to offer such features to varying degrees (e.g., tasks only, LMSs only, or both tasks and LMS for formative assessment). The previous section discussed our major findings and their implications for areas of further development in digital products or materials for formative uses targeting EL students.

As mentioned earlier, readers must bear in mind the major caveat of this review when interpreting our findings. That is, our review of digital products was limited to official descriptions online and samples that were publicly available. As such, this study was not an in-depth, exhaustive analysis but rather a high-level, exploratory overview of the features prevalent in the current digital products for formative assessment uses with EL students. Despite this significant limitation, our study yielded several noteworthy findings and specific features that hold promise for EL students and their teachers.

The first noteworthy finding of our review is that despite the plethora of digital products for educational purposes in K–12 settings, we found that comprehensive digital products specifically developed to focus both on formative assessment and on EL students were relatively few as of the time of our review. The possibilities for targeted, technology-enhanced instruction afforded by the products under review suggest that powerful innovations in the formative assessment of EL students are indeed possible given recent advances in computer- and Internet-based technology, but at present, few available products appear to exploit this potential.

The second finding is that among the many innovative features observed in the products under review, only a handful were geared toward the needs of EL students specifically. Those features were limited to L1 language support (translation) and interactive glossaries to help EL students complete particular tasks. Considering the major elements of formative assessment described earlier (e.g., clear learning goals, tasks to elicit student learning evidence, actionable feedback), the lack of EL-specific features relative to formative assessment elements was notable. For example, although many products currently provide innovative methods of delivering feedback, most of this feedback simply communicates the correctness of a student's answer or general guidance on how to answer correctly next time. Given recent advancements in the capabilities of natural language processing technology, feedback targeting EL students' various needs—both linguistic and associated with content learning—appears to be an area of greatly underexploited potential in the quest to enhance existing products for formative uses.

The third finding is that our review suggests that contemporary developers of digital products for formative purposes have already endeavored to implement a wide variety of diverse and innovative features into their products. Moreover, despite the fact that few of these features target EL students specifically, we believe that with slight modifications, several of them could. Central among these is adaptive content, whereby the content of upcoming learning or assessment tasks is automatically adjusted based on a student's past performance to maximally hone in on that student's current knowledge or abilities. This feature can be beneficial for EL students whose English-language proficiency is widely varied even within the same grade level. Coupled with this feature, products that offer access to extensive item banks and provide teachers with tools for creating their own novel content present potentially useful capabilities for building EL-specific tasks for formative uses. Several of the products we reviewed contain the feature of providing prefabricated templates within which instructional and assessment content can be created. The use of these templates allows teachers to easily create custom content according to their needs as well as EL students' needs in a systematic fashion. For instance, teachers may be able to use the templates to add scaffolded and potentially adaptive tasks contingent upon EL students' current abilities. This systematicity and adaptiveness to EL students' needs has the potential to lead to both efficient and effective formative assessment in the digital era.

Various other technology-enhanced features were also notable, even though they were not necessarily targeted for EL students. Examples of technology-enhanced features that we encountered included multimedia, drop-down menus, rollover and pop-up contextual menus, text highlighting, internal dictionaries, note taking, text-to-speech functionality, configurable color coding, and the ability to provide teacher or peer feedback/annotations on learners' work (e.g., directly within a product's LMS). Some of these features enabled greater interaction with users compared to traditional paper-based tools. Previous research has suggested that interactive features can boost student engagement (e.g., Kennewell & Beauchamp, 2007; Moreno & Mayer, 2007), thus representing an additional benefit of technology enhancement in learning and assessment products. For EL students in particular, technology enhancement could aid in the implementation of language support, as discussed earlier (e.g., clickable glossaries, on-demand translation, read-aloud, visual aids for complex texts), at the student's control. Moreover, the ease of embedding additional resources (e.g., multimedia, Web sites) could benefit EL students

in further honing their linguistic and cultural knowledge as it relates to the targeted learning goals.

The final two features that deserve mention here are interrelated, namely, the provision of feedback and opportunities for self-assessment, both of which are integral elements of formative assessment. Heritage et al. (2015) stressed that one element of the philosophy underlying formative assessment is that students should be active participants in their own learning. Thus ongoing opportunities for feedback and self-assessment should be an important part of any product designed with formative assessment in mind. In general, we observed that feedback and (where available) self-assessments are delivered via the products' various LMSs, through which the teacher can then disseminate feedback to students as needed, or else which students can directly log in to review the feedback themselves and conduct self-assessment. However, as briefly described earlier, the feedback and self-assessment components of the reviewed LMSs did not seem to be designed with accessibility for EL students in mind. For instance, feedback that models appropriate responses for EL students or that provides language-oriented scaffolding to help EL students understand what makes for linguistically well-formed responses would be useful and relevant for these students and their teachers. Along with the integration of multimedia and graphics accompanied by accessible language, the features of students' feedback and self-assessment could therefore also be enhanced to cater better to EL students' particular learning needs.

The final finding of our review is that, as reported earlier, we also observed that many products' LMSs employed a number of technology-enhanced features pertaining to the interactive, dynamic, or otherwise graphical presentation of students' performance data. The wide range and flexibility of options for graphing data that we encountered were seen as presenting significant analytical advantages for educators. More importantly, the use of these existing capabilities not merely to represent performance in a summative fashion but also to indicate students' learning progress longitudinally would be beneficial for EL students with limited English proficiency.

Concluding Remarks

Technology-enhanced learning, instruction, and assessment are rapidly gaining prominence in contemporary K–12 classrooms. Moreover, recent research has suggested that a majority of educators believe digital and computer-adaptive instructional tools are particularly

effective in providing meaningful instruction to EL students (McGraw-Hill Education, 2017). These findings, combined with the fact that EL students represent the most rapidly growing student population in the United States, form the backdrop against which our review of digital products for formative assessment uses was conducted.

Our review sought to provide a glimpse of the potential features that such products currently leverage to facilitate teachers' formative assessment practice as they seek to target the idiosyncratic learning needs of EL students. Our findings suggest that while these products collectively demonstrate an impressive set of technology-enhanced capabilities, the large population of EL students in particular appears underserved by them. We believe that if deployed strategically, several of the features we encountered could cater to this population quite effectively. However, given the apparent paucity of digital products for EL students, empirical evidence about the effectiveness of specific features in boosting learning outcomes for these students and their teachers remains to be further collected. These lines of future research should in turn inform the development or enhancement of effective digital products so as to meet the needs of EL students and their teachers.

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