

Reasons to Let Multimodal Resources in:  
Multimodal Resources' Contributions to Improving Adolescent English Language Learners'  
In-Class Reading Comprehension

Jiayi Wang

Vanderbilt University

## Abstract

With the development of modern technology and renewal of teaching approaches, although integrating multimodal resources into reading instruction has already occupied an important position, this present review is putting a specific eye on English Language Learners (ELL) in classroom settings, in particular the adolescent age group. This is a group of people worth noticing because adolescent ELLs not only have diverse cultural and family backgrounds, which require educators to take their cultural identity into consideration when creating classes, but also they have some unique characteristics different from monolingual adolescents when decoding and perceiving information. In this literature review, evidence from research is generated to support the main investigation of how multimodal resources assist adolescent ELL's in-class reading comprehension. Various representations and functions of multiple modalities will be examined and connections will be built between the application of multimodalities and students' progress in reading comprehension. Potential solutions will also be provided in order to guide future educators, policymakers and curriculum designers.

*Keywords:* multimodal resources, adolescent, English language learners, reading comprehension

**Reasons to Let Multimodal Resources in: Multimodal Resources' Contributions to Improving Adolescent English Language Learners' In-Class Reading Comprehension****Introduction**

Challenging current traditional teaching and learning strategies, the burgeoning of global economic-technological development provides conditions that expedite the revolution of the means of education and provides a basis for imagination (Donald J. Leu & Kinzer, 2000, Goodwin, Cho, Reynolds, Brady, & Salas, 2020; Forzani & Leu, 2012; Mills, 2010). This tendency provides public with fresh notions of methodologies, and, bring about more expectation on educators, policymakers, administrators, and students, asking for the update in their attitudes towards teaching and learning to keep with the mainstream. From the past to the future, literacy instruction is influenced by global developments and, at the same time, regulating and modeling how literacy would be instructed (Donald J. Leu & Kinzer, 2000). On the other hand, the traditional fashion of literacy instruction is challenged by the introduction of new modalities (Cope & Kalantzis, 2009).

As to what emails and computers mean to our reading and learning today, the prevalence of these applications was unpredictable five years ago (Donald J. Leu & Kinzer, 2000) and what will happen to our future learning and teaching is hard to imagine. Maintaining new literacies is central to becoming a "critical global citizen" (Leu, Forzani, Rhoads, Maykel, Kennedy, & Timbrell (2014). It expands cultural and linguistic diversity so that every single student should put their identities into the real world. Among students, English Language Learners (ELLs) within the population serve as a special group who needs particularly emphasized attention on improving literacy abilities. According to Yuan, Wang and Eagle (2019), ELLs are "critical consumers and producers of information" (p. 129). As a result, to be literate, developing digital literacy skills is an "intuitive process" (Yuan et al., 2019, p.128). Their conflicting and interwoven language skills and cognition process allow them to think

somewhat differently and even more abstract than monolingual students. Even social economic status (SES) can have an impact on ELL's class performance, where data shows those who are in lower SES have significantly less exposure and access to new concepts and vocabulary (Shepard-Carey, 2020). This lack of vocabulary input and cultural knowledge may hinder ELL's progress in accumulating vocabulary for future reading. Teachers cannot repeat every word to them all the time, and class time is extremely limited for reaching overall linguistic achievement, so assisting tools, or in other words, multimodal resources and related facilities, can not only provide sufficient resources but also motivate students more as they are introduced into class settings (Shepard-Carey, 2020). Aligning with this understanding, integrating multimodal resources into ELL's reading instructions seems to be a meaningful and challenging pursuit.

The trend in instructing reading now is not simply the shift of teaching platforms from the old-fashioned to new fancier ones but should break the limitation of older learning supports and make a shift in both form and content, which will cause a change in thinking and working patterns. So teaching facilities should offer assistance in imparting knowledge but not be the protagonist in the learning process. To meet the requirements of developing a new literate generation, contemporary forms of communication approaches should be assisted with multimodal resources, including but not limited to static representation, oral languages, visual, audio and spatial representation, and gesture (Cope & Kalantzis, 2009; Mills, 2010), to regulate, improve and rejuvenate the teaching and learning relationship. An experiment conducted by Ng (2012) tested the hypothesis that whether teenagers who were unfamiliar with educational technologies, their "digital nativeness" (P.1066) would release their unfamiliarity when confronted with new technological concepts and objects. Results supported the assumption that those "digital natives" (Ng, 2012, p.1065) have an intuition to integrate and actively synthesize technology into the learning process. However, as Ng (2012) pointed out, digital natives are

probably less likely to actively look for, probe into and skillfully manipulate new technologies. They would only do they when introduced with a specific purpose and with precise instruction. Based on this fact, timely and correct guidance is necessary because digital literacy is deictic, whose meaning changes over time, so educators still have to be aware of intervening with technology for valuable and efficient learning (Leu et al., 2011; Ng, 2012). Cope and Kalantzis (2009) emphasized the significance of reconfiguring “the modalities of multimodality” (p.175) because if provided with timely and sufficient instruction in digital literacy, the younger generation can easily turn the invisible technology into actual output (Ng, 2012).

In addition, globalization in many social fields promotes the fusion of young groups’ cultural understanding and educational preferences, especially adolescents who are the ones who are at the age where "reading challenges occur" (Goodwin et al., 2020, p.1839) for the reason that they are curious about their surroundings and are catching and absorbing information all the time, even unconsciously. According to Smith (2019), when considering the group of adolescent, instead of simply isolating the monolingual environment, diverse means of learning resources provides learners who are of diverse cultural and linguistic background sufficient choice and relaxing atmosphere to merge into English language environment and reduce the burden of learning in English, especially when ELLs found familiarity in the alien discourse. For, instance, students found it effective when “conducting image searches, using Google Translate, and listening to words or phrases online.” (Smith, 2019, p.211) This is because images can convey information with less ambiguity among populations even though they entertain different sociocultural backgrounds and socio-semiotic understandings, which cannot happen in literal illustration due to the variation of verbal representation.

Present literature review narrows the lens of multimodal readings down to class-based settings. Multimedia and electronic resources cause an effect that varies in different usage

scenarios from out-of-school to in-class situations. The latter happens at school and under teachers' instruction while the former one is too easily affected by many social and family factors, which are hard to measure and control when discussing as a whole (Smith, Pacheco, & Khorosheva, 2020).

To formulate countermeasures to help students improve reading comprehension, it is necessary to understand how multimodal resources affect the learning process of students, what happens in their minds and what changes in their reading behaviors during that process. Therefore, the present literature review is aiming to elaborate on how the use of multimodal resources that are integrated into instruction affects reading comprehension for ELLs in middle school classrooms. The present research question is -- How are reading processes and reading comprehension shaped under the influence of the application of multimodal resources among bilingual English Language Learners (ELLs) in middle school classrooms?

Within the scope of the current research question, this review is examining the question through three sub-questions.

