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Six Effective Learning Strategies: Do Teachers in Japan Know and Use them?

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日本の教員に伝授する６つの効果的な学習指導法

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ABSTRACT

Learning strategies exist, but they are not well communicated to teachers during teacher training programs (Pomerance, Greenberg, & Walsh, 2016). This potential lack of awareness risks creating inefficient educational contexts. This paper examines six learning strategies shown to be effective (Weinstein et al, 2018) and then reports on data collected on teacher awareness and purposeful implementation of these strategies by teachers working in Japan. The data show that most teachers are unaware of the strategies and that even fewer purposefully implement them. The data also reveal that the most common strategy employed by teachers in western contexts, elaboration (Karpicke & Blunt, 2010) differs to the most often used learning strategy for teachers working in Japan, using concrete examples. A recommendation is made for teachers to avail themselves of the current extant knowledge on learning to improve their teaching and the learning practices of their students.

Keywords: learning strategies, teacher education, effective learning

1. Introduction

Effective learning strategies exist (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). Cognitive psychologists have been studying learning and how best to achieve it for well over forty years (Metcalfe & Kornell, 2007), and have identified what works and what doesn't; however, much of this research has been conducted in laboratory settings and is published in academic papers that seldom reach the hands of teachers (Pomerance, Greenberg, and Walsh, 2016). If in-service teachers and teachers in training do not have access to information regarding how students learn most effectively, it is unlikely that students will arrive at maximally effective learning strategies themselves as metacognitive studies of student Judgements of Learning (JOLs) indicate that students usually opt for less effective study strategies (Rohrer & Pashler, 2010).

In a recent examination of forty-eight teacher education textbooks carried out by Pomerance, Greenberg, and Walsh (2016), 59% made no mention of empirically verified effective learning strategies. What is more, only 10% of the books gave more than a page of coverage to explain the strategies. Clearly, this isn't sufficient to empower teachers with enough knowledge to then pass on these strategies to their students or to use them effectively in their lessons.

Before determining how best to inform the in-service teachers about effective learning strategies, it would be prudent to assess what strategies teachers are and are not aware of. To that end, this research aims to learn the level of awareness and purposeful implementation of six effective learning strategies:

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1. Spacing
2. Retrieval Practice
3. Elaboration
4. Interleaving
5. Concrete Examples
6. Dual Coding

With some baseline data, it will be possible to conduct further studies as well as design some effective training programs to close the awareness gap between educational researchers and teacher practitioners.

2. Six Effective Learning Strategies

2.1 Introduction

Students read. That is great, but to truly learn they must go beyond that simple learning strategy. According to one study, 65% of students report rereading as a regularly used study method (Dunlosky et al, 2013); however, most students do not know of or use more effective learning strategies. Teachers are well positioned to be the ones who teach students how to study efficiently and effectively, yet most do not go much beyond encouraging their pupils to 'study hard' (Chew, 2008). Following is a primer on six learning / teaching strategies that have been shown to benefit learning.

2.2 Spaced Practice

Spaced practice (also known as distributed practice) is not new. Cognitive researchers have been aware of the powerful learning potential of spaced practice since Ebbinghaus (1885/1913) demonstrated empirically how distributed practice allowed him to improve the efficiency of his learning by attaining the equivalent level of learning usually achieved in sixty-eight study cycles in only thirty-eight study cycles through spacing the study sessions across three days as opposed to completing the study in one massed session (Roediger, 1985). Since the time of Ebbinghaus, hundreds of studies have sought to better understand the power, limitations, and underlying mechanisms of spaced practice. These have been carried out both in laboratories and classrooms and have examined the impact on people of all ages.

Spaced practice is the studying of the same information distributed over time in multiple study sessions. This form of study is contrasted with massed practice, which is the covering of an amount of material in a single study session (Weinstein et al, 2018). How far apart the study sessions should take place (the lag time) and if they should occur at regular intervals or with increasingly longer lag times is still under investigation (Dunlosky & Rawson, 2015); however, it is generally accepted that longer lag times (e.g., greater than one month) lead to better retention (Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006) (Figure 1).

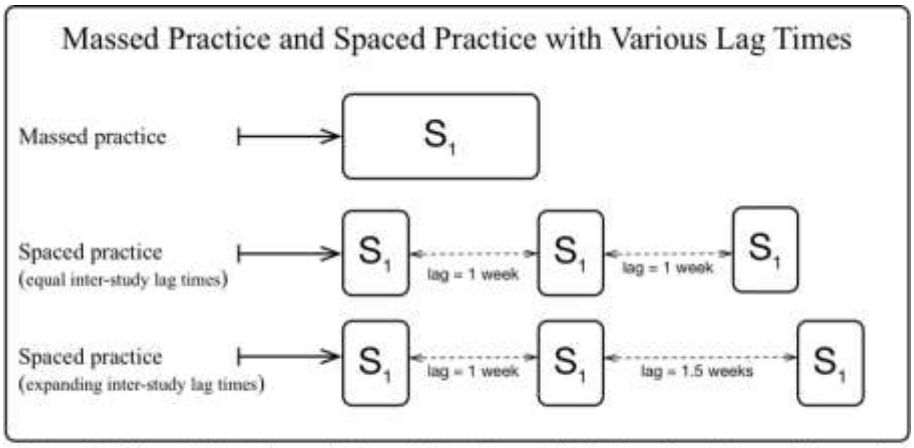

Figure 1. Massed Practice and Spaced Practice with Various Lag Times. Shows the various study options available to the teacher / student. Note that the content of each study season does not change (S_1).

