

## Article

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## Schema Theory and Language Acquisition: Justification for the Implementation of a Spiral Syllabus

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### ABSTRACT

In the realm of foreign language education, most educational institutions' syllabi and textbooks organize content in a linear fashion, moving from topic to topic. By nature of having disparate topics, the vocabulary and grammar can vary widely with little overlap beyond the most frequently used words of a language. While the linear approach may be suitable for learning topics in one's first language (L1) since a rich linguistic schematic network has already been built, in the case of EFL students, this approach is flawed due to students' lack of meaningful exposure and practice of the target language/vocabulary outside of the classroom, and as a result, second language (L2) learners forget much of the vocabulary that is studied. A different approach, via using a spiral syllabus, is proposed to teach L2 learners, which may build a richer schematic network and consequently strengthen long-term memory. In this interpretative analysis, the relationship between schema theory, memory, and its application to second language learning is explored. Justified by the theoretical research of schema theory and empirical studies of spaced repetition systems, a proposal for a spiral syllabus and the need for further research in this area is described.

**KEYWORDS:** spiral syllabus; schema theory; schemata; spaced repetition

## Introduction

A way of understanding language acquisition is a combination of memory processes which involve both knowledge (e.g. the words, grammar, etc.) and skill (i.e. the ability to know how to use and comprehend language knowledge fluidly). The conceptual bridge between knowledge and skill may perhaps be found in *schema theory* and considerations of this theory points to a better way to design foreign language syllabi.

Schema theory refers to *schemata* (or *schemas*, both plural of *schema*) being “the relevant packages of prior knowledge and experience that we have in memory and can call on in the process of comprehension” (Usó-Juan & Martínez-Flor, 2006, p. 93). Rumelhart (1980, p. 33-34) describes them as “the building blocks of cognition” and are data structures for representing general or prototypical knowledge about all concepts. Rumelhart gives the example of the concept of *buy*, which encompasses other concepts such as *purchaser*, *seller*, *merchandise*, *money*, and *bargaining* (1980, pg. 34-35). Each of those accompanying concepts is its own schema with branching associative concepts attached to them. In schema theory, any single concept is thought of as a vast network of other concepts. Thus, any vocabulary or grammatical structure learned in a second language will be indelibly linked to other concepts a learner has in their schematic network.

In second language education, the goal is to build one’s L2 schemata within its own linguistic system while not being reliant on L1 schemata (i.e. translations). This paper argues that a possible strategy to enhance L2 schemata construction is a deliberate and systematic recycling of the target vocabulary and grammar that students are expected to learn. This paper advocates for the experimentation of a “spiral syllabus”, which recycles course content (e.g., topic, vocabulary, grammar) in a structured way. This paper’s goal is two-fold: 1) to provide a theoretical justification of a spiral syllabus in L2 courses or textbooks by way of schema theory and its relationship to language acquisition and spaced repetition research, and 2) to introduce fundamental considerations on how to design a spiral syllabus.

## Literature Review

### Schema theory and language acquisition

Schema theory is a cognitive linguistic theory which purports that people draw meaning from mental representations that are formed from experiences which link with past experiences (Bartlett, 1932, p. 200-201). For example, the mental representation of an ‘egg’ may interact with many other items experienced in the past in which there is some relationship (see Figure 1).