(1) How can multiple modalities ground the foundation of different representations of reading materials?

(2) How is information transmitted differently through varied modalities and therefore influence reading comprehension in the reading speed, reading results, and reading difficulties and so on?

(3) Through the lens of the psychological and cultural characteristic of adolescent group, how do bilingual ELLs perceive and synthesize information that is gathered from multimodal resources?

Many previous studies examine how multimodal resources, such as, web-based texts, hyperlinks, digital games, online reading and e-books, influence students' literacy achievement and reading comprehension, and examine students' comprehension levels by comparing

different performances students have when confronted with digital and printed texts (Dalton, 2012; Hillesund, 2010; Silverman, Artzi, McNeish, Hartranft, Martin-Beltran, & Peercy, 2019; Smith, Pacheco, & Khorosheva, 2020; Sun, Shieh, & Huang, 2013). Above studies aimed at investigating that if there were significant differences in comprehension achievements contributed from various modalities. As the process of “socially purposeful sense-making” (Yuan et al., 2019), plenty of tools can be applied to evaluate and measure the achievement of reading comprehension according to previous studies, such as post-design question, length of reaction time when producing composition, (Pellicer-Sánchez Tragant, Conklin, Rodgers, Serrano, & Llanes, 2020). Wexler, Reed, and Sturges's (2015) research aims at observing and testing students' reading behaviors to figure out how several key independent factors will make a difference in students' comprehension level, such as general motivation and sense of self-efficacy. However, the first goal of this review is to examine the mechanism of how integrated use of multiple resources influence adolescent ELL’s reading comprehension with teachers’ instruction. The second goal is to provide potential directions for future research and bring ideas for educators and policymakers about how to build new literacy awareness among students and create a harmonious and instructive teaching process with multimodal resources to increase efficiency and quality in reading comprehension.

### Theoretical Framework

#### **Multimodal Resources**

Multimodality refers to a variety of teaching methods includes but is not limited to digital texts, images, audio records, action or body language, etc., In this review, multimodal resources are frequently mentioned to represent the different formats of displaying teaching materials, including printed texts, websites with images, charts, diagrams and videos (Mertala, 2021; Shepard-Carey, 2020; Smith et al., 2020; Yelland, 2018). Regarding the concept of new literacy that grounded the theoretical base of this review, the internet environment raise many

requirements for learners' literacy abilities and understanding levels, requiring them to upgrade their transformation ability of new information outside on the internet (Coiro, 2011). The application of multimodal resources provides more possibilities for communication, adding more colors to in-class discourse, which bridges the gap between isolated linguistic input, including verbal presentation and physical text, and the expectation of advanced achievement in in-class reading comprehension (Early, Kendrick, Potts, 2015). Brown (2016) gave new perspectives in teaching literacy, where he emphasized the necessity of maintaining sensibility when using multimodal resources to contribute to a highly interactive and independent reading process, but the actual significance of physical books also should be involved into consideration. Since making students get used to multiple resources stimulates their potential in benefiting from those devices, they are also time-consuming and require teachers to scaffold them in advance, including digital devices, the combination of graphs, audios and texts, etc. It is interesting to notice that researchers did find online reading is more time-consuming for students than off-line reading so the present standard, where Common Core State Standards, was used as the example, cannot guarantee development in new literacy skills (Leu & Maykel, 2016).

As mentioned earlier, in the present study, multimodal resources, which can be classified through many dimensions, including but not limited to the means of traditional tools (paper book or other print-based materials), visual media (pictures, videos, movies, online account, discussion board, etc.), audio (recordings, music, speech, etc.), kinesthetic input and physical actions (head movement, facial expression, sign, gestures, or other physical contacts, and even smell or touch), and material objects (handcrafts, models, etc.) (Brown, 2016; Meneses, Escobar, & Véliz, 2018; Mills, 2010; Moreno & Mayer, 2007; Yelland, 2018; Yum et al., 2021).

### **Digital Literacies**



Donald and Kinzer (2000) believe that digital literacy, serving as technological deixis, pushes learners to acquire more advanced skills to be well-prepared for any future challenges. The central consideration of new literacy is to meet the expectations for better acquiring “knowledge, skills, dispositions and attitudes” (Timmis, Broadfoot, Sutherland, & Oldfield, 2016, p. 454) that are necessary to help the young generation merging into the advanced digital world. Instead of perceiving isolated knowledge and skills, young learners are more eager for advanced literacy instruction because those new literacy skills matter in maintaining personal identity, breaking and expanding cognitive boundaries, and constructing cultural connections (Frankel & Brooks, 2020). Therefore, it becomes a serious and challenging issue for educators to take advantage of adolescents’ experience and interests in social practices and other digital literacy practices as “the transnational knowledge bases” (Frankel & Brooks, 2020, p. 711) in order to foreground future teaching.

In actuality, even though digital education methodology is not a brand new concept, there is still a lack of pragmatic evidence as to what degree multimodal teaching methods have an impact on reading comprehension and literacy development (Martin-Beltrá, Tigert, Percy, & Silverman, 2017). Hence, more investigation needs to be launched upon through what way can multimodal resources make a difference during ELL’s reading comprehension process, appealing to more researches to figure out the mechanism lying beneath the seemingly fancy technological gadgets (Goodwin et al., 2020). Admittedly, it is pointless to evaluate the pros and cons among different teaching modalities from a mutually exclusive perspective because people have already unconsciously merged those means in practice. What should be cautiously thought about is how to synergistically combine multiple modalities smoothly and harmoniously, in regards to classroom composition and time allocation.

### **ELL’s Reading Comprehension**

Researchers show that as long as educators can draw upon ELL’s diverse linguistic and

cultural background knowledge when designing class activities and conversational instructions, it is logical that these teaching approaches will engage ELL more and then their literacy practices will be greatly enriched (van Steensel et al., 2016). The reasons lie in the fact that ELL peers are able to get used to a certain discourse unconsciously within their similar cultural and linguistic communities (Martin-Beltrán, Daniel, Percy, & Silverman, 2017). The association between vocabulary-decoding and reading comprehension is stronger than expected, especially at ELL's early age when reading ability is under a speedy developing period but their ability often slightly decreases a bit from about the first grade in elementary school (van Steensel et al., 2016). When entering middle school, different performances in reading comprehension are largely pre-determined by individual ability in "higher order skills" (van Steensel et al., 2016, p.423), suggesting that skills in decoding new words, transforming them into understandable and extractable messages and endowing them with inferential representations help them understand contexts (Cho, Woodward, & Li, 2018). Meta-cognitive instruction maintains a significant role in founding the base of adolescent reading comprehension, according to Van Steensel and colleagues' (2016) experiment. If they do not receive accurate lexical scaffolding, ELL may encounter more difficulties due to limited vocabulary in their second language.