There are many theories that attempt to account for the mnemonic benefits achieved through spaced practice, yet no consensus on which theory is best supported through the empirical studies has been reached. A full analysis of the varying theories of spaced practice is beyond the purview of this paper; however, I will provide brief descriptions of five possible theories. The first is the deficit processing theory (Hintzman, Block, & Summers, 1973; Cepeda et al, 2006), which is based on the idea that the level of attention given at encoding and subsequent re-encoding relate directly to the quality of the memory trace. At the point of initial exposure to something, attention is increased; however, in massed study sessions (with no-lag) and spaced practice with very short lags between study sessions, there is little novelty so the increase in attention does not occur. This decrease in attention level results in a decreased level of encoding. A second proposed theory is encoding variability theory (Glenberg, 1970; Cepeda et al, 2006). When something is studied, the learned item is encoded. Along with the newly encoded item, the context in which it was studied is also encoded. For something that is learned through massed study, the associated contexts may be very limited; however, if spaced practice is employed each learning event is potentially associated with other contexts. This resulting increase in contexts also increases the associated pathways which could raise the probability for retrieval of the learned item. A third explanation why spaced practice improves learning, the consolidation theory (Wickelgren, 1972; Pavik & Anderson, 2003; Cepeda et al, 2006), posits that second (and subsequent) exposures to something previously learned produce new memory traces. Each new trace is incorporated into the existing memory trace. If the existing memory trace is not a new memory (as it would be in massed practice or spaced practice with very short lags) and is already well consolidated, then this new trace will also become well established. A fourth proposed theory is the study-phase retrieval theory (Thios & D'Agostino, 1976; Cepeda et al, 2006) in which the new trace acts as a cue to recall the previously existing trace. As with the consolidation theory, integration at re-encoding may lead to facilitated access to the original memory trace. A fifth theory that may explain the benefits of spaced practice is the new theory of disuse (Bjork & Bjork, 1992; Bjork, 2012). This theory considers how two aspects of memory, storage and retrieval, interact. Specifically, it seeks to explain how the long-term storage of memories can be vast while the retrieval ability can be frail and prone to lapses (Bjork, 2012). In the new disuse theory, each memory has two strengths: a retrieval strength (a measure of the accessibility of the memory) and a storage strength (the degree that a memory trace is consolidated in long-term memory). These two are related in that items that have a high retrieval strength (e.g., what you just ate for lunch) may have a weak storage strength. Conversely, some things that were once known very well (e.g., the combination to your locker during high school) may be completely inaccessible now. With the appropriate cues, it may be possible to recall the memory as it still exists; it is just very difficult to gain access. During study or practice, both the storage strength and the retrieval strength of a trace increase; however, the greater the level of retrieval strength during that study, the less the storage strength will gain. Robert Bjork summed up the dynamic by saying "When something is very, very accessible right now, virtually no learning can happen" (Bjork, 2012).

This interplay between retrieval and storage relates to the comparison of massed versus spaced practice. During massed practice, the familiarity and the retrieval strength of the study subject increases with time spent on task. Therefore, the rate of increase in storage strength decreases with time spent on task. In spaced practice, the onset of each study session is associated with a decreased level of retrieval strength. Therefore, for a given period of study (e.g., three hours), having the time divided into separate study sessions would result in a greater increase in storage strength (learning) than a single massed session would. It is worth noting, that massed practice can be useful if the time between study and a summative test is insufficient to benefit from the lags between study sessions. Immediately following a session of massed practice, the retrieval strength is very high, yet this does not transition into lasting memory.

There are many ways that teachers can introduce spaced practice. With a little planning across the semester, a teacher could create opportunities to revisit the same material some days or weeks or even months after it was originally covered. A second option that requires almost no planning is to review the content of previous lessons in subsequent classes. Spaced practice is not limited to activities that take place within the classroom. Homework assignments that return to previously studied content can expand one study session to cover many previous points of study. For example, the assignment could have a question pertaining to content from two months ago, one month ago, and one week ago. Another means of introducing spaced practice to a course is through formative assessments. Low stakes quizzes or other forms of assessment can meaningfully reintroduce content that students may be losing the ability to retrieve.

2.3 Retrieval Practice

Learning is much more than the passive taking in of knowledge. It is a process of receiving input, encoding that input as a memory, and then actively reconstructing that memory through retrieval. This last part - retrieval - is an integral component of the learning process. As Karpicke et al (2011, p.772) wrote, "Not only does retrieval produce learning, but a retrieval event may actually represent a more powerful learning activity than an encoding event". The positive boost to learning derived from retrieval, which is also known as the testing effect, was first described in 1917; however, recently there has been an increase in research in the area (Roediger, Putnam, & Smith, 2011).

