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Inclusion in the learning game: Applying considerations from cognitive neuroscience, educational psychology, and SLA to language learning activity and materials design

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Abstract

Considering the need for pedagogically effective learning activities and materials to support language learning, particularly within teacher-led instruction, it is curious that at present there is no overarching, research-based framework available to educators to draw from when designing and implementing such activities and materials. To address this gap, the authors of this paper have drawn from a host of relevant research pertaining to cognitive neuroscience, educational psychology, and second language acquisition to establish a framework for designing and implementing activities and learning materials capable of facilitating enhanced language learning outcomes within an inclusive classroom. Incorporating ten key considerations – attention and focus, desirable difficulty, depth of processing, deliberate practice, novelty and surprise, wakeful rest, visible learning, meaningful feedback, affective engagement, and strategic choice and use – this versatile framework not only provides teachers with necessary knowledge for designing language learning activities and materials in an engaging and efficacious manner but may also embolden them to do so.

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Introduction

Teaching is ultimately about improving learning outcomes for students. It is thus imperative for professional educators to possess a comprehensive understanding of how people learn and be equipped with a repertoire of research-informed and evidence-based learning activities, materials, and protocols they can draw from to effectively guide their students towards achieving their learning goals. By incorporating such approaches, educators can enhance the efficacy of their instructional practices and promote optimal learning outcomes for their students.

Fortunately, over the past decades, research from the domains of educational psychology, cognitive neuroscience, and second language acquisition (SLA) has uncovered practices and concepts which have demonstrably enhanced learning outcomes across a broad range of domains. Unfortunately, the majority of TESOL educators have either not been made privy to these research findings during their pre-service teacher training, possibly due to varying degrees of quality, duration, and focus of English Language Teaching courses (see Freitas, 2017; Jha, 2015) or have not engaged in continuing education practices that may provide this information (Binnie & Wedlock, 2022).

With the goal of adopting a research-informed approach in the language teaching industry, this paper introduces ten evidence-based considerations aimed at enhancing learner engagement and fostering improved learning outcomes in the context of utilizing and designing activities and learning materials to promote effective and efficient language learning. These considerations are based on the premises that:

i) language educators should embrace a research-informed approach to education;
ii) appropriate pedagogical strategies can significantly enhance learning outcomes and learner engagement;
iii) at least 20% of the population are neurodivergent (Goldberg, 2022) meaning that there exists significant, but often unrecognised, neurodiversity among language learners. To maximise learner engagement, pedagogical strategies should cater to both neurodivergent (ND) and neurotypical (NT) ways of learning; and
iv) a deeper understanding of the neurobiological and psychological aspects that underpin the learning process can support teachers in making more effective pedagogical decisions for all learners.

How people learn: Four ways

Before presenting our framework, we feel it pertinent to offer a concise overview of the four fundamental ways in which people learn. This serves a dual purpose: firstly, to furnish educators with the theoretical underpinnings that form the basis of our subsequent framework, and secondly, to offer some useful theoretical knowledge deemed integral for a comprehensive understanding of the learning process.

Novelty

Extensive research exploring the relationship between novel stimuli and critical cognitive processes (Barto et al., 2013; Bunzeck & Düzel, 2006; Daffner et al., 2000; Kafkas & Montaldi, 2018) has shown that the human brain displays a natural inclination towards novelty (Daffner et al., 2000; Mather, 2013). This connection extends to crucial aspects of learning, establishing links between novelty and key processes like reinforcement learning (Gershman & Niv, 2015; Houillon et al., 2013), declarative memory (Quent et al., 2021), recognition and recall (Tulving & Kroll, 1995), and curiosity (Gruber & Ranganath, 2019; Mather, 2013). Moreover, novelty is implicated in motivating both exploratory and avoidance behaviors (Barto et al., 2013), enhancing attention and retention (Bunzeck & Düzel, 2006; Kafkas & Montaldi, 2015; Van Kesteren et al., 2012), and fostering motivation (Barto et al., 2013). However, it is worth noting, when integrating the needs of NT and ND learners, a supportive environment is crucial, as novelty, especially absolute novelty (see below), can provoke anxiety for some ND learners. It is thus vital that appropriate levels of scaffolding are used by educators and that levels of novelty are appropriate for different students (Goldberg, 2022).