Understanding the stages and process of ELL's reading processes and cognitive patterns can greatly contribute to the exploration of the present review, where valuable support can be found to clarify the relationship between various influences that multimodal reading instruction have on reading comprehension and ELL's reflection and reaction in response to external stimuli. As a result, better reading comprehension can be achieved by designing reading instruction in terms of adolescent ELL's features and preferences when reading.

#### Methods

The present literature review will focus on how multimodal resources scaffold English language learners' in-class reading comprehension in middle school classroom settings, by offering existing teaching methods of applying these resources to promote adolescents' reading performance. To increase credibility, the studies included are all peer-reviewed and from the following databases: ERIC, Linguistics and Language Behavior Abstracts (LLBA), and JSTOR. As a result, 38 studies are included in the present literature review to seek supportive evidence and answer the research questions on how reading processes and reading comprehension are shaped under the influence of the application of multimodal resources among bilingual ELLs.

The inclusion criteria take concept relevancy and target population into consideration. Studies including broader or more narrow scope than mine were welcomed. Potential key words this review used to narrow down the scope of research are "English language learners/L1 and L2", "bilingual learners" "middle school/adolescent", "reading instruction", "reading comprehension", "multimodal resources/multiple modalities", "technological-assist instruction", "new literacy/ digital literacy" and so on. Other supportive resources such as cognitive load, adolescent's psychological features, and the comparison of paper reading and digital reading are included to ground the theoretical framework.

This review excluded studies first through publication date, where the latest published studies maintain a priority because the discussion under multimodal resources and technological-assist teaching methods are still somewhat new today and are continuously be reformed and updated. Therefore, most of the studies were from 2015 till now. There are a few articles published before 2015 that were also included since they provided some great and classic experiments and findings. In total, 12 articles like this were reserved.

As for the population discussed in this review, this review maintains the inclination on the development of multimodal teaching and learning and the potential ways to combine multiple modalities to support in-class reading comprehension. The uniqueness of adolescents, who are

ranged from 7th grade to 9th grade, is also taken into consideration. The excluded studies are those who particularly focus on populations of those with reading disabilities or immigrants, resettled and refugees, but in this review since more social-economic status and other influential factors need to be considered as a whole, which goes beyond the scope of this review, so refugee and people with reading disabilities will not be specifically discussed and analyzed.

### Findings

#### **Input and Perception of Multimodal Information**

To figure out how the application of multimodal resources influence reading and understanding process, firstly, it is important to distinguish that how information is presented differently with the assistance of multimodal educational resources. This change results from the changes in the knowledge carrier (such as e-readers, mobile devices, physical materials and hard copies, etc.) and the varied purposes for information production. Since information is presented in different ways, when reading, students are confronted with different presentations of information, activating their different abilities. Multimodal resources create new approaches for language or knowledge input that paves the way for learners to actively engage in the learning process. For example, the gesture is helpful in ESL learning (Seo, 2021). This grounds the classroom with a flexible, diverse and relaxing atmosphere. The present study is trying to probe the issue of how multimodal representation appears differently for ELL learning. For example, (1) what is the influence of visual and auditory input, (2) whether simultaneous multimodal input challenges students' processing capacity, and (3) do traditional print-based materials and digital reading lead to different comprehension results.

**Visual and Auditory Input as Influential Factors.** By tracking eye movements, Pellicer-Sánchez and colleagues (2020) found that the performance of 11-12 year-old-ELL's reading comprehension under reading-only (RO) and reading-while-listening (RWL) conditions were different. More time was put on processing texts rather than images under the

RO condition while learners showed more focus on images under RWL condition. No significant difference in processing time and the accuracy of comprehension of given texts was observed among learners between RO and RWL condition. In the experiment, under L1 context, no significant progress was observed with the participation of multimedia to represent reading materials, while in L2 context, diverse representations of the given text showed positive support in promoting comprehension of the reading materials. Images replenish and enrich the content to be more engaging to learners, improving their abilities to derive meanings from words. People learn more deeply from combined sensory input, consisting of visual, audio and kinaesthetic input. This result indicates to educators that extra modalities can be introduced into a single task to developing learners' diverse skills simultaneously, where learning processes and the development of linguistic ability will be more efficient.

However, this is not a fixed result as well, because more researches should touch upon the differences in noticing preference on images and textual materials when processing multimodal resources and determine their allocation of focusing time (Pellicer-Sánchez et al., 2020). Generally speaking, visual and auditory stimulation can increase students' performance in English linguistic tasks. Multiple modalities provide varied modes to represent and transform information and reduce potential and invisible barriers for students in learning (Pellicer-Sánchez et al., 2020).

**Extra burden or not?** Some studies worry about the fact that multimodal resources would add on extra workload on students' reading difficulties. For example, involving additional but content-related musical resources into instruction process (Moreno and Mayer, 2000), especially on some ELL classes (Pellicer-Sánchez et al., 2020). To a certain degree, the split-attention is sometimes caused by the involvement of digital facilities, because, for instance, the computer screen is limited and cannot display everything without scrolling down, which is unavoidable. And here the physical integration of diagrams and texts together cannot fully

satisfy learners' need in understanding better. On the contrary, Roland and colleague (2016)'s experiment results disproved this argument, demonstrating that multimodal resources might not necessarily add on extra burden on students' understanding. In their study, simply adding subtle background music, rather than ordinary input, has a very limited effect on extending reaction time. The results contradicted previous studies, probably because learners are limited in the number of signals they can receive and process under low-, medium-, and high-load reading input conditions, and therefore respond differently. As result, Roland (2016)'s experiment showed that applying various types of modalities into reading instruction made no significant difference in increasing students' cognitive burden and prolonging processing time. Since not all elements that are stored in memory systems require a high focus to code and decode, where the interaction of elements is less active, this means that one element does not need to cope with other elements to make a difference to the entire context (Sweller, 2020). Thus, although some text seems complicated and time-consuming to read, it does not necessarily mean that it entertains a high cognitive load. Instead, multiple methods can serve as assisting tools for them to activate prior stored memory/element and help learners to reflect previous learning quickly. Thus, a more encouraging solution is to apply several dual-modalities that include audio input, textual input, oral instruction together, adding on the available element that can be coded in memory (Sweller, 2020). But such obstruction largely occur to ELLs who are used to studying in the L1 context so that the collision of bilingual information may push them over the edge (Pellicer-Sánchez et al., 2020).