Retrieval practice is using output to solidify and improve learning. Although it is also known as the testing effect, the purpose for including it is not for formal summative assessment. Rather, it is a learning activity. A normal pattern may be beginning with a study session and then following the study phase, retrieval is used in a variety of ways. This series of retrieval opportunities may culminate in a summative test as would be the norm in a study / re-study classroom pattern (Figure 2).

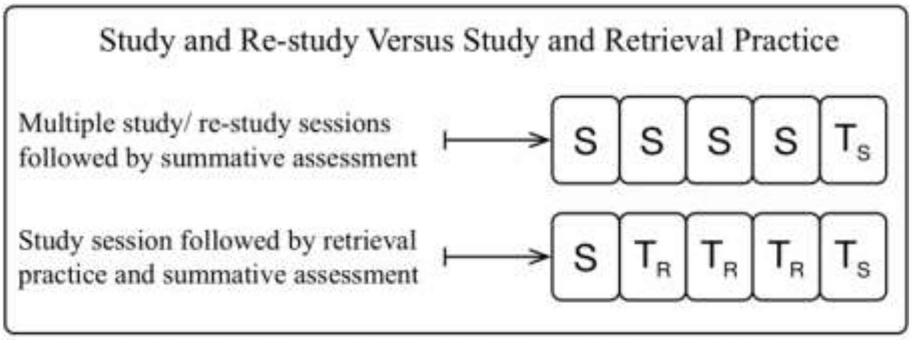

Figure 2. Study and Re-study Versus Study and Retrieval Practice. Demonstrates two possible patterns of study and assessment. In the multiple study/ re-study design, multiple study sessions are followed by a summative test (Ts). In the study and retrieve design, the learning occurs through both a study session and through retrieval session (T_R), which are then followed by a summative test. (Ts).

The benefits of retrieval practice have been demonstrated across many different subjects including general knowledge facts (e.g., Lyle & Crawford), foreign language pairs (e.g., Pyc & Rawson, 2009), and science (e.g., McDaniel, Agarwal, Huelser, McDermott, & Roediger, 2011). Furthermore, they have been shown to be effective with learners ranging from young children (Agarwal, Bain, & Chamberlain, 2013) to older adults (Logan & Balota, 2008).

Retrieval practice can range from very easy to implement activities such as asking students to put away their study materials and to simply write down everything they know about a subject to more complex quiz types of activates requiring significant teacher preparation. Each type of retrieval offers different benefits to the learners (Agarwal, et al, 2017). Roediger, Putnam, and Smith (2011) explore ten benefits of retrieval practice,with one being a direct benefit and nine being indirect benefits (Figure 3).

The direct benefit of retrieval practice is improved consolidation and strengthened retention of memories. The improvements are similar to those posited by Robert Bjork (2012) in the new theory of disuse. The challenge of recalling a memory has the effect of increasing the storage strength of that memory. An indirect benefit of retrieval is that it lays bare what is and what is not retrievable. This information is valuable to the student as it could help them to know where further revision is needed. Students often fail to accurately judge the effectiveness of their learning (Metcalfe, 2009). Study strategies such as rereading provide students with a very