Novelty, far from being a unidimensional construct, takes various forms, notably absolute, contextual, and relative (see Kafkas & Montaldi, 2018; Quent et al., 2021; Van Kesteren et al., 2012). Absolute novelty pertains to stimuli devoid of prior encounters, lacking pre-existing representations (i.e., schemas) in the brain. Contextual novelty arises from incongruities between stimulus components and their contextual framework, while relative novelty is characterized by situations where familiar features are arranged in novel combinations. In relation to learning from novelty, a high level of prediction error (i.e., the range of discrepancy between expectation and reality or outcome) is generally required. Thus, it is posited that "incongruent information that is inconsistent with a dominant schema" (Van Kesteren et al., 2012, p. 211) (i.e., contextual novelty and relative novelty) enhances memory for novel stimuli since it introduces the highest level of prediction error. This aligns with Mather's (2013) assertion that the optimal level of novelty exists when there is a moderate "discrepancy between a stimulus and an observer's representation of that stimulus" (Mather, 2013, p. 492). Conversely, novel stimuli in a novel location (i.e., absolute novelty) may not result in enhanced memory due to the absence of pre-existing schemas, thus limiting prediction error (see Quent et al., 2021; Van Kesteren et al., 2012). These nuanced classifications provide educators with a lens to examine the impact novelty has on learning. Recognizing the various forms of novelty allows educators to strategically design and implement learning protocols and activities that best capitalize on the power of novelty in learning (Quent et al., 2021; Van Kesteren et al., 2012).

Repetition and recall

The concept of learning through repeated exposure, known as Hebbian repetition learning, is grounded in the principle that "cells that wire together, fire together" (Attout et al., 2020; Munakata & Pfaffly, 2004). Initially demonstrated through an immediate serial recall task, the

Hebbian repetition learning effect manifests as an incremental improvement in recalling repeated digit sequences compared to novel ones (Hebb, 1961). This fundamental learning mechanism underscores the idea that repeated exposure leads to the wiring together of neural cells, facilitating enhanced firing. Such learning processes are pivotal in various domains, encompassing vocabulary acquisition (McMurray et al., 2012), reading (Bogaerts et al., 2016; Attout et al., 2020), mathematics (De Visscher et al., 2015), and statistical learning, which is vital for language processing (Munakata & Pfaffly, 2004; Tovar & Westermann, 2023), as well as phonological awareness (Page & Norris, 2009). However, research on Hebbian repetition with adults on the autistic spectrum finds that while (visual) repetition improves recall, this improvement is generally not transferred when the task is slightly changed (Harris et al., 2015). In this study, they also found that less frequent repetition of stimuli led to improved habituation.

In conjunction with Hebbian repetition learning, the significance of retrieval and recall in the learning process is underscored by the foundational principle that effective learning is not solely about encoding and storage but crucially hinges on the ability to retrieve information (McDermott & Roediger, 2018; Rajaram & Barber, 2008; Tulving, 1991). Recalling learned material through focused methods such as testing and free or cued recall tasks (see Rajaram & Barber, 2008), especially in situations where the learner is cognitively engaged in processing the stimulus, acts as a powerful form of repetition, strengthening neural pathways (Sousa, 2016). This targeted and intentional repetition enhances memory consolidation and promotes more robust long-term retention. Research, dating back to Ebbinghaus (1885/1964) and extending through subsequent decades, consistently highlights the positive impact of repeated retrieval on long-term retention. Furthermore, retrieval processes may contribute to metacognitive awareness, allowing learners to gauge their understanding, identify knowledge gaps, and refine study strategies – although explicit coaching in such strategies is often required (Carpenter et al., 2022), especially for ND learners. In essence, retrieval and recall are not mere consequences of learning but practices that actively contribute to learning itself (Karpicke & Roediger III, 2008; Tulving, 1991, 1995).

Affective resonance

Several decades of research has demonstrated that emotions profoundly impact diverse cognitive processes, encompassing perception, attention, learning, memory, reasoning, and problem-solving (Dolcos et al., 2020; Tyng et al., 2017). Significantly, content or contexts eliciting emotional responses, whether positive or negative, consistently exhibit heightened memorability, underscoring the integral role of emotion in the cognitive landscape (Dolcos et al., 2020). Beyond influencing the initial encoding and retrieval of information, the impact of emotions on learning extends to attention modulation, shaping its selectivity, and motivating actions and behaviors (for further discussion, see Tyng et al., 2017). For instance, a state of curiosity, characterized as an affective state associated with psychological interest in novel or surprising stimuli, often prompts further exploration and primes the brain for learning (Gruber & Ranganath, 2019; Kang et al. 2009; Oudeyer et al., 2016). Conversely, feelings of surprise, an affective state denoting a mismatch between prior expectations and what is observed or

experienced (Barto et al., 2013), is implicated in learning for the role it plays in not only directing attention toward the to-be-learned material but also enhancing its saliency (Itti & Baldi, 2005).