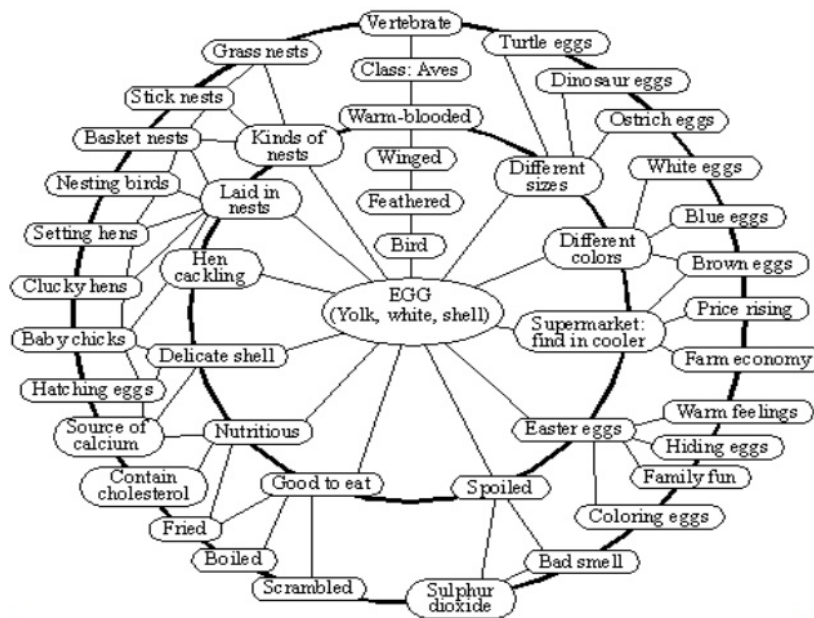


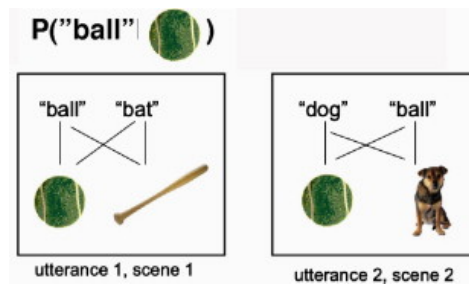
Figure 1: A representation of a possible schema for “egg”  
 (“Social Cognition (Psych 201 - Chapter 4 - Spring 2014)”, 2014)

The beneficial effect of the mind’s natural process of creating schemata is two-fold: 1) to reduce the amount of mental processing by applying a mental model to stimuli (Barrett, 2020, p. 46), and 2) to build upon entrenched mental models (Zhiqing, 2015, p. 84). For the first beneficial effect, an example of easing mental processing is a person recognizing or knowing how to use a light switch or frypan independently of its size, shape, or other idiosyncratic trait. For the second beneficial effect, building upon entrenched models allows a person to make a relatively small adjustment to an established mental model if it turns out the stimuli is responding the way he thought it would. For example, pulling a door to open it that is met with resistance will induce a

person to search for a new solution. Pushing seems to fail as well. Finally, the solution is found by locating a knob above the door handle that must be turned before pulling. Viola! The door opens. The act of finding the solution to opening the door is referred to by Piaget as *accommodation* (updating one's knowledge of the world) while knowing how to turn the knob in the first place is known as *assimilation* (utilizing a previous mental model of 'turning knobs') (Huitt & Hummel, 2003). Language works in the same way. For example, assimilation is when a toddler sees a racoon and yells out "cat!". The schema of "cat" for the child may include physical features such as small, furry, four-legged, a tail, and pointy ears. The other process, accommodation, is when an adult corrects the child and informs him/her of the correct name "cat". It is important to note that adults hold such erroneous beliefs often as well and are in a constant process of forming patterns between concepts. For example, many adults do not know the categorical differences between an alligator and crocodile, or a frog and toad. Adults will usually accommodate the new information when some outside force makes a person reevaluate their schema. For either the child or adult, any revision (or in Piaget's terms, *accommodation*) of a schema requires the new short-term memory of the word to be transferred to long-term memory, which occurs through frequency or intensity of the new information (Thurgood 1985, p.1). Frequency (or quantity) is how often an item is encountered. Naturally, the more a vocabulary item appears over time, the more likely it is to be remembered. Intensity (or quality) is how meaningful the content is for the learner. Meaningfulness can be achieved in two ways: association with pre-established schema or emotional involvement/depth (Thurgood 1989, p.2).

Although the assimilation/accommodation process occurs throughout life, when it comes to the building of language schemata, this process is mostly cemented during childhood. The unique aspect of language comes from its very own intrinsic characteristic—a cyclic feedback system. Before toddlers can utter a word in their first language, they have already been exposed to a number of words and phrases they have heard on multiple occasions and different circumstances. While it is said that toddlers can speak around 50 words by the time they are 24 months old, they can comprehend two to three times that amount by that time ("Language Development from 18-24 Months | Healthy Families BC., n.d.). Even 6-9 months-old have been shown to comprehend many common nouns shown by eye-fixation experiments (Bergelson & Swingley 2012). One process which has perplexed researchers in this field is how infants are able learn words from stimuli which

have multiple referents. For example, if a child is looking at a picture book and sees a scene of grassy hills with a bright sunny background, a rainbow, some clouds, and a horse standing on one of the hills, when a parent says the word “rainbow”, from the child’s perspective, it is unclear which of the aforementioned features the word “rainbow” refers to. Of course, a finger pointing to the target referent can guide the child into understanding what the rainbow is, but it seems to be the case that small children do this automatically as well through cross-situational experience as shown by experiments by Smith and Yu (2008). These experiments show that infants can rapidly attach meaning from sound-referents to pictures they see through multiple exposures and to scenes which contain a referent that has been repeated. For example, if there are two scenes shown to a toddler, one where the words “ball” and “bat” are spoken, and another where the words “dog” and “ball” are spoken, regardless of the order in which the words are spoken, toddlers evidently have the ability to recognize which word was repeated and therefore mitigate ambiguity (Smith & Yu, 2008) (see Figure 4 below).