As Rummer and colleagues (2011) tested, the contiguity assumption and visuospatial load assumption and finally came to a conclusion that learners would benefit from "auditory recency effect" (2011, p.172) when audio and short or temporal visual stimuli were presented simultaneously. For long visual texts, the comprehension of texts depends on whether the input is displayed sequentially or simultaneously, because, for the former one, the learners could

process audio while looking through visual input. For the latter one, learners can only make use of the recently-heard audio resources to facilitate their understanding of texts due to memory limitations. The ideal interaction between users and multimodality should be synergistic (Smith, 2019). Standing in line with this belief, Smith and colleagues(2020)'s argument, suggesting that as long as ELL are capable to manipulate study tools/devices they can be optimistic and attracted in further learning. Aligning with Roland(2016) and Rummer and colleagues' (2011) conclusion, Castro-Alonso and Sweller (2020) also stated that the separability of the influence from extraneous stimuli and working memory based on their experimental results that both adults learners and elementary learners, with additional auditory explanation together with the learning materials, overperformed on test scores than those who were only provided with text information on the screen. As it earlier said, the main inclination is that when working within the maximum of students' cognitive capacity, "extraneous load" (Roland BRÜNKEN, 2016, p.130) will not add on the extra workload that may cause a negative effect on understanding the context. With that said, the genre of texts also changes how modalities make a difference in learning. As studies conducted by Castro-Alonso and Sweller show (2020), when reading texts during STEM subjects, students' investigations of selective interference support the hypothesis that nonverbal information, such as concept maps, graphic annotation or moving cartoons, was actually separately processed from verbal information, for instance, static texts. Taking this into consideration, careful attention should be put on distinguishing "extraneous processing, representational holding, essential processing, and generative processing during learning" (Moreno & Mayer, 2007, p.314). These findings inspire educators that the sequence and time duration of each modality should be carefully allocated by educators to make the most advantage of multimodal resources.

**Print-based or digital devices?** After considering the effect of involving dynamic media into the conventional reading process, different reading behaviors and performances also can

result from the use of physical reading materials and digital reading carriers. First, static reading is like a road that can be seen through from the beginning while digital reading provides readers with a more dynamic and fluctuant input (Corio, 2011). This explains why previous studies have concluded that electronic materials are inferior to paper because adolescents are not well-prepared to handle the virtual information environment when they just entered middle school. In the very first place, there is a misunderstanding that electronic devices are better in promoting students' learning where the print-based materials were left behind and were out-of-date. Many studies proved the importance of paper books, but also showed that there are indeed advantages in technological-assistive teaching methods. As a result, multimodalities can enrich classroom content and teaching methods, while combining the advantages of several means, and helping educators to adjust to changes in educational objectives at any time.

Goodwin and colleagues (2020) raised experiments among 5-8th graders where previous work suggested that digital reading seemed less effective than paper reading because they found that readers made more annotation during paper reading than digital reading where there is a traditional belief that more annotation and highlights point the way to a deeper understanding of the context. However, this argument lost its position in the present work. Previous work did not push forward the investigation on how different reading behaviors, including hyperlinks, annotations, highlights, etc., influence students' understanding of the contexts. Although based on experimental results, there are more highlighted and annotated notes appearing on physical paper materials than on digital reading devices. Goodwin used post-questions to assess students' comprehension and found that notes of the paper-reading group appeared outside of the important area for answering the question and understanding the core idea of the texts. Thus, what matters is not the exterior reading trajectory but how the annotation relates to the actual understanding of the texts.



**Relationship between Multimodal Input and Cognitive Capacity.** As is discussed above, students' comprehension achievement is challenged by involving multiple resources in reading. To figure out where is the balance of reaching the highest understanding level by controlling and manipulating the use of multimodal resources within an acceptable and digestible level, this section is exploring the relationship between multiple uses of resources and students' cognitive ability. Although every class or learning practice maintains different learning goals, students can master knowledge through multiple sources. Multimodal resources ground the opportunity for divergent thinking and deductive reasoning abilities since students and educators can review the lesson materials as many times as they like without the limitation of time and space. In Smith and colleagues (2020)'s research, integration of digital multimodal tasks can not only reshape ELL ideology in response to diverse cultural identities and also expands the boundaries of time and space because learners usually compose different purposes and audiences.

According to several research studies in bilingual students' cognitive theory, it is said that the learning of a second language will become much more difficult if learners are not intentionally asking for targeted instruction (Sweller, 2020). The theory mainly puts expectations and potential concerns about which processes and steps information should be passed through and digested during instruction, where multiple instructional methods are absolutely needed (Pellicer-Sánchez et al., 2020). According to Reinhardt (2020), L2-online teaching could be equipped with multiple mediations, which should not only be described with the word "tools" and students can benefit from the new relationship between teaching and learning which is distant, technological, and private. Educators should make the most of cognitive architecture, which Sweller (2020) summarized as the randomness of acquiring information, the principle of borrowing and re-constructing, process and storage of memory, transferring stored memory into practice, when creating instructional procedures in order to

reduce the working memory load so that the complex information will not draw students' attention away from the main content.

### **Multimodal Resources Contribute to Personalized Reading Instruction for ELL.**

Applying multimodal resources can be an efficient method for personalized instruction because both educators and learners have the right to choose different tools based on different learning discourse and purposes. In terms of their findings, Moreno and Mayer (2007) distinguished the difference between the concept of mode and modality, where the former means the producer that codes the information and the latter one refers to the receiver of information. As long as enough chances are provided to learners, they can always find the most instrumental and conducive way to engage in study. The mixed-modality cannot give birth to understanding on its own and the crux of the matter here is to realize the importance of mediating multiple resources and students' learning capacity to form a harmonious and interactive connection (Moreno & Mayer, 2007). McTigue and Slough (2010) brought out five characteristics that through linguistic and visual modalities ease the way for students' understanding of contexts, including accuracy and precision of language, delivers voice and tone, consistent and organized structure, vivid and illustrative visual inset, and the arrangement and composing of verbal and visual elements.

Multimodal resources themselves can be static and "pre-determined" (Moreno & Mayer, 2007, p.310), for example, an illustrative animation or a paragraph in a book containing texts inserted with colorful images. It is how students interact and manipulate different resources to obtain knowledge that makes multimodal-assistive learning processes fresh and meaningful, including the stages of "guided activity, reflection, feedback, control, and pretraining" (Moreno & Mayer, 2007, p.310). When meaningful and heuristic learning happens, learners can screen both verbal and non-verbal messages that meet their comprehension level and cognitive capacity within their memory load, and, as a result, the next step learners should do to succeed in learning is to perceive the new knowledge and link it to their previous knowledge

by organizing multiple representations into a “coherent mental model” (Moreno & Mayer, 2007, p.313). Educators should not panic here, but it is their responsibility to simultaneously create “pre-planned” teaching materials and “in-the-moment scaffolding” according to learners’ live reactions flexibly (Symons, 2020, P.65). Therefore, to leveraging reading comprehension, students need to successfully transform the information to accessible, memorable and sharable codes in their memory system. As Sweller (2020) pointed out, the acquisition of secondary information is from the exterior, so the re-constructing and re-organizing comes into great significance for instructional processes, in particular, standing in the center of computer-assisted learning.

### **Influential Factors of Decoding Performance among ELL**

In answering the research question of how reading comprehension is shaped under the influence of the application of multimodal resources, how adolescent ELL perceive information is worth noticing because when information is transferred from the outside into the student's brain, different kinds of knowledge can be presented by different modes, which determines that the student's processing changes accordingly. Technological approaches make contributions to the decoding and processing of the input, serving as a connecting axle, building a pathway between the sender and receiver. First, key features of adolescent ELL are introduced and then, this review will explain how ELLs perceive information and digest it.