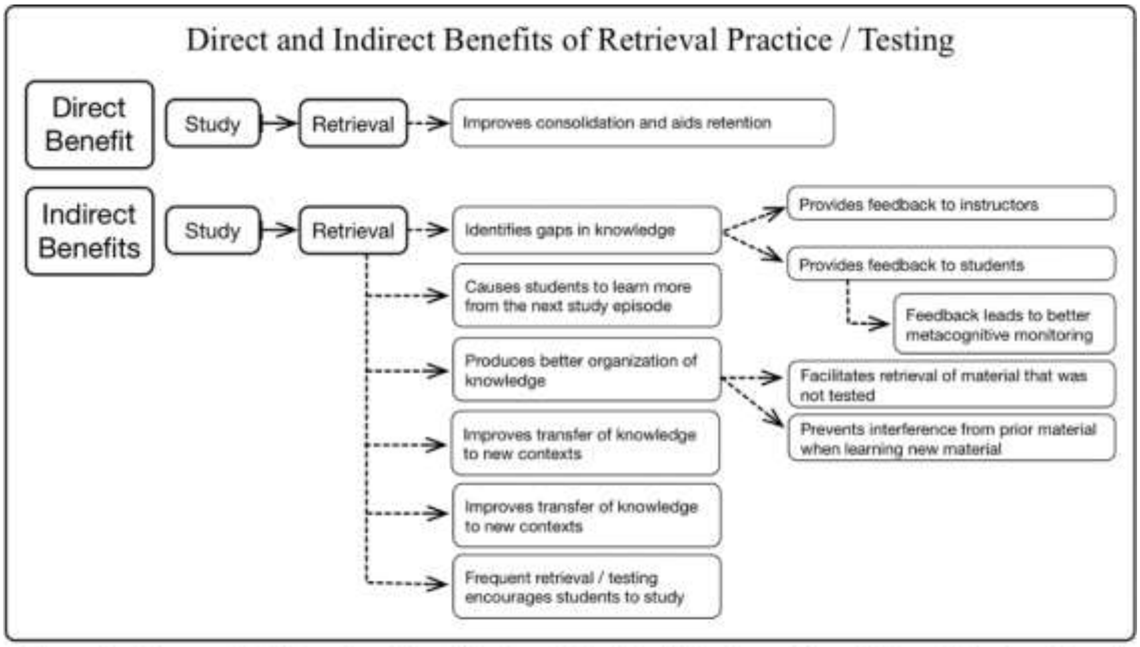

Figure 3. Direct and Indirect benefits of Retrieval Practice / Testing. Adapted from "Ten benefits of testing and their applications to educational practice" Roediger, H. L., Putnam, A. L., & Smith, M. A. (2011). In J. Mestre & B. Ross (Eds.), *Psychology of learning and motivation: Cognition in education* (pp. 1-36). Oxford: Elsevier.

positive judgement of learning (JOL) which can lead them to be mistakenly overconfident (Putnam, Nestojko, Roediger, 2016). It could also help the teacher in planning lessons and knowing what pedagogical approaches have been the most effective at promoting lasting learning. A third indirect benefit is that it potentiates learning (Izawa, 1966; Pyc & Rawson, 2010) thus improving the connections from cue to target memory. A fourth indirect result of retrieval practice is an improvement in the organization of knowledge. In a free recall test, Masson and McDaniel (1981) found that one testing session following study resulted in a significant improvement in category organization of words. The goal of education is not to fill students with facts and rote-learned knowledge. The ideal is to produce students who learn something and then are able to apply the underlying concept to new contexts. This is known as transfer, and practicing using retrieval can help it to occur. Once students become conditioned to regular retrieval practice, they adjust their study habits to accommodate the need to actively produce knowledge (as opposed to passively re-experience it). Weinstein, Gilmore, Szpunar, and McDermott (2014) found that student anticipation of being tested led to an increase in encoding of new information. Moreover, the challenge of testing oneself can be motivating, so students may look forward to opportunities to display their abilities. This 'rising to the challenge' is one aspect of gamification strategies in education (Cassie, 2016).

The level of challenge used in retrieval practice is very relevant to the outcomes achieved through employing this study strategy. Gains can be greatest if the difficulty in retrieval is significant (Finley, Benjamin, Hays, Bjork, & Kornell, 2011); however, if the challenge is such that retrieval success is very low, then the benefits are limited (Karpicke, Blunt, et al., 2014). Conversely, when retrieval is very easy, the potential for learning is reduced. This too-easy situation would be equivalent to reading and rereading a word. It is not at all difficult to recall the word that you read a brief while ago. Therefore, retrieval should be balanced in difficulty (Kang, McDermott, & Roediger, 2007). In a mixed class, it can be difficult to find the perfect level of difficulty, but providing feedback following retrieval helps students who may be struggling (Kornell, Rawson, and Klein, 2015).

Successful retrieval is not the key factor in whether learning will occur (Kornell, Rawson, and Klein, 2015). Retrieval is a two-stage process with the first part beginning when a question is asked and the search for an answer is initiated. The second stage of the process begins when an answer is found which then transitions into a re-encoding of the information. What does not seem to matter is where the answer is located. If the student recalls the answer, then it, along with the current context, will be added to memory. If the student fails to recall the information and it is provided externally (e.g., by the teacher), then it, along with the current context, will be encoded in memory (Figure 4).

Retrieval practice is quite easy to add to a curriculum and does not require any significant adjustments or in-depth planning. (For an excellent collection of retrieval practice ideas and considerations, please see Agarwal et al, 2017).

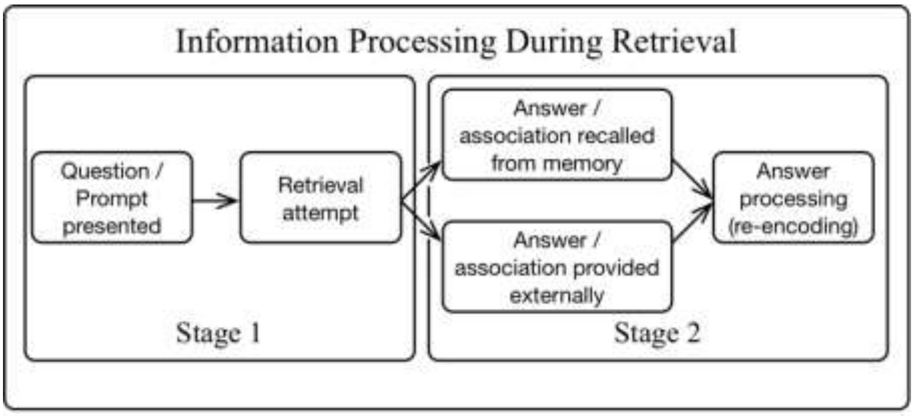

Figure 4. Information Processing During Retrieval. Adapted from "Retrieval Attempts Enhance Learning, but Retrieval Success (Versus Failure) Does Not Matter" Kornell, N., Rawson, K.A., & Klein, P. J. (2015). In *Journal of Experimental Psychology: Learning, Memory, and Cognition*, Vol. 41, No. 1 283-294.