*Figure 2: Associations among words and referents across two individually ambiguous scenes (Smith & Yu, 2008, p. 2).*

Therefore, when parents make roughly 300-400 utterances an hour to their children (Hart & Risley, 1995), ambiguity of the meaning of words is gradually reduced through repeated exposure to phrases and words. This makes vocabulary and grammar schemata in the first language incredibly “sticky” (i.e. hard to forget) as a result of relevant exposure. If language could be learned by exposure alone, then playing a recording of a second language in the house of a growing toddler should suffice in making the child bilingual. Of course, we know that people are very good at understanding how relevant things are to their lives, thus any baby in such a hypothetical situation would likely ignore most of the L2 audio as it simply does not apply to them. Tomasello (2000) also emphasizes the social constraints of children learning vocabulary and their ability to recognize

the communicative intentions of others as being a likely mechanism as to how children acquire language. These ideas of the importance of frequency and relevance being the mechanisms for updating schemata is at the crux of integrating spaced repetition into a syllabus. What such a syllabus may do is aid a student’s ability to remember via meaningful repetition of vocabulary/grammar. A similar process of making meaningful associations between referents may occur with an L2 student in a classroom setting if a cyclical feedback system of target vocabulary and grammar is incorporated in the syllabus.

**The Benefits of Spaced Repetition in Foreign Language Learning**

Forgetting words or expressions is a problem that everyone has experienced in their first language and likely much more often if studying a second language. Even if a word or sentence is comprehended, there is a common tendency to forget what was just learned. Why are words forgotten so easily? Decay theory, developed by Hermann Ebbinghaus (1885, cited in Tabibian et al., 2019), states that any information that we have learned fades away with the passage of time. His experiments showed a steep drop in the ability to remember, which has since been replicated with similar results (see Figure 3).

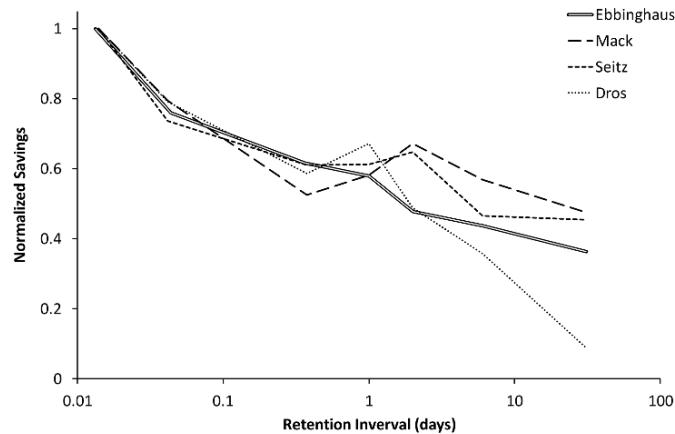


Figure 3: A comparison between studies which show normalized savings on the y-axis (Ebbinghaus’ normalized savings refers to how long it takes to relearn something to get a perfect score) and retention intervals (days) on the x-axis (Murre & Dros 2015)

Most traditional syllabi and textbooks do not repeat target content enough, and rather organize their content into separate topics. Given the array of subjects a student is expected to undertake in a year or semester, it is no surprise that repetition is hardly found. Using a university textbook as an example, viewing its table of contents, it is little wonder why such repetition is implemented as it might be awkward to do in such unrelated subjects (see figure 4).