In terms of academic emotions, i.e., affective states "directly linked to learning, instruction, and academic achievement in formal and informal settings" (Um et al., 2012, p. 1), numerous studies reveal that positive affect plays a pivotal role in various cognitive processes essential to learning (Tyng et al., 2017). These processes include information processing, communication processing, negotiation processing, decision-making processing, category sorting tasks, and creative problem-solving processes (Isen, 2015). Exemplifying the intricate connection between emotional experiences and cognitive functions, these findings emphasize the pivotal role that emotions play in the learning process, whether in face-to-face settings (Vogel & Schwabe, 2016) or online environments (Shen et al., 2009; Um et al., 2012).

Association

Almost six decades ago, Ausubel (1968) asserted that "the most important single factor influencing learning is what the learner knows already" (p. vi). This foundational notion underscores the integral significance of prior knowledge in shaping comprehension, retention, and broader learning outcomes, as corroborated by extensive research (e.g., Brod, 2021; McCarthy & McNamara, 2021; Tse et al., 2007; Van Kesteren et al., 2014). Functioning as a form of cognitive infrastructure, prior knowledge facilitates the assimilation of new information into existing schemas, optimizing memory processes (Tse et al., 2007).

However, the impact of prior knowledge on learning is nuanced and hinges on three key determinants: the activation of prior knowledge, its relevance to the learning task at hand, and congruence with the content being learned. The interplay of these determinants shapes the relationship between prior knowledge and learning outcomes (Brod, 2021; McCarthy & McNamara, 2021). Navigating these nuances is essential for educators to effectively leverage learners' prior knowledge in shaping educational strategies and optimizing the learning experience.

In the context of education, recognizing how knowledge acquisition guides successful learning becomes fundamentally important (Van Kesteren et al., 2012). In short, learning is enhanced when new information aligns with existing mental frameworks or schemas, serving as organizational tools that enable individuals to understand and assimilate new knowledge and skills more readily. Educators play a pivotal role in facilitating learning by encouraging learners to establish connections between new material and their prior knowledge or by devoting time to helping learners develop appropriate schemas (see Hattan et al., 2023). Such intentional association and schema activation not only contribute to heightened comprehension but also significantly aid in the long-term retention of information.

To enhance and guide the schema building and activation process, educators need to maintain an understanding of the role of scaffolding, especially macro-scaffolding for long-term planning, meso-scaffolding for guiding task selection and sequencing, and micro-scaffolding for supporting real-time interactions between educators and students (see De Oliveira, 2023; Walqui, 2006). By possessing knowledge of how schemas promote learning, educators are in a better position to design more effective learning protocols.

In summary, the literature review above has elucidated the four fundamental ways people learn: novelty, repetition and recall, affective resonance, and association. With this understanding, we will now shift our focus to presenting ten considerations that language educators are urged to bear in mind when designing and implementing activities, tasks, games, and materials aimed at facilitating language learning in an efficacious way.

Designing and implementing activities for language learning: Ten considerations informed by cognitive neuroscience, educational psychology, and SLA

Grounded in an extensive body of research pertaining to cognitive neuroscience, educational psychology, and second language acquisition (SLA), the framework presented in this paper offers educators a comprehensive approach to guide the selection, design, and implementation of activities and materials for language learning purposes. By integrating research-based strategies, this framework aims to enhance learner engagement, motivation, and self-efficacy, optimizing language learning outcomes while also considering learner neurodiversity. The framework presented below comprises 10 considerations that educators can embed within their learning and teaching design. These considerations are:

1. Encourage attention & focus;
2. Factor in desirable difficulties;
3. Ensure depth of processing;
4. Don’t be afraid of deliberate practice;
5. Exploit novelty and surprise;
6. Take a wakeful rest;
7. Maximize motivation by providing opportunities for visible learning and micro successes;
8. Remember, affective engagement matters;
9. Provide meaningful feedback and feedforward; and
10. Strategic selection and use.

In the exposition of these considerations, we provide tips alongside each that demonstrate how educators can employ them in their learning and teaching. It should be noted that we are not suggesting that all of these considerations need to be embedded in every bout of learning and teaching, or in every activity, but that these are ways in which learner engagement and efficacy of learning can be improved. Educators may want to adopt some or all of them in their

pedagogy. Indeed (and we hope), many educators may already be doing these things, and our framework simply provides an explanation for why they work, thus affirming existing teaching practices.

Through the incorporation of this framework, we believe that educators will be better equipped to select, design, implement, and leverage activities and learning materials to create engaging and pedagogically beneficial language learning experiences for their students. It should, however, be noted that as the research tends to focus on neurotypical learners, some of these strategies may not be effective for neurodivergent learners. Where it would make sense to adjust such strategies to create an inclusive classroom, this is signalled in our discussion.