2.4 Elaboration

Elaboration has been defined as "A conscious, intentional process that associates to-be-remembered information with other information in memory" (Hirschman, 2001, p.4369). Looking at Hirschman's definition, three key components can be seen and they are a lens through which to consider how elaboration can be used as a learning strategy. The three parts are:

- That elaboration is conscious and intentional,
- That elaboration is about making associations,
- That the associations are with things currently in memory.

Some learning strategies can happen covertly without the student realizing that they are doing something that may improve the level of transfer of their learning, such as retrieval practice, but with elaboration this is not the case. Elaboration is pointing out connections between one thing and other things and then identifying what makes them the same and what makes them different. In this way, new knowledge is integrated into the pre-existing knowledge structures (Weinstein, Maden, & Sumeracki, 2018). In order to direct attention to associations, a technique called elaborative questioning (Dunlosky, et al, 2013) can be used. This involves forming open ended wh-questions that help the student see how something that they know relates to something else. An example of this would be connecting the concept of gyroscopic procession to something that the student is familiar with. In the abstract, it may be difficult to understand; however, when related to the experiences of the student (e.g., riding a bike, throwing a ball, or spinning a yo-yo on a string) the concepts may be made clearer. Some elaborative interrogation questions to pose to a student might include: When does a bicycle stay upright most easily? What is happening at that time that is not happening when the bicycle is still? If you throw a ball where does it go? If you put a two-meter long string on the ball, where would if go once thrown? What would happen if you swung the ball by the string? How would the movement of the ball change if you suddenly changed the motion of your hand? There are many more possible questions, and each one aims to connect existing knowledge to the target concept. As the student searches for answers to whatever elaborative questions they have, it is important that the associations that they form be verified. If not, incorrect notions and understanding could be encoded in memory. One challenge in using elaborative encoding is that making questions (if students are given the task of developing their own questions) or answering questions given by the teacher can be very time consuming. Dunlosky et al (2013) give elaboration an evaluation of moderate utility in the classroom.

2.5 Interleaving

Interleaving is the 'inter-spacing' of learning episodes such that some new knowledge (Thing A) is alternated with related but different knowledge (Thing B) (Figure 5). The differences between Thing A and Thing B should not be too obvious as very extreme differences between the two things being studied render the positive learning effects of interleaving useless. Interleaving benefits learning by improving discriminability (Rohrer & Pashler, 2010). This is the ability to identify the differences between two or more things. Additionally, once one can discern that Thing A is not the same as Thing B, then a strategy of what should be done next it a process could be correctly applied. The inability to make these distinctions can result in discrimination errors. In the domain of language learning, such errors may come in the form of minimal pair sounds (e.g., / l / versus / r / for Japanese learners of English). A domain that is commonly studied is mathematics. Rohrer, Dedrik, & Agarwal, (2017) present the situation where various geometrical calculations (Pythagorean theorem, slope, and area of a triangle) could be performed on the same triangle. Presented with the same triangle and asked to calculate one of the outcomes, it may be difficult for a student to identify which of the formulas they need to use. One source of this difficulty in the study of mathematics is that almost all mathematics textbooks use blocked study as opposed to interleaved study (Rohrer & Pashler, 2010). In blocked study, the same form of thing is studied repeatedly. Although this is a good practice to develop competency with one pattern (Rohrer, 2012), practice should progress toward also including other forms of questions. When the practice is blocked and does not interleave a variety of question forms, the student gains competence in completing one question type but may not understand the underlying relationship of the task with the desired answer.

A second benefit of interleaving is that it can help students to improve their category induction knowledge. This is when a variety of things are present and through interaction with different yet similar things side-by-side, it become possible to comprehend the differences. Bjork and Kornell (2008) reported on a study in which students had to learn to identify the styles of various artists. In one group, the artists' work was presented in block formation. In a different group, the paintings were presented in an interleaved manner. On the final test, subjects saw paintings that they had not yet seen and had to identify the artist. The blocked group scored 36% whereas the interleaved group scored 59%. One limitation to using interleaving in the classroom is that the main benefit of the strategy is that it helps in discrimination tasks. Although such tasks do arise in normal courses of study, there will also be times when interleaving is not useful.

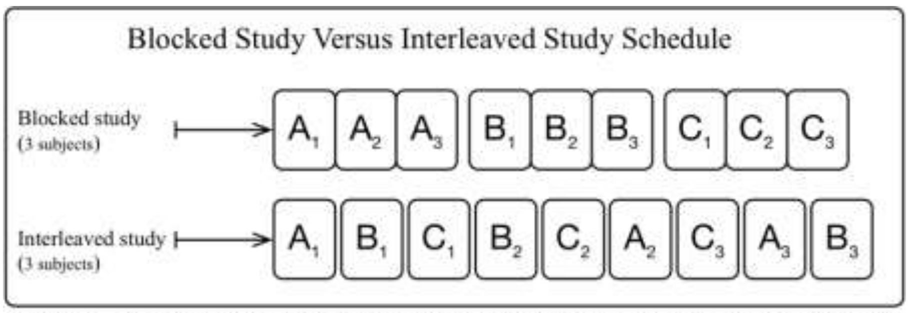

Figure 5. Blocked Study Versus Interleaved Study Schedule. Shows a possible pattern of study wherein study content does not progress across one study area, but rather shifts from one area to another and then returns to reengage with a previously covered domain.