UNIT	READING PASSAGES	UNIT	READING PASSAGES
<b>1 GLOBALIZATION</b>  Academic Disciplines Cultural Studies / Sociology	1 Turkish Treats (blog post) 2 Changing Eating Habits in Italy (essay)	<b>5 ARCHITECTURE</b>  Academic Disciplines Architecture / Urban Planning	1 We Need More Green Buildings (article) 2 Form, Function, or Both? (essay)
<b>2 EDUCATION</b>  Academic Disciplines Communications / Education	1 Should I Major in Business or Engineering? (article) 2 Distance vs. Face-to-Face Learning (article)	<b>6 ENERGY</b>  Academic Disciplines Engineering / Physics	1 Renewable Energy (fact sheet) 2 Reduce, Reuse, Recycle (essay)
<b>3 MEDICINE</b>  Academic Disciplines Health Sciences / Medicine	1 The Homeopathy Debate (debate) 2 Should Healthcare Be Free? (blog post)	<b>7 ART AND DESIGN</b>  Academic Disciplines Design / Fine Art	1 All that Art Is (article) 2 Photography as Art (essay)
<b>4 THE ENVIRONMENT</b>  Academic Disciplines Ecology / Environmental studies	1 Controlling Certain Disaster (interview) 2 Combatting Drought in Rural Africa (report)	<b>8 AGING</b>  Academic Disciplines Economics / Sociology	1 The Social and Economic Impact of Aging (interview) 2 Saudi Arabia: The Realities of a Young Society (case study)

Figure 4: The table of contents of *Prism Reading Level 3 Student's Book with Online Workbook Student Edition* (Kennedy & Sowton, 2018, p. 4, 6) a textbook used at Ritsumeikan Asia Pacific University for upper intermediate English students.

For second language learning, Krashen proposes that *comprehensible input* is at the crux of language acquisition and his *input-hypothesis* suggests syllabi be designed in a way that gradually increases the “building blocks” of language with input that is comprehensible and that pushes the student only slightly beyond their current level (He represents this as “*i + 1*” with “*i*” representing the current competence of a student) (1984, p.21-2). In the environment of a first-language classroom (or perhaps even ESL), this approach may be appropriate if the objective is to give students a range of subject matter to learn. In the context of a first language classroom, learners have enough of a grasp of the language that input that is roughly tuned to their current level can be comprehended far easier even when they are introduced to new vocabulary. L1 learners’ schemata are fundamentally different from L2 learners’—they are more complex and developed (Singhal 1998). In the EFL environment (i.e. not surrounded by the target language), teachers are supposed to roughly tune their output (or the student roughly tune their own input) to match the

level of the student without concern whether  $i+2$  or  $i+3$  occurs as long as  $i+1$  is present as well (Krashen, 1982, p.23-24). Krashen's proposal of roughly-tuned input, however, can encourage syllabus and textbook designers to take an approach of simply aiming for the general level of their students and assuming the students will naturally acquire language slightly beyond their level. This may be inefficient not because the syllabus is rough in its attempt to match with the student's level, but because there is no prescription for recycling that  $+1$ . This approach may be inefficient in the EFL context because students lack exposure to the target language. Whatever is studied may not connect as well with the developing L2 schemata because there is too much to process, which could subsequently make it harder for students to remember, or at the very least be an inefficient usage of time when time is precious in the EFL class.

L2 learners have many gaps in their L2 schemata that must be filled over time. Take the topic of globalization, for instance. Even if a learner has a relatively developed L1 schema for this topic, it is still a struggle when studying about it in the L2 if they do not know the vocabulary (e.g. import, export, tariffs, etc.) or expressions (e.g. global village, developing country, first-world country) that would be needed to converse or read about it smoothly. Certainly, their background knowledge of the topic can help them understand the topic in general and may help them pass a test, or in some cases even assist them in having a richer understanding of the L2 vocabulary if there is a word or expression which is equivalent in their native language (i.e. a cognate). However, they must first know the vocabulary and associated words of that topic (including collocations) in the L2, otherwise background knowledge may be difficult to access because of lack of comprehension, or in the case of output, frustratingly not being able to conjure the words one wants. Frequency of exposure to L2 vocabulary words can fill in the gaps, but it must be done gradually. The fact that long-term memory is enhanced when learning is spaced out, called the *spacing effect*, has been well studied (Kang, 2016, p. 14). There are several hypotheses of why gradual training is more optimal than abrupt training; these include the *attention hypothesis*, *rehearsal hypothesis*, *encoding variability*, *retrieval hypothesis*, and *reconstruction (accessibility) hypothesis* (Janiszewski et al., 2003, p. 139). The *attention hypothesis* claims that people are less inclined to pay attention to information that is repeated in a short time frame. The *rehearsal hypothesis* assumes that short-term memory holds a set of rehearsal items, and if an item is presented soon after the initial item, it would replace the initial rehearsal item. *Encoding variability* is a theory which purports that the



variability of contexts can give a learner more cues to draw from. The *retrieval hypothesis* claims that learners retrieve the memory from the initial learning phase when presented a subsequent time. And finally, the *reconstruction (accessibility) hypothesis* asserts that retrieval of a memory is reconstructing the memory; meaning if an item that one is trying to learn is repeated while it is still in short-term memory, there needs to be no reconstruction of that memory, thus long-term memory of that item is not strengthened (Janiszewski et al., 2003, p. 139-140).