To understand how to instruct reading for adolescent ELLs, it is of great significance to figure out how ELLs take various input differently. First of all, as Smith (2019) illustrated, adolescence is a special but typical group of people who are divergent and creative in thoughts, easy to accept and show tolerance to new information in order to adapt to the new environment. Symons (2020) established a model of “nested instructional practices” which showed the containment and progressive relationship of emergent bilingual’s logic process of relating actual in-class participation by applying multiple modalities to extra-linguistic assistance and

amplification of linguistic practices, where sits the very core of reading acquisition to understand the context. She examined and proved “iterative readings, attention to language, and multimodal experiences” cannot be discussed separately and positive evidence was found that when holding text-based in-class discussion and instructing informational texts in the science texts, teachers can scaffold bilingual ELL’s comprehension of conceptual ideas with multiple modalities (Symons, 2020, P.70).

Additionally, ELLs are a heterogeneous and complex group since researchers sometimes put themselves into a convoluted status when trying to define these people (Smith et al., 2020). In fact, this population embraces a wide range of people for the reason that English is the most widespread language throughout the world and over one-tenth of students in the US are English language learners (National Center for Education Statistics, 2019). Influenced by personal ideologies, environments and cultural-historical background, English language learners examined in Rowe’s (2019) study was seen through a wider lens including emerging bilinguals, short-term and long-term learners. From this perspective, it gives plenty of restrictions and challenges to in-class reading instruction as well as to educators because this group of people in middle school usually hold the preference of connecting both languages together, especially when confronted with unfamiliar things, which are, as said above, sensitive and curious about any external information. Previous research suggested that bilingual ELL tend to store memory and consolidate understanding in various forms, even in distinct language systems (Smith et al., 2020). Educators should respect ELL’s inclination where they are actually expecting the use of L1 to repeat, translate and explain questions, simplifying sentence structure, and oral and physical encouragement (Martin-Beltrán, Daniel, et al., 2017). Because in Montero Perez’s (2020) study, the combination of textual representation and moving images can actually activate ELL’s bilingual cognitive process and motivate learners’ comprehension of these materials.

According to Smith, Pacheco, and de Almeida (2017), multimodal code-meshing can activate L1 and L2, building connections. In their experiment, they observe the behaviors of students when they constructing PowerPoint slides, where students search and screen information through their L1 and in a recursive and gyroscopic method. According to this study, teachers should view reading comprehension from a macro perspective that it is more significant to see students' logic flow and how they construct their understanding step by step to meet their social purpose.

Additionally, in response to the sub-question three in the Introduction section, in order to formulate countermeasures to help students improve reading comprehension, it is necessary to understand how multimodal resources affect the learning processes of students and what happened in their minds and what changed in their reading behaviors during that process. With an eye specifically focused on adolescent ELLs, in Akçor's (2017) study, it was found that integrating visuals and interactive activities largely increase learning motivation among older learners after elementary school although there are not any obvious improvements appearing in learning scores or another quantitative level. While this finding really opens a window for researchers to dig into the relationship between adolescents' development, psychologically, and reading performance, educators can find suitable modalities, which, according to Akçor (2017), can be visuals and interactive technological tools, and choose corresponding teaching strategies for a stronger motivation in reading and better achievement in reading comprehension, which cannot be simply reflected on scores or other quantitative assessment tools.

As most bilingual learners have the capability of maintaining two languages at the same time, second language acquisition is usually not a tough problem for them. However, they sometimes do need proper stimulus to activate their sensitivity to a second language. Technological-assistive methods could offer timely help because the hyperlinks, online

searching, and bulk of media resources enable them to build up their own knowledge structure in a way they feel most comfortable. In some situations, present reading instruction methods lack a bridge to connect students' reading abilities across English and their native language(Ascenzi-Moreno & Quiñones, 2020). ELLs have a stronger desire and need more space to involve both languages within the same field to mix and learn as a whole, especially during reading comprehension processes because reading and languages are closely connected in bilingual classrooms. Even though some ELL may have long exposure in English-speaking environments, assistance and scaffolding are still essential to shorten the distance caused by cultural, geographic or psychological differences. In this way, particularly, as Ascenzi-Moreno and Quiñones (2020) in their study suggested, when teacher's oral instruction seem dull and less-illustrative, varied modalities serve as the lifting jack to trigger bilingual learners' knowledge and learning motivation in a refreshing way, generously offering a bunch of choices and letting students access their familiar things, narrowing the distance between students capabilities and expected achievement. When considering bilingual learners' reading comprehension procedure, Yum, Cohn, and Lau (2021) noticed that integrated reading modalities can ease the difficulty of meaning-making among ELL as a whole, which not only raises interest and shortening reading time but also increases comprehension accuracy as a result. As Smith (2019) illustrated in his study, nonverbal modalities promote understanding in meaning of given contexts. People should understand concept of trans mediation correctly, that trans-mediation should involve creative thinking and adaptive adjustment across modes, which illustrates the fact that if it is expected that the trans-mediation of information can truly come into play, the preconditions is that students are able to digest and assimilate contents of different kinds and are capable to design creatively and think critically during the process (Smith, 2019). The authentic purpose of multimodal application is located within the recreating process (Smith, 2019). Smith (2019) conducted an experiment by creating two projects, one is hypertext

projects and the other is video analysis, where both require student to process information passively and expandedly, including but not limiting in "screen capture, video observations, and design" (Smith, 2019, p. 197). This study aimed at figuring out how meaning is produced through synergistic interactions between different models. Many bilingual ELLs in the study shared that composing projects with multiple modalities offer great help in understanding the language, which is English as their L2, and the contexts they analyzed, as well as accurately representing their opinions (Smith, 2019). Our understandings of multimodal composition are also informed by research in translanguaging, where bilingual ELL's L1 are respected as their cultural and ideological heritage, and Rowe (2019) emphasized the possibility of applying digital devices to fill the gaps across languages. After all, the existence and transformation of language aims at meeting communicative goals through a series of comprehensive and integrated interactive practices, carried by semiotic codes expressed by linguistic output, physical gesture textual information, digital representations and other modalities (Smith et al., 2020) as a "discursive mediation" (Martin-Beltrán, Daniel, et al., 2017, p.152) of bilingual ELL when taking part in reading practices.