2.6 Concrete Examples

Concrete examples connect new knowledge with prior knowledge and are naturally associated with perceptual and/or motor experiences. This has been demonstrated both at the word level (Caplan & Madan, 2016) and at the concept level (Goldstone & Son, 2005). If a concrete example is not broadened to become more abstract, then the student understanding of the final idea may not transfer beyond the confines of the specific concrete form. If students only remember a variety of discrete concrete examples, then the new information will not be well integrated with pre-existing knowledge and risks being forgotten. One way to facilitate transfer from concrete examples to abstract concepts is through concreteness fading (also known as progressive idealization). In this process, the details of a concrete example are progressively lost and elements common to a variety of examples are identified. Bruner (1966) suggested that new concepts and procedures should be presented in three forms: an enactive form (a physical, concrete model); an iconic form (a graphic or pictorial model), and finally a symbolic form (an abstract model of the concept). Goldstone and Son (2005) studied how effective this progression is for learning science concepts and found that subjects learned best when examples progressed from concrete to abstract. The reverse, abstract to concrete, did not generate the same level of learning.

Teachers can incorporate concrete examples into lesson materials without significant changes to a curriculum; however, care should be taken in the selection of which concrete examples to use. Some examples may be interesting, but if they do not add to the students' understanding of an abstract concept, then they may not be truly beneficial.

2.7 Dual Coding

A single picture contains a lot of information. Were a person to try to convey the equivalent idea in a comprehensive and exacting way, it would take a significant amount of time (Figure 6). This communicative efficiency is one of the aspects of dual coding that helps it improve understanding and learning. When something is presented with words and pictures in conjunction, learners can more readily understand the explanation than if it were given in words alone (Mayer, 2002). Dual coding is based on the premise that human information processing processes visual / pictorial input and auditory / verbal input separately. This assumption is in line with Baddeley's (2015) theory of working memory. Paivio (1986) describes dual channels of processing input which represent visual and verbal modes. He also explains that the effect of combining the two modes is additive. This increase in neural network signal strength has the power to improve retention. When learners make connections between dual modes of information, they are also establishing connections between multiple brain regions.

Including multiple modes of informational input can assist with comprehension and learning; however, teachers should be careful in their selection of media. Added elements such as pictures or simple graphics that are germane to the goal of the lesson will improve understanding. Extraneous sounds (e.g., music) complex pictures (e.g., real pictures of varied scenes) and entertaining but irrelevant content (e.g., cute dancing graphics) can impede comprehension as they compete for cognitive resources and divert attention away from the relevant material (Mayer, 2002).

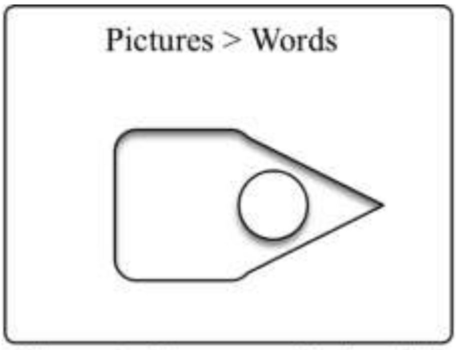

Figure 6. Pictures > Words. This simple picture takes a fraction of a second to comprehend, yet to describe it fully to the point that it could be reproduced exactly based upon a verbal account alone would take much longer.

3. Methods

3.1 Research Questions

Primary Questions

- How familiar are teachers in Japan with a selection of six empirically supported learning / studying strategies?
- To what extent do these teachers purposefully employ these learning / studying strategies in their lessons?

Secondary Questions

- To what degree do these teachers use learning / teaching strategies that they are aware of?
- Which learning / teaching strategy do these teachers use most (of those included in the research tool)?

3.2 Hypotheses

Based upon the literature (Pomerance, et al., 2016; Dunlosky, et al., 2013; McCabe, 2010), I suspected that many teachers were not familiar with the many learning strategies that have significant efficacy. Although it is possible that some teachers do use some teaching strategies without being aware that they are practicing an empirically studied method, it is likely that an increased level of knowledge of a strategy, including an understanding of its impact upon learning, would lead to an increased level of adoption of high impact strategies and a reduction in low impact strategies. Concomitant with my expectation that most teachers are not aware of the range of highly effective strategies, was an expectation that few teachers purposefully employed the empirically supported strategies in their lessons.