With the goal of promoting long-term memory storage and a rich schematic network in the L2, it may appear that *space repetition systems* (SRS) could provide the answer with its focus on frequency. Spaced repetition systems, which are presently popular in L2 education via software and mobile applications, have been shown to be highly effective to form long-term memory (Kornell, 2009; Roediger & Butler, 2011; Underwood, 1970, cited in Hanson & Brown, 2020) and in L2 learning specifically, as well (Varela, 2020; Hanson, 2020). The way in which SRS can assist this process of memorization has been subject of many experiments and research papers. Karpicke & Bauernschmidt (2011) conducted an experiment in which American undergraduate students used an SRS to study Swahili words. The researchers found that increasing the absolute spacing, that is “the total number of trials that occur between repeated tests” (p. 1250), between testing intervals was highly effective compared to retrieval of three mass tests no matter what type of spacing. Whether the spacing was expanding— items to recall gradually increasing (e.g. intervals of 1-5-9), equally spaced—items to recall not gradually increasing (e.g. 5-5-5), or contracting schedules—items to recall gradually decreasing (e.g., 9-5-1) made no significant difference (Karpicke & Bauernschmidt, 2011). Therefore, according to this research, it seems that the way in which vocabulary words are spaced out makes little difference, however the total number of spacing is what increases the likelihood of those words to be remembered. Furthermore, they also discovered that the longer the spacing, the better the recall of vocabulary items (2011, p. 1254). Therefore, in the case of a spiral syllabus, longer spacing between target items may also be advantageous.

Although SRSs have many well-known benefits to encourage long-term memorization, there are some criticisms of SRS. Nakata (2011) pointed out the weaknesses of many popular spaced repetition programs in that many do not offer data entry capabilities and do not arrange the

exercises in order of increasing difficulty; and none of them encourage generative use by themselves. Seibert Hanson and Brown (2020) have shown the effectiveness of spaced repetition but point to the shortcoming of students' motivation of using such a program being an important factor that must be considered. Chukharev-Hudilainen and Klepikova (2016) have revamped a typical SRS in their experiment by adding supplemental activities to computer-based repetition programs (e.g. matching, spelling, fill-in-the-blank, and listening activities, etc.) and discovered that such activities increased retention rates three-fold compared with a control group. Both aspects of generative use and motivation would presumably be addressed in the context of transferring an SRS model to a class syllabus so long as the content, activities, and teachers are interesting and engaging. Since supplemental activities appear to help SRS, this provides more evidence that embedding SRS in the classroom would be beneficial, since foreign language classrooms are typically full of supplemental activities. Repeated L2 vocabulary or grammar throughout a syllabus would theoretically help to build a richer L2 schematic network by exposure to target items in varying contexts, and furthermore would lend itself to accommodation (in the Piagetian sense) opportunities in the classroom. Regarding typical L2 syllabi and textbooks, although good textbooks have a review component, and good teachers will often implement review activities (usually for the sake of a test), what is lacking in this type of review process is continuous spaced repetition and communicative depth.

As an example, presented in Figure 5 is a vocabulary review of Unit 1 of *Reading Explorer 2 Third Edition* (Macintyre & Bohlke 2020) a textbook used at a Japanese university for intermediate English students. The only review section in the textbook below comes at the end of each unit. There are no subsequent reviews of the vocabulary once a unit is finished. One may also note the dull nature of how the vocabulary words are to be reviewed.

Although frequency of exposure to words alone is not enough to efficiently acquire a second language (i.e. build a vast schematic network in the L2), it is a crucial component and informs us that a linear syllabus should be replaced by a syllabus that is more cyclical in nature.

 **VOCABULARY REVIEW**

Do you remember the meanings of these words? Check (✓) the ones you know. Look back at the unit and review any words you're not sure of.