Multimodal resources as a mediator in the reading and comprehension process can be dynamic for the fact that they can imperceptibly merge into learners' reading processes. Unfortunately, it is risky to underestimate the difficulty of the challenges that multimodality offers to educators, for the fact that simply stacking and listing several modalities is not the right way to be naturally and comprehensively involved in the classroom setting. Martin-Beltrán, Tigert and colleagues (2017) worried that some of the educators misunderstand the reason why multimodal resources are taking position in multilingual classroom settings. The reason is that they underestimate the value and difficulty in designing a qualified technology-assisted teaching strategies, just going with the flow. Moving physical words from printed handouts to PowerPoint on the screen is absolutely not teaching multimodally, and students are

still following a similar reading strategy and not engaged more and think more actively (Martin-Beltrán, Tigert, et al., 2017). Hence, the truth behind the phenomenon is that educators and learners are expected to get out of existing reading pattern and take adventure in testing advanced technology and other modalities for heuristic reading instruction, looking for more improvement in leveraging reading comprehension level. Educators should bear in mind that although any kind of teaching method is aiming to achieve teaching goals and help students meet their academic expectations, it is important to create a positive learning atmosphere. The goal of those facilities is to be “invisible” so that students can focus on the knowledge itself but not the appearance of learning technologies.

#### Discussion

As it says in Goodwin (2020)’s passage, although students annotated and highlighted more on printed materials while there were less on digital reading platforms, annotation and notes on printed materials occurred on unrelated sections that did not match with the post-test questions while notes on e-readers or computers appeared in sections of higher relevance to the post-reading question. Therefore, the duality of multimodal resources needs to be carefully understood and applied. Educators should notice that one should select modality carefully based on learners’ learning purposes and how the reading material is related to their L1 and to what degree can they use their L2 to contribute to the overall comprehension of the given texts (Pellicer-Sánchez et al., 2020). In general, the present review investigated the relationship between multimodal resources with reading comprehension among bilingual adolescent students. Findings are discussed mainly from three aspects. Firstly, multimodal resources have plenty of presentation formats for reading materials which ask for different reading strategies and abilities for learners, where teachers should give timely instructional guidance to teach how to use those tools and execute them together with students to make the best of those modalities. Within this section, whether adding more modalities into learning processes will



put an extra burden on comprehension difficulty and cognitive load was also explored. Besides, apart from diverse representation formats, multimodal resources also ground the foundation for personalized learning where learners have ample space to select the best suitable way for themselves to read more efficiently.

Secondly, multimodalities provide bilingual ELL sufficient opportunities to display and represent ideas. On the other hand, multimodal representation required learners to decode and understand not only the text itself but also invisible meanings carried by various modes of communication that make up reading composition (Meyer & Jiménez, 2017).

Thirdly, awareness is needed in assessing comprehension level. Performance on reading comprehension can be measured by recording reading speed, length of reaction time, comprehension accuracy, and can be evaluated through interest/satisfaction of the reading (Goodwin et al., 2020; Yum et al., 2021). When determining the efficiency of multimodal resources and designing future teaching strategies, educators should distinguish the origin of students' better performance in reading comprehension tests, for instance, the improving speed in reading and better scores in answering questions, because sometimes increase in the imperceptible expression such as learning motivation may also be the by-products of multimodal application, which may not absolutely cause a difference in measurable and quantitative tests (Yum et al., 2021). Serafini, Moses, Kachorsky and Rylak (2020) created a multimodal reading assessment template as a framework to record students' reading behavior and performance. As Serafini and researchers (2020) admitted, It is undecided whether this model is of great significance in providing teachers with useful suggestions in future instruction strategies, but it leverages teachers' perception of students' identity and multidimensional ability measurement.

Proposed by Moreno and Mayer (2007), educators are supposed to think of how to create a learning environment that best suits learners' desires and appeals from five basic guiding

principles, where they responded to the legitimate approaches for constructing an interactive multimodal learning environment. They emphasize that when dealing with various kinds of composition, one has different preferences and educators should scaffold learners and wisely arrange allocation of modalities in terms of different teaching goals. Apart from the significance and necessity of using meta-language in the classroom context, adolescents indeed show different affordance in front of different composition tasks and different levels of preference in digesting and internalizing them (Smith et al., 2020).

This review also provides potential solutions for bilingual ELL educators on how to use multimodalities to improve reading comprehension in middle school classes. Based on the studies above, closely combining digital materials, computer-assisted technologies, and online platforms/forums with traditional print-based materials is worth trying because it is a great chance to bring old-fashioned methods new energy and put new technology in the classroom practice. This should inspire educators to be careful and well-prepared in designing and arranging teaching materials and facilities by choosing modalities that are mastered and adapted by students to take full advantage of their preference as digital natives and prior knowledge.

In the following, potential solutions for the situation in these findings will be explored. The present review raises some attention and makes recommendations for future research and for educators who may care about successfully merging multimodal resources into future reading instruction with ELLs.

### Conclusion and Implications

The present review illustrates possible ways in which multimodal learning ecologies were composed and aimed at finding approaches to support learners' reading comprehension from multiple aspects. In terms of previous research, applying multimodal resources requires careful design and scientific arrangement. Leu, Forzani, Timbrell, and Maykel (2015) mentioned that

students teaching each other and conducting the internet-based in-class workshop, which means to teach the student with the literacy skills of applying technologies, showed a positive effect on improving the understanding level of the texts. Although self-motivation matter in promoting self-learning, timely instructional provided by teachers is more necessary for adolescent ELL to achieve a higher level of reading comprehension. In Meyer and Jiménez (2017)'s opinions, they provided four teaching directions for student's better understanding of graphic novels, serving as multimodal texts, including (1) navigator, the start point to passively catch main ideas of text from grammatical and syntactical perspectives, (2) interpreter, multiple cues represented by linguistic, visual, auditory, social modalities, (3) designer, initiatively produce oral, written, even physical reaction to respond to the texts, and (4) interrogator, the macro-view from a socio-cultural perspective, reflecting on learners' personal cultural identity, which is important for ELL with a diverse background.

Teachers' in-class instructional intervention is highly valued when bringing multiple resources into a class setting. Therefore, re-considering and re-constructing the relationship between empowering new literacy with multimodal resources and rejuvenating traditional reading instructive strategies need more focus. As Coiro (2003) suggested, maintaining new literacy skills meets the need for being able to "access, manipulate, and respond" (p. 460) to new information for not just adolescent ELL but teachers. Aligning with Coiro (2011), the present review believes that educators, whoever have already applied multimodal instruction methods or those who still persist traditional simple teaching modality, mostly are only print-based, should refresh their notion on the issue discussed in this review, for seeking new ways to improve students reading comprehension and update their own teaching strategies. They are not supposed to be fooled by the idea of "digital natives" (Boyd, 2020, pp.176) who are claimed to be intuitively capable of tackling technological-related facilities. For practical action, according to diverse characteristics and cultural backgrounds of bilingual students, educators

should put different stress on not only selecting culturally responsive materials but also how assignments are made in class, how activities are arranged, and, most importantly, how multiple instructional methods are dynamically interweaved to build up understanding and promote in class efficiency in reading. Limitations

The allocation of educational resources limits the wide application of multimodal resources due to differences in socioeconomic status and policy restrictions, which requires policymakers and educators to reconsider alternatives to rejuvenate present teaching logic and traditions. The present study does not take situations that are outside of the norm into consideration, for example, students with reading disabilities, areas with disadvantaged technical facilities and learning environments with less professional support from teachers due to limited teacher quality.