3.3 Context

The research tool for this study was an online questionnaire distributed via Google Forms. Respondents were contacted and requested to participate using a chain-referral method (Cohen et al., 2011). The initial request for participation was sent to eighty-five personal contacts who are teaching in Japan. Of these, sixty were teaching at the tertiary level and the remaining twenty-five were teaching in other contexts. In a chain-referral method of data collection, the initially selected respondents are asked to identify other potential respondents. In this research, they were requested to forward the link to the questionnaire to their own peer group of teachers. A total of thirty-three responses was collected. Most, respondents (N= 30; 90.1%) were teaching in Japan with the remainder of respondents teaching in Canada (N=2; 6.1%) or the United Kingdom (N=1; 3.0%). Since this study aimed to assess teachers within Japan, the three teachers from other countries were not part of the dataset. The original request for participation as well as the questionnaire were written in English. No data relating to country of origin or gender were collected.

3.4 Design

In designing an online questionnaire to collect the data, the hope was that a broad cross-section of the teaching population could be sampled and thus be better represented in the data. Unfortunately, this led to some challenges. It was assumed that a low threshold of technical ability would be required to complete the survey online; however, feedback from a couple of potential respondents indicated that there was some difficulty in using Google Forms. This unforeseen challenge may have biased the data received towards a more technologically savvy sub-group of teachers. Furthermore, this technical difficulty may have contributed to the low number of respondents.

Although the goals of this study centered around teacher knowledge and usage of six effective teaching and learning strategies, the questionnaire contained twenty questions in an effort of obfuscate the points being studied and thus to avoid any influence of subject expectancy (Brown, 1998). The twenty questions could be divided into three groups: Group 1- six effective learning strategies (Pomerance, Greenberg, & Walsh, 2016; Dunlosky et al., 2013; McCabe, 2010; Weinstein, Maden, & Sumeracki, 2018), Group 2- legitimate teaching and learning activities (Hattie, 2012), and Group 3- fabricated teaching or learning strategies. This third group (fabricated teaching or learning activities) was included to determine the validity of the responses. The questions that the respondents had to answer did not require any proof of knowledge; all that they had to do was self-assess awareness and frequency. The questions of Group 3 provided a level of insight into the degree that any respondents may claim knowledge or usage of any of the strategies. The degree of affirmative knowledge of non-existent learning strategies would provide insight into how much error in reporting may exist within the legitimate learning strategies.

3.5 The Research Tool

The questionnaire consisted of two parts. The first section collected sorting data including country in which the respondent teaches, the current teaching context, any previous teaching contexts, the number of years teaching, and the subject area(s) currently taught. The second part of the questionnaire collected category data ascertaining the degree of familiarity and purposeful implementation of a given teaching strategy. The questions were organized in pairs around each of the strategies listed with the first measuring degree of familiarity and the second addressing frequency of purposeful implementation. The answers to the first question were given on a four-point Likert-type scale (rating scale). The answer options to the familiarity questions were *Very*, *Somewhat*, *I've heard of it, but I don't know much about it*, and *I've never heard of it*. The answer options to the frequency of purposeful implementation questions were *Very often*, *Frequently*, *Occasionally*, *Never*, and *I've never heard of it, so I don't know for sure*. The fifth option (i.e., *I've never heard of it, so I don't know for sure*), was added based upon feedback from an initial pilot run of the questionnaire. Some reviewers felt that there could be a possibility of using a given strategy without being aware of the formal name ascribed to that strategy. To avoid the unethical situation (Cohen et al, 2011) of creating a question where a respondent felt pressured into answering a certain way, the fifth option was added. For the purpose of analysis; however, it was calculated along with the fourth option (i.e., *Never*) as a teacher could not purposefully implement a learning strategy that they were not aware of, notwithstanding the possibility that they do, in fact, employ that strategy in their lessons.

3.6 Handling of Data

All data collected in this research was keep secure. No names nor ISP data were collected therefore all responses within the questionnaire are anonymous. I did provide my contact information (institutional e-mail address, institution, and full name) within the questionnaire so that any respondents could contact me to comment on the research or to verify that this was a legitimate exercise in research and not an Internet based scam.

3.7 How the Data were Analyzed

The questionnaire responses were recorded and descriptive statistical analyses were conducted.

4. Results

4.1 <u>Spaced practice</u>

Using a chi-squared test, familiarity with spaced practice was determined to be evenly distributed across the four values with χ^2 greater than C. (χ^2 (3) = 10.8) with C @5%= 7.815; the *p*-value was 0.013. Purposeful implementation of spaced practice was not evenly distributed across the four values with χ^2 (3) = 6, so it was not greater than C with C @5%=7.815; the *p*-value was 0.112. As can been seen from the histogram (Figure 7), the purposeful implementation is less than the familiarity for categories *Very familiar* and *Somewhat familiar* and were slightly greater for the categories *Heard of* and *Never heard of*. This shift toward less active implementation relative to awareness is a common pattern in many domains of knowledge.