Encourage attention & focus

When it comes to learning, one thing is certain, without attention, focus, and engagement, very little learning takes place. This assertion, which is supported by findings from cognitive neuroscience (e.g., Chun & Turk-Browne, 2007; Craik & Lockhart, 1972), educational psychology (e.g., Kirschner & Hendrick, 2020), and SLA (e.g., Schmidt, 2012), is congruent with Posner and Rothbart's (2014) claim that "[o]f all the factors that influence learning, attention to the learned material may be the most important" (Posner & Rothbart, 2014, p.14). Bearing in mind Leamnson's (2000) contention that "the really difficult part of teaching is not organizing and presenting the content (by whatever technology) but rather in doing *something* that inspires students to focus on that content" (Leamnson, 2000, p. 39 – original italics), a suggested approach is to design activities that learners are inspired to engage with. Distraction can be a problem for both NT and ND learners, so by managing the learning environment in such a way that learners are not distracted from the learning activity, and the learning activity is somehow interesting to the learner, educators can encourage greater attention on task. One way to do this is to avoid information overload and to present tasks in small, easily absorbed chunks. Another is to provide clearly structured activities where the instructions and goals are clear (Mohebbi, 2023). Indeed, taking this approach would not only help ensure that neurotypical (NT) learners remain focused but also promote a more inclusive learning environment for neurodivergent (ND) learners. However, additional consideration needs to be given to the specific difficulties with focused attention experienced by learners with attention-deficit/hyperactivity disorder (ADHD). This can be achieved by mitigating distractions and disorientation and by providing clear instructions (Meyers & Bagnal, 2015).

Tip 1

To design learning activities and materials that encourage greater levels of attention, focus, and engagement, educators should attempt to leverage reward prediction error (see Consideration 5), provide an element of novelty and surprise (see Consideration 5), be affectively stimulating (see Consideration 8), and present activities in ways that motivate learners to engage with the activity with limited prompting from the teacher (something which

can often be achieved by incorporating an element of fun, encouraging friendly low-stakes competition between learners, and where possible, highlighting the relevance of the learning outcome to the students). Finally, ensure the duration of the task does not exceed the learners' capacity to concentrate, and, as much as possible, minimize competing stimuli in the learning environment to reduce distractions (Wedlock & Binnie, 2023).

Factor in desirable difficulties

Consistent with research indicating the benefits of desirable difficulties, which involve adaptive task manipulations requiring increased cognitive effort (Bjork & Bjork, 2011; Bjork & Kroll, 2015), studies from various domains suggest that optimal learning occurs when there is a balance between an individual's perceived skills and the difficulty level of the learning activity (Kidd et al., 2012; Metcalfe & Kornell, 2005; Wilson et al., 2019), and when one's expectancy of success in a given learning task is high (Bandura, 1977; Rea, 2000). This sweet spot for optimal learning (Wilson et al., 2019), often referred to as the "Goldilocks Zone" (Kidd et al., 2012), is hypothesized to occur when training accuracy is around 85% (Wilson et al., 2019). Although this accuracy rate is dynamic and influenced by several factors beyond the scope of this paper, research suggests that training that is neither too easy nor too hard not only supports learner interest and arousal, but also expedites learning (Rea, 2000; Wilson et al., 2019). Additionally, this zone promotes "flow"—a state where learners become so engrossed in an activity that they lose track of time (Engeser & Rheinberg, 2008; Nakamura & Csikszentmihalyi, 2014; Rea, 2000)—and provides challenges that learners perceive as realistically achievable (for more on optimal challenges, see Abuhamdeh & Csikszentmihalyi, 2012; Rea, 2000).

Tip 2

Keeping in mind that the goal of teaching is to facilitate robust learning outcomes for students, learning activities and materials should be designed in such a way as to capitalize on the benefits of various desirable difficulties. This can be done by presenting appropriate to-be-learned materials in a randomized order, interleaving recently-learned material with to-be-learned material, introducing a mismatch between where encoding and retrieval take place (so as to limit the impact of place-dependent memory), testing (i.e., recalling the target material), adding level/skill-appropriate time pressure, encouraging the generation of answers (even if these answers are incorrect, as this affords the teacher an opportunity to provide meaningful feedback), and varying the way the to-be-learned material is presented and engaged with (e.g., processed visually and then spoken out loud, processed auditorily and then written down) (see Consideration 10 for further ideas).

In addition, educators should consider both the 'nominal difficulty' (i.e., the task's inherent difficulty), which involves evaluating not only the complexity of the task or activity itself but also the difficulty of the to-be-learned target language (for an overview of *second language*

difficulty, see Housen & Simoens, 2016), and the 'functional difficulty' (i.e., the level of challenge for an individual under various conditions) of any given learning task or activity (for a comparable view of task difficulty in language education, see Hlas, 2021). These considerations provide educators with an effective means of gauging the overall skill-challenge balance of a given task and allow for a productive learning experience for a broader range of learner neurotypes (see Guadagnoli & Lee, 2004).