Besides, in the present review, the classification of digital literacy was not explicitly defined and framed, for example, Ng (2012) framed different digital literacy abilities according to various inclinations, including “critical, visual, multimodal and reproduction literacies” (P.1077), where enriching and complicating scope of digital literacy. Since the development of students’ cognitive processes and working memory systems matter in the investigation of reading comprehension pedagogies, further analysis is needed to focus on how to refine digital literacy and how different classes influence the ongoing reading process. Potential research directions can be: to what extent can students develop sufficient digital literacy to meet the requirement for different kinds of given texts/materials/discourse and what are the influential factors?

In addition, Moreno and Mayer (2017) touched upon the influence caused by multimodal resources in bilingual ELL’s reading comprehension level with the input of science texts, which is full of abstract texts and explanatory images. Since the instructional tools educators choose to use are also greatly influenced by genres as well (Smith et al., 2020), it brings out a potential

question about how different genres of reading materials make a difference in comprehension processes. For example, if technology makes a difference when dealing with informational text or fictional text, is worth exploring in the future study.

## References

- Akçor, G. (2017). Bring the Action! Involving Technical Preparatory Students in EFL Reading Classes: An Action Research Study. *Eurasian Journal of Applied Linguistics*, 3(2), 171–189. <https://doi.org/10.32601/ejal.460986>
- Aukerman, M. (2008). In praise of wiggle room: Locating comprehension in unlikely places. *Language Arts*, 86(1), 52-60.
- Boyd, d. (2020). Literacy are today's youth digital natives? In *It's Complicated* (pp. 176–198). Yale University Press. <https://doi.org/10.12987/9780300166439-009>
- Brown, S. (2016). Young Learners' Transactions With Interactive Digital Texts Using E-Readers. *Journal of Research in Childhood Education*, 30(1), 42–56. <https://doi.org/10.1080/02568543.2015.1105887>
- Castro-Alonso, J. C., & Sweller, J. (2020). The Modality Effect of Cognitive Load Theory. In *Advances in Intelligent Systems and Computing* (Vol. 963). Springer International Publishing. [https://doi.org/10.1007/978-3-030-20135-7\\_7](https://doi.org/10.1007/978-3-030-20135-7_7)
- Cho, B. Y., Woodward, L., & Li, D. (2018). Epistemic Processing When Adolescents Read Online: A Verbal Protocol Analysis of More and Less Successful Online Readers. *Reading Research Quarterly*, 53(2), 197–221. <https://doi.org/10.1002/rrq.190>
- Coiro, J. (2003). Exploring Literacy on the Internet: Reading Comprehension on the Internet: Expanding Our Understanding of Reading Comprehension to Encompass New Literacies. *The Reading Teacher*, 56(5), 458-464. Retrieved November 27, 2020, from <http://www.jstor.org/stable/20205224>
- Coiro, J. (2011). Predicting Reading Comprehension on the Internet: Contributions of Offline Reading Skills, Online Reading Skills, and Prior Knowledge. *Journal of Literacy Research*, 43(4), 352–392. <https://doi.org/10.1177/1086296X11421979>

- Dalton, B. (2012). Multimodal composition and the common core state standards. *Reading Teacher*, 66(4), 333–339. <https://doi.org/10.1002/TRTR.01129>
- Donald J. Leu, J., & Kinzer, C. K. (2000). The convergence of literacy instruction with networked technologies for information and communication. *Reading Research Quarterly*, 35(1), 108–127.
- Early, M., Kendrick, M., & Potts, D. (2015). Multimodality: Out From the Margins of English Language Teaching. *TESOL Quarterly*, 49(3), 447–460. <https://doi.org/10.1002/tesq.246>
- Forzani, E., & Leu, D. J. (2012). New Literacies for New Learners: The Need for Digital Technologies in Primary Classrooms. *Educational Forum*, 76(4), 421–424. <https://doi.org/10.1080/00131725.2012.708623>
- Frankel, K. K., & Brooks, M. D. (2020). Pathways for Educators to Challenge Deficit Perspectives: Adolescents' Transnational Digital Literacy Practices in the Classroom. *Journal of Adolescent and Adult Literacy*, 63(6), 711–714. <https://doi.org/10.1002/jaal.1042>
- Goodwin, A. P., Cho, S. J., Reynolds, D., Brady, K., & Salas, J. (2020). Digital Versus Paper Reading Processes and Links to Comprehension for Middle School Students. *American Educational Research Journal*, 57(4), 1837–1867. <https://doi.org/10.3102/0002831219890300>
- Hillesund, T. (2010). Research on reading Development of reading technologies. *First Monday*, 15(4), 15. <http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/rt/prINTERfriendly/2762/2504>
- Leu, D. J., Forzani, E., Rhoads, C., Maykel, C., Kennedy, C., & Timbrell, N. (2015). The New Literacies of Online Research and Comprehension: Rethinking the Reading Achievement Gap. *Reading Research Quarterly*, 50(1), 37–59. <https://doi.org/10.1002/rrq.85>

- Leu, D. J., Forzani, E., Timbrell, N., & Maykel, C. (2015). Seeing the forest, not the trees: Essential technologies for literacy in the primary-grade and upper elementary-grade classroom. *Reading Teacher*, 69(2), 139–145. <https://doi.org/10.1002/trtr.1406>
- Leu, D. J., & Maykel, C. (2016). Thinking in New Ways and in New Times About Reading. *Literacy Research and Instruction*, 55(2), 122–127. <https://doi.org/10.1080/19388071.2016.1135388>
- Martin-Beltrán, M., Daniel, S., Percy, M., & Silverman, R. (2017). Developing a Zone of Relevance: Emergent Bilinguals' Use of Social, Linguistic, and Cognitive Support in Peer-Led Literacy Discussions. *International Multilingual Research Journal*, 11(3), 152–166. <https://doi.org/10.1080/19313152.2017.1330061>
- Martin-Beltrán, M., Tigert, J. M., Percy, M. M., & Silverman, R. D. (2017). Using digital texts vs. paper texts to read together: Insights into engagement and mediation of literacy practices among linguistically diverse students. *International Journal of Educational Research*, 82, 135–146. <https://doi.org/10.1016/j.ijer.2017.01.009>
- Meneses, A., Escobar, J. P., & Véliz, S. (2018). The effects of multimodal texts on science reading comprehension in Chilean fifth-graders: text scaffolding and comprehension skills. *International Journal of Science Education*, 40(18), 2226–2244. <https://doi.org/10.1080/09500693.2018.1527472>
- Mertala, P. (2021). The pedagogy of multiliteracies as a code breaker: A suggestion for a transversal approach to computing education in basic education. *Br J Educ Technol*, 00, 1–15. <https://doi.org/10.1111/bjet.13125>