**Reading A**

<input type="checkbox"/> addiction	<input type="checkbox"/> advertise	<input type="checkbox"/> battle	<input type="checkbox"/> cut down on	<input type="checkbox"/> drug
<input type="checkbox"/> efficient	<input type="checkbox"/> facilities*	<input type="checkbox"/> obvious*	<input type="checkbox"/> recommend	<input type="checkbox"/> store

**Reading B**

<input type="checkbox"/> continent	<input type="checkbox"/> crop	<input type="checkbox"/> flavor	<input type="checkbox"/> historic	<input type="checkbox"/> produce
<input type="checkbox"/> quality	<input type="checkbox"/> scale	<input type="checkbox"/> seed	<input type="checkbox"/> suggest	<input type="checkbox"/> variety

\* Academic Word List

Figure 5: Vocabulary review of Unit 1 of *Reading Explorer 2 Third Edition* (Macintyre & Bohlke, 2020, p. 20).

### A Proposal for Spaced Repetition in Course Materials and Syllabi

So far, this paper has delved into the theoretical justification of researching the effectiveness of a spiral syllabus. Schema theory and the effectiveness of SRS justify the need for further research of integrating spaced repetition in language courses. What such a syllabus could look like has not yet been discussed and is the purpose of this section. The idea of a spiral syllabus was proposed in the context of K-12 education by Kang (2016), which he defines as “material...revisited repeatedly over months and across grades with increasingly deeper levels of complexity” (p. 17). While many digital SRS systems space out testing in time intervals, Kang (2016) proposes using *interleaved practice* for the classroom. Interleaved practice, a system that many digital SRSs use, intersperse items in between repetitions of an item, such as the sequence ABCABCABC, where two items intervene in between the repetition of “A” (Kang, 2016, p. 15). Experiments have shown that interleaved practice compared against *blocked practice* (e.g. a sequence of learning such as AAABBBCCC) derived more benefits in motor skill acquisition, category learning, and mathematics problem solving (Kang, 2016, p. 15). Furthermore, in an actual classroom study, interleaved practice was implemented in a mathematics syllabus for certain topics along with blocked practice for other topics; two weeks after the last homework assignment, students were given an unannounced test and found that students scored higher on topics that were interleaved throughout the course (Rohrer et al., 2014). Another study of a classroom (of engineering students)

showed that “the combination of spaced retrieval practice and required feedback viewing had a powerful effect on student learning of complex engineering material” (p. 339). “Feedback viewing” means that the students were required to view the teacher’s feedback or else not receive credit. Similarly, another potentially potent combination is utilizing spacing with testing. Instead of rereading as a way of reviewing items, testing during the review phase (which is known as *spaced retrieval practice*) has been shown to produce the best results (Kang, 2016, p. 14).

As can be seen, there are a number of options on how to implement a spiral syllabus. Educators may need to consider the following when deciding how to integrate spaced repetition: type of interval (increasing, equally spaced, or contracting), spacing (temporal or interleaved), feedback, and retrieved practice. Target items of a course/textbook could also be recycled in spaced intervals and integrated within new topics. If globalization is one topic that is studied and the following unit is about sea life, then syllabus or textbook designers could figure out ways in which to incorporate the vocabulary, phrases, and grammar into the new chapter. Despite its apparent awkwardness to do so, there could be creative ways in which to incorporate studied vocabulary across subsequent subjects, and often times much of the vocabulary that is to be recycled is flexible enough to be reiterated in any subject. I propose a preliminary study be done on interleaved vocabulary recycling to see if students can remember the meaning of studied words better at the end of a course in an L2 classroom context than a control group who studies those same words in mass.

The benefits of a spiral syllabus, besides the well documented advantage of spaced repetition over massed practice (Cepeda et al., 2006), are that it is cost-effective and easy to implement as it only requires a rearrangement of homework assignments and students would spend less time relearning content that has been forgotten, leaving more time for higher-order analysis and application of knowledge (Kang 2016, p. 16-17; Butler et al., 2014, p. 338). Certainly, an overhaul of a syllabus or textbook is also another option but would require much more work and would be more time-consuming. Undoubtedly, further research and experimentation is needed to ascertain the ideal integration of spaced repetition in the context of a L2 syllabus or L2 textbook.

## Conclusion

Based on the analysis of schema theory and SRS research, it behooves educators to approach syllabus and textbook design in a cyclical way to mitigate forgetfulness. According to implications from schema theory and research of spaced repetition systems, the best way to promote the construction of an L2 learner's schematic network in the second language is by imitating the process by which individuals learn their first language—building rich schemas of the language through copious and various usages of recycled and communicative vocabulary; In other words, recycle content in the classroom. Certainly, a spiral syllabus needs further research to test its effectiveness in various EFL levels and to determine how it would be designed and the objectives of the educational institution must be considered as well.

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