Ensure depth of processing

Since the way in which a learner engages with a given stimulus (i.e., the target language) largely determines their learning outcomes (Craik & Lockhart, 1972; Kirschner & Hendrick, 2020; Leow & Mercer, 2015; Schmidt, 2012), teachers should strive to ensure learning activities and materials are designed so that they promote deeper levels of cognitive processing and engagement with the to-be-learned material.

Tip 3

Given that the use of the target language is essential for promoting deeper levels of processing, it is paramount to design or implement activities that encourage students to use the target language in progressively more intricate ways as their linguistic competence increases (see Considerations 2 and 7). If designing or utilizing a game, this objective can be achieved by incentivizing longer or more complex responses, or the use of new language, with additional game points or other game-related benefits.

In relation to depth of processing and material design, it is important for educators to design learning materials in a manner that encourages learners to actively reflect on, apply, and manipulate the target language to yield enhanced learning outcomes. As such, learning materials should be designed so they encourage learners to connect new language elements with existing knowledge and schemas. Existing research suggests that educators should design tasks that go beyond simple fill-in-the-blank activities and aim at creating learning materials that provide an optimal skill-balance challenge (see Consideration 2), requiring learners to engage in deeper levels of cognitive processing.

Don't be afraid of deliberate practice

Drawing on the seminal work of Ericsson et al. (1993) and their concept of deliberate practice, research on expert performance consistently highlights the significance of deliberate effort rather than sheer experience in acquiring expertise (Van Gog et al., 2005). Aligned with the concept of desirable difficulties (see Consideration 2) and incorporating elements such as immediate feedback (see Consideration 9), problem-solving and evaluation time, and opportunities for repeated performance to refine skills, deliberate practice not only represents

the gold standard of practice (Ericsson & Pool, 2016) but is also conducive to language learning (Wedlock & Binnie, in press). Hence, when designing activities for language learning purposes, educators are encouraged to incorporate deliberate practice, characterized by effortful and goal-directed exercises aimed at skill and knowledge improvement (see Wedlock & Binnie [in press] for caveats and considerations).

Tip 4

Deliberate practice may be promoted by designing activities that require or encourage the learner to intentionally and repeatedly process and/or use the target language during the activity. For example, if the goal of a game or activity is to help learners develop their ability to use six-digit numbers, the game should not only provide more opportunities to use six-digit numbers but also reward their correct use with more game points compared to the use of other numbers (see Consideration 5 for a caveat). During the game, the frequency and type of errors are noted by the teacher and feedback is provided (see Consideration 9). Finally, based on the level of mastery attained, the teacher modifies the activity to not only consolidate what has been learned thus far, but also to promote additional learning before repeating the activity again in a future class (see Consideration 10 for a discussion on the importance of the strategic use of activities and learning materials).

To apply the principles of deliberate practice to learning material design (e.g., worksheets), educators need to structure resources with well-defined learning objectives, targeting specific language skills. The materials should offer repeated opportunities for focused effort and advancement, challenging learners slightly beyond their current proficiency levels. Immediate feedback mechanisms, such as answer keys or peer evaluations, play a crucial role in refining responses and facilitating learning (see Consideration 9). The incorporation of repetition and variation, along with incremental progression and opportunities for feedback, not only reinforces learning but also contributes to enhanced comprehension and learning outcomes.

Exploit novelty and surprise

If it is true that at the most fundamental and mechanistic level, learning is a neurobiological phenomenon that results in physical changes in the brain cells (Owens & Tanner, 2017), then "the ability of a teaching technique to harness the processes in a student's brain that support the formation and retrieval of long-term memories will help determine that technique's effectiveness in promoting that student's learning" (Owens & Tanner, 2017, p. 7). This being the case, and understanding the important roles that the neurotransmitters dopamine, acetylcholine, and norepinephrine (Kafkas & Montaldi, 2018; Shohamy & Adcock, 2010) play in attention and focus regulation, learning, and motivation, the concepts of novelty (i.e., something not previously experienced or encountered), surprise (i.e., the result of the mismatch between an expectation and the actuality), and reward prediction error (i.e., the differences

between received and predicted rewards) (see Shohamy & Adcock, 2010; Watabe-Uchida et al., 2017), should not be overlooked when designing activities for educational purposes (Barto et al., 2013; Kafkas & Montaldi, 2018). Optimal learning, as noted by Boeve-de Pauw et al. (2019), seems to occur in settings of moderate novelty, striking a balance between too little, which can cause boredom, and too much, which can be distracting or create anxiety. As educators with experience of ND learners will understand, complete surprise is not a desirable strategy for some of these learners (e.g. ASD) while others (ADHD) may actively seek out novelty (Goldberg, 2022), so this may be one strategy that might be adjusted using greater scaffolding, which requires educators to have a good level of understanding of their students and their learning needs. In other words, what we are advocating is that a one size fits all approach is not advisable, and the role of the teacher as an active facilitator of learning is essential.