- Meyer, C. K., & Jiménez, L. M. (2017). Using Every Word and Image: Framing Graphic Novel Instruction in the Expanded Four Resources Model. *Journal of Adolescent and Adult Literacy*, 61(2), 153–161. <https://doi.org/10.1002/jaal.666>
- Mills, K. A. (2010). A Review of the “Digital Turn” in the New Literacy Studies. *Review of Educational Research*, 80(2), 246–271. <https://doi.org/10.3102/0034654310364401>
- Montero Perez, M. (2020). MULTIMODAL INPUT in SLA RESEARCH. *Studies in Second Language Acquisition*, 42(3), 653–663. <https://doi.org/10.1017/S0272263120000145>
- Moreno, R., & Mayer, R. (2007). Interactive multimodal learning environments: Special issue on interactive learning environments: Contemporary issues and trends. *Educational Psychology Review*, 19(3), 309–326. <https://doi.org/10.1007/s10648-007-9047-2>
- Moreno, R., & Mayer, R. E. (2000). A Coherence Effect in Multimedia Learning: The Case for Minimizing Irrelevant Sounds in the Design of Multimedia Instructional Messages. *Journal of Educational Psychology*, 92(1), 117–125. <https://doi.org/10.1037/0022-0663.92.1.117>
- National Center for Education Statistics. (2019). English language learners in public schools. Retrieved from [https://nces.ed.gov/progr\\_ams/coe/indicator\\_cgf.asp](https://nces.ed.gov/progr_ams/coe/indicator_cgf.asp)
- Ng, W. (2012). Can we teach digital natives digital literacy? *Computers and Education*, 59(3), 1065–1078. <https://doi.org/10.1016/j.compedu.2012.04.016>
- Nuzzaci, A. (2012). The “Technological Good” in the Multiliteracies Processes of Teachers and Students. *International Journal of Digital Literacy and Digital Competence*, 3(3), 12–26. <https://doi.org/10.4018/jdlldc.2012070102>

- Pellicer-Sánchez, A., Tragant, E., Conklin, K., Rodgers, M., Serrano, R., & Llanes, Á. (2020). YOUNG LEARNERS' PROCESSING of MULTIMODAL INPUT and ITS IMPACT on READING COMPREHENSION. *Studies in Second Language Acquisition*, 42(3), 577–598. <https://doi.org/10.1017/S0272263120000091>
- Reinhardt, J. (2020). Metaphors for social media-enhanced foreign language teaching and learning. *Foreign Language Annals*, 53(2), 234–242. <https://doi.org/10.1111/flan.12462>
- ROLAND BRÜNKEN, J. L. P. and D. L. (2016). Assessment of Cognitive Load in Multimedia Learning with Dual-Task Methodology : Auditory Load and Modality Effects. 32(1), 115–132.
- Rowe, L. W. (2019). Emergent bilingual students' translation practices during eBook composing, *Bilingual Research Journal*, 42:3, 324-342, DOI: 10.1080/15235882.2019.1632756
- Seo, M.-S. (2021). Multimodally Enhanced Opportunities for Language Learning: Gestures Used in Word Search Sequences in ESL Tutoring. *Journal of Language Teaching and Research*, 12(1), 44. <https://doi.org/10.17507/jltr.1201.05>
- Serafini, F., Moses, L., Kachorsky, D., & Rylak, D. (2020). Incorporating Multimodal Literacies Into Classroom-Based Reading Assessment. *Reading Teacher*, 74(3), 285–296. <https://doi.org/10.1002/trtr.1948>
- Shepard-Carey, L. (2020). Making sense of comprehension practices and pedagogies in multimodal ways: A second-grade emergent bilingual's sensemaking during small-group reading. *Linguistics and Education*, 55, 100777. <https://doi.org/10.1016/j.linged.2019.100777>
- Silverman, R. D., Artzi, L., McNeish, D. M., Hartranft, A. M., Martin-Beltran, M., & Peercy, M. (2019). The relationship between media type and vocabulary learning in a cross age peer-learning program for linguistically diverse elementary school students. *Contemporary Educational Psychology*, 56(December 2018), 106–116. <https://doi.org/10.1016/j.cedpsych.2018.12.004>

- Slough, S., & McTigue, E. (2010). Introduction to the integration of verbal and visual information in science texts. *Reading Psychology*, 31(3), 206–212
- Smith, B. E. (2019). Mediational modalities: Adolescents collaboratively interpreting literature through digital multimodal composing. *Research in the Teaching of English*, 53(3), 197–222.
- Smith, B. E., Pacheco, M. B., & de Almeida, C. R. (2017). Multimodal codemeshing: Bilingual adolescents' processes composing across modes and languages. *Journal of Second Language Writing*, 36(May 2016), 6–22. <https://doi.org/10.1016/j.jslw.2017.04.001>
- Smith, B. E., Pacheco, M. B., & Khorosheva, M. (2020). Emergent Bilingual Students and Digital Multimodal Composition: A Systematic Review of Research in Secondary Classrooms. *Reading Research Quarterly*, 1–20. <https://doi.org/10.1002/rrq.298>
- Sun, S. Y., Shieh, C. J., & Huang, K. P. (2013). A research on comprehension differences between print and screen reading. *South African Journal of Economic and Management Sciences*, 16(5), 87–101. <https://doi.org/10.4102/sajems.v16i5.640>
- Sweller, J. (2020). Cognitive load theory and educational technology. *Educational Technology Research and Development*, 68(1), 1–16. <https://doi.org/10.1007/s11423-019-09701-3>
- Symons, C. (2020). Instructional practices for scaffolding emergent bilinguals' comprehension of informational science texts. *Pedagogies*, 16(1), 62–80. <https://doi.org/10.1080/1554480X.2020.1738938>
- Timmis, S., Broadfoot, P., Sutherland, R., & Oldfield, A. (2016). Rethinking assessment in a digital age: opportunities, challenges and risks. *British Educational Research Journal*, 42(3), 454–476. <https://doi.org/10.1002/berj.3215>
- Wexler, J., Reed, D. K., & Sturges, K. (2015). Reading Practices in the Juvenile Correctional Facility Setting: Incarcerated Adolescents Speak Out. *Exceptionality*, 23(2), 100–123. <https://doi.org/10.1080/09362835.2014.986602>

Yelland, N. J. (2018). A pedagogy of multiliteracies: Young children and multimodal learning with tablets. *British Journal of Educational Technology*, 49(5), 847–858.  
<https://doi.org/10.1111/bjet.12635>

Yuan, C., Wang, L., & Eagle, J. (2019). Empowering English language learners through digital literacies: Research, complexities, and implications. *Media and Communication*, 7(2 Critical Perspectives), 128–136. <https://doi.org/10.17645/mac.v7i2.1912>

Yum, Y. N., Cohn, N., & Lau, W. K. W. (2021). Effects of picture-word integration on reading visual narratives in L1 and L2. *Learning and Instruction*, 71(September 2020), 101397.  
<https://doi.org/10.1016/j.learninstruc.2020.10139>