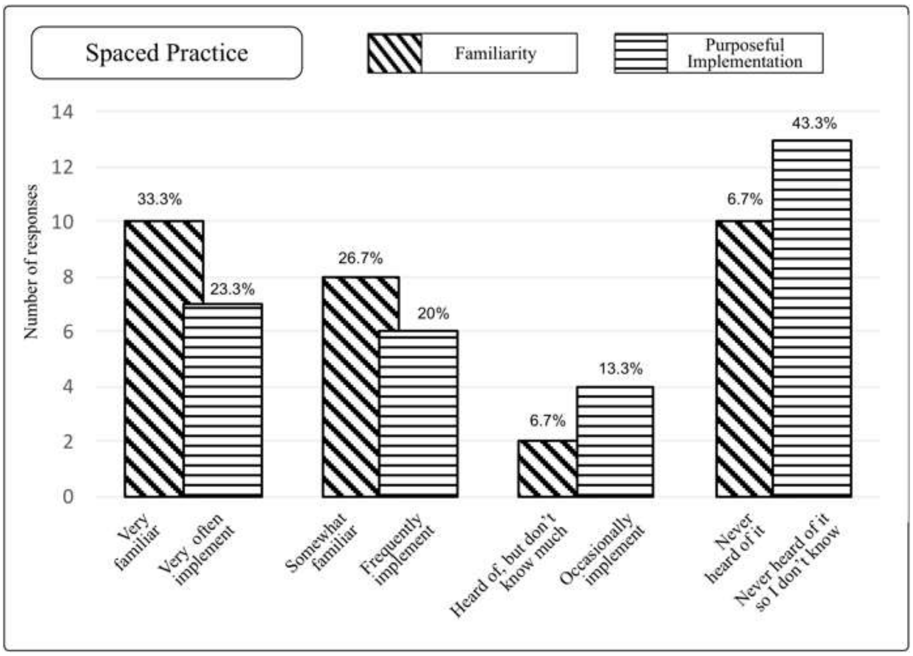

Figure 7. This histogram shows the levels of familiarity (diagonal stripes) and implementation (horizontal stripes) for spaced practice.

4.2 Retrieval practice

Using a chi-squared test, familiarity with retrieval practice was found to be not evenly distributed across the four values with χ^2 greater than C. (χ^2 (3) = 10.8) with C @5%= 7.815; the *p*-value was <0.001. Purposeful implementation of spaced practice was not evenly distributed across the four values with χ^2 (3) = 27.867, so it was greater than C with C @5%=7.815; the *p*-value was <0.001. As can been seen from the histogram (Figure 8), th the familiarity with and purposeful implementation of retrieval practice was quite low. Twenty percent of respondents stated that they do not purposefully use retrieval practice in their classes.

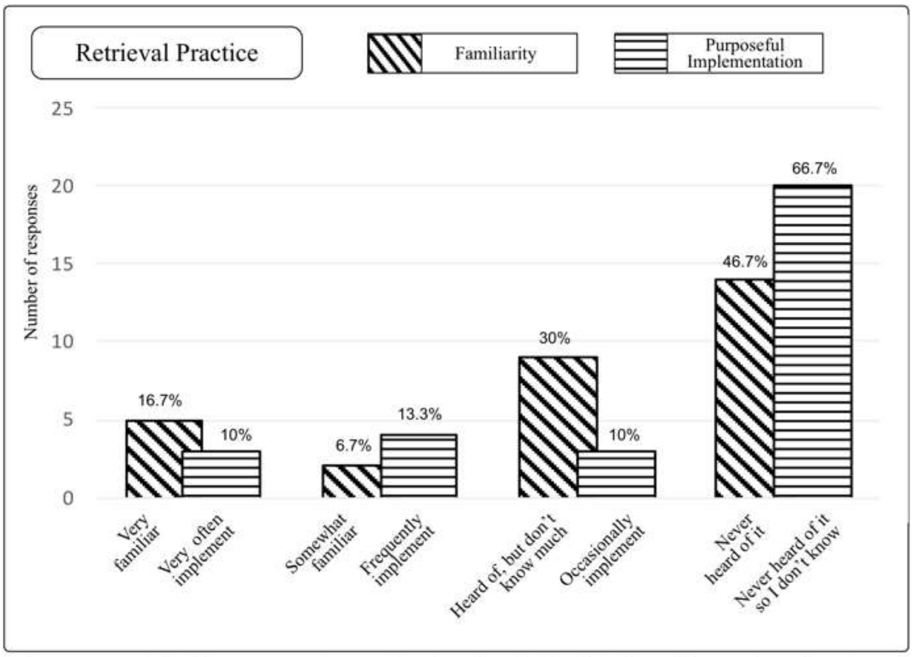

Figure 8. This histogram shows the levels of familiarity (diagonal stripes) and implementation (horizontal stripes) for retrieval practice.

4.3 Elaboration

Using a chi-squared test, familiarity with elaboration was found to be evenly distributed across the four values with χ^2 not greater than C. (χ^2 (3) = 2.267) with C @5%= 7.815; the *p*-value was 0.519. Purposeful implementation of elaboration was not evenly distributed across the four values with χ^2 (3) =12.4, so it was greater than C with C @5%=7.815; the *p*-value was 0.006. As can been seen from the histogram (Figure 9), elaboration is moderately used with 43% of respondents indicating that they either *frequently implement* or *occasionally implement* elaboration.