Tip 5

To leverage the power of novelty, surprise, and reward prediction error, educators should consider designing their activities so that not all payoffs (e.g., game points, outcomes) match the learners' expectations. For example, let us assume you have designed an activity that incorporates both previously learned vocabulary and new vocabulary, and unbeknown to your learners you have structured the activity so that students get larger payoffs for engaging with the new material than for engaging with known material. Instead of always rewarding engagement with the to-be-learned material with larger payoffs and the engagement with previously learned material with smaller payoffs, incorporate surprise by occasionally rewarding engagement with known materials with larger payoffs, and engagement with the new material with smaller payoffs (or even larger than expected payoffs). Not only can this approach support learning (students are usually rewarded for taking on challenges), but it can also keep an activity novel (needed for engagement) and allow learners who may not be ready to take on a desirable difficulty or engage with the new material, an opportunity to experience positive reward prediction errors (thus boosting their motivation and levels of affective engagement) (see Consideration 7).

When designing worksheet-style activities or learning materials, educators can strategically incorporate elements of novelty, surprise, and reward prediction error to optimize the neurobiological processes supporting learning, although care should be taken not to overstimulate or confuse learners by providing too much novelty at once. Introducing novel or unexpected elements within the worksheet content or format can capture students' attention and stimulate the release of neurotransmitters like dopamine, known to enhance memory formation and motivation (Kafkas & Montaldi, 2018; Shohamy & Adcock, 2010). Moreover, educators may consider integrating reward systems or unexpected positive reinforcements within the worksheet structure. This approach aligns with the concept of reward prediction error, where disparities between anticipated and actual rewards can foster heightened engagement and cognitive processing (Watabe-Uchida et al., 2017). By strategically infusing these neurobiologically relevant elements into worksheet design, educators have the potential to create more effective and engaging learning experiences for students.

Additionally, it is crucial to recognize that the "novelty effect" tends to diminish with overutilization of an activity, possibly due to habituation and a reduction in its novelty value (e.g., Fryer et al., 2019; Zhang & Zou, 2022). To address this, educators are advised to take a strategic approach to the frequency of activity use (see Consideration 10). Lastly, educators should be aware that novelty is not always a prerequisite for learning success. Familiarity with a given task or learning protocol can often yield superior results (Poppenk et al., 2010), especially for some ND learners for whom novelty and surprise may be uncomfortable. Therefore, deciding whether to incorporate or forgo novelty depends on the specific learning goal, stage of learning, and characteristics of the learners.

Take a wakeful rest

The brain consolidates memories through rest, hence why sleep is so important for learning (Walker & Stickgold, 2004). However, as important as sleep is for the consolidation of memories, it has also been suggested that the consolidation process could be enhanced by taking brief breaks interspersed throughout a learning bout, or between the conclusion of one learning task and the commencement of another (e.g., Bönstrup et al., 2019). Indeed, this is a widely implemented strategy for ND learners who may need frequent breaks from learning activities, and movement breaks tend to be a preferred option (Peiris et al., 2021). Moreover, movement breaks have been found to be useful for both ND and NT learners, with Peiris et al. (2021) finding that regular movement breaks within university classes improved alertness, concentration, and enjoyment for students. Wakeful rests have been shown to enhance memory retention under certain circumstances (e.g., Bönstrup et al., 2019; Dewar et al., 2014; Helton & Russell, 2015). Theorized to provide "optimal conditions for consolidation of recently acquired memories, perhaps due to minimal encoding of novel interfering information" (Dewar et al., 2014, p. 1), findings from a number of studies indicate that wakeful rests have the potential to reinforce the encoding and consolidation processes of learning (Bönstrup et al., 2019; Dewar et al., 2014; Helton & Russell, 2015), and may be as important to learning as practice itself (Bönstrup et al., 2019). Turning to the neuroscience of learning, Mazzoli et al. (2021), who investigated a mixed ND & NT sample of primary school students, find a "greater positive change in the proportion of deoxygenated haemoglobin in the left dorsolateral prefrontal cortex of children assigned to cognitively engaging active breaks compared to the control group" (Mazzoli et al., 2021, p. 2). This measure of neural efficiency also correlates with increased engagement in classes for both NT and ND students, further underscoring the value of breaks during classes.

Tip 6

Wakeful rests can be used to re-focus the learners' attention (see Consideration 1) while at the same time potentially allowing for the memory consolidation process to begin. Wakeful rests also allow teachers the opportunity to re-focus their attention and level of engagement

in the teaching process and/or make any adjustments to the activity deemed necessary to match the learners' current performance (see Considerations 2 and 7). It is advisable to either schedule wakeful rests at the end of each activity (within reason), or design activities and materials that incorporate wakeful rests within the activity/material itself (e.g., a wakeful rest could be placed after the second round of a three-round game or placed after the second activity on a worksheet). Some studies, (e.g. Mazzoli et al., 2021) suggest that rests that involve movement, or at least not sitting down, are more effective than resting in place, so if the environment allows, some movement is encouraged during such breaks.

Maximize motivation by providing opportunities for visible learning and micro successes

To achieve optimal motivation, Rea (2000) posits that three conditions must be met: (i) an optimal challenge must be provided (see Consideration 2), (ii) students must be 100% focused and engaged (see Consideration 1), and (iii) a state of optimal arousal must be reached. Based on the concept of "flow" (see Csikszentmihalyi, 1990; Nakamura & Csikszentmihalyi, 2014), these three conditions, according to Rea (2000), can be met when there is a balance between the serious-minded process and the fun-minded process, a process referred to as "serious-fun" (Rea, 2000). Elaborating on this notion further, Rea (2000) posits that the ideal learning condition to promote motivation is therefore one which provides learners with interesting challenges that they believe, based on their current abilities, can be overcome (i.e., the learners have a high expectancy of success) (see also Abuhamdeh & Csikszentmihalyi, 2012).

In line with the above assertion, and grounded in research suggesting that when it comes to learning, success breeds success (e.g., Wulf & Lewthwaite, 2016; Salanova et al., 2012), several scholars have emphasised the positive contribution that signs of visible learning and successful learning attempts have on one's feelings of self-efficacy and motivation (e.g., Bandura, 1977; Busse, 2014; Deci & Ryan, 2000; Kirshner & Hendrick; 2020; Rea, 2000; Salanova et al., 2012). As such, educators are strongly recommended to consider the facilitative role micro successes and signs of visible learning can play in supporting motivation, and to design their activities accordingly (see Consideration 2).

Tip 7

Since successful attempts at learning often result in increased feelings of self-efficacy and motivation, activities and learning materials should be designed so that they provide learners with manageable, but not overwhelming, challenges (i.e., optimal challenges). This can be done by designing activities/materials which combine previously learned items with to-be-learned items, especially in ways that necessitate the use of current knowledge to process and/or assimilate new linguistic input. For example, if using an activity to introduce new vocabulary (e.g., fruit), incorporating several known vocabulary items (e.g., colours) into the activity can be an effective way to not only increase depth of processing (see Consideration 3) and consolidate and/or review known vocabulary items, but also as a way to provide

learners with visible micro successes as they figure out the relationship between the previously learned items and the to-be-learned items (e.g., a yellow banana, a green grape).

Remember, affective engagement matters

From modulating attention and motivating action, to facilitating the encoding and retrieval of the target stimuli, the influence emotions have on learning has been widely discussed in the literature (e.g., Ki & Jeong, 2020; Tyng et al., 2017). Considering the relationship that exists between the psychological and neurobiological processes implicated in learning (Ki & Jeong, 2020; Leamnson, 2000; Tyng et al., 2017), the importance of affective engagement should not be overlooked when it comes to designing and implementing games, tasks, and activities for educational purposes.

Beginning with the design process, Houser and DeLoach (1998) assert that effective game design (or, for this paper, activity, task, and material design) should be visually pleasing; incorporate an "attract mode" (e.g., an appealing title page or introduction video) aimed at capturing the attention and imagination of potential players (i.e. learners); have clearly defined goals; and be user-friendly. These design principles, coupled with research indicating that catalysts for affective engagement, including passionate teachers (e.g., Leamnson, 2000; Serin, 2017), social interaction (e.g., Ki & Jeong, 2020), optimal challenges (e.g., Bjork & Kroll, 2015; Rea, 2000), self-efficacy (e.g., Bandura, 1977; Rea 2000), and enjoyment (Lucardie, 2014), suggest that for learning activities and materials to be affectively engaging, they should be designed with both the psychological and neurobiological processes of learning in mind.

Tip 8

Design elements—like the school's emblem, visually appealing layouts, and the inclusion of teacher and/or student names or photos (mindful of privacy and legal considerations)—add a touch of familiarity and relevance, thus contributing to a more engaging and personalized experience.

Regardless of specific design choices and modifications, educators play a vital role in deepening affective engagement when implementing learning activities. By injecting enthusiasm, being emotionally invested, adding a touch of humour, and fostering a classroom culture that values inclusion and sees mistakes as valuable learning opportunities, educators can create a learning environment that resonates with students on both a personal and pedagogical level. Incorporating these intentional design and instructional elements not only enhances emotional engagement but also helps establish a conducive environment for learning.

Provide meaningful feedback and feedforward

There is little question that, independent of what is being learned, feedback is necessary for correcting mistakes, monitoring progress, and improving the skill, knowledge, and performance of learners (Heritage, 2019; Luft, 2014). However, since the impact of feedback will vary depending on the type of feedback given (Ammar & Spada, 2006; Li, 2010), the learner's proficiency level (Ammar & Spada, 2006; Li, 2010; Lim & Renandya, 2020), the type of error made (i.e., a knowledge error or a performance error), the skill and knowledge of the teacher (Heritage, 2019), and as a direct result of the way a learner processes and actions feedback (Luft, 2014; Metcalfe, 2017), it is recommended that educators think about their feedback goals and strategies before employing their learning activities. Additionally, and as mentioned above, feedback is not solely about error correction; it also involves guiding future performance (Heritage, 2019). This is where the concept of feedforward – a formative process aimed at providing learners with information they can use to enhance future performance or facilitate progress (Hattie and Timperley, 2007) – is crucial. To effectively integrate feedforward, educators might find it beneficial to consider which strategies they can employ to capitalize on any formative feedback opportunities that arise during a lesson.

Tip 9

Teachers have numerous options for developing a feedback/feedforward strategy. For example, they could provide feedback whenever an error is made, at defined points (e.g., during slide transitions or at various stages throughout a game), or at the conclusion of the activity. Alternatively, educators may make strategic decisions, such as only providing implicit correction (e.g., a recast) for previously encountered items, and more explicit and detailed correction and feedback for to-be-learned items or structures. However, regardless of the type and intensity of feedback and feedforward provided, if it is not noticed, considered, and acted upon by the learner, it is arguably of little benefit.

Strategic selection and use

When it comes to learning, the deliberate selection and strategic utilization of activities and learning materials are of paramount importance in promoting robust learning outcomes. If the primary aim of learning is to enhance individuals' knowledge, skill, or performance in a specific domain, the learning activity/material should be chosen, designed (or modified), and implemented purposefully to achieve this goal. Merely selecting an activity or learning material in an ad hoc manner, or because it is perceived as inherently enjoyable or assumed to miraculously enhance learner motivation, does not guarantee its suitability for the intended learning outcomes, or its intended learners.

An inappropriately chosen game or activity may result in disengaged learners – a facet not extensively explored in much of the literature on second language learning or education in

general but experienced by many teachers. To optimize learning outcomes, educators must consider not only the learning goals but also the protocols they will employ, such as spaced repetition, daily practice, low-stakes competition, testing, deliberate practice, or leaderboards. Additionally, they should consider the stage of learning in which to employ these learning activities to best help realize any stated learning goals.

Tip 10

Unless being repeatedly utilized as part of a deliberate practice protocol (see Consideration 4), or as part of structured curriculum, it is important that educators refrain from overusing their favourite activities (since overuse often results in declined levels of student engagement, as mentioned in Consideration 5), or simply employing them for "fun". Limiting the use of each individual activity allows these resources to not only remain novel (see Consideration 5), but also allows them to retain their value as viable pedagogical tools capable of enhancing affective engagement (see Consideration 8). Therefore, it is advised that educators develop a range of fit-for-purpose, research-informed activities and learning materials that can be strategically employed in their classrooms as a means of complementing other intentionally selected learning tasks to optimize learning outcomes (also see Zhang & Zou, 2022).

Conclusion

This paper has introduced an evidence-informed framework designed to support educators in the effective design and implementation of learning activities (which also include games and tasks) and materials for language learning purposes. By utilizing this framework, educators can expect to enhance pedagogical effectiveness, increase student engagement, foster emotional investment, and elevate motivation levels in language learning. To ensure the utilization of resources with genuine pedagogical benefits, educators are encouraged to consider not only the key aspects of how people learn, such as novelty/surprise, repetition and recall, affective resonance, and association but also the underlying mechanisms that drive the learning process, including focus, depth of processing, optimal challenges, deliberate practice, and feedback.

In conclusion, while the framework presented in this paper specifically focuses on activities and materials for language learning, it is important to acknowledge that educators, regardless of their subject area, who possess a more comprehensive understanding of the neurobiological and psychological processes involved in learning for both NT and ND learners are better positioned to harness the pedagogical potential of a wide range of learning technologies, traditional, online or otherwise. By leveraging this understanding, educators can optimize the design and implementation of learning activities, thereby creating meaningful and effective educational experiences, all while encouraging inclusion in the learning game. To this end, we hope this paper has provided insightful contributions.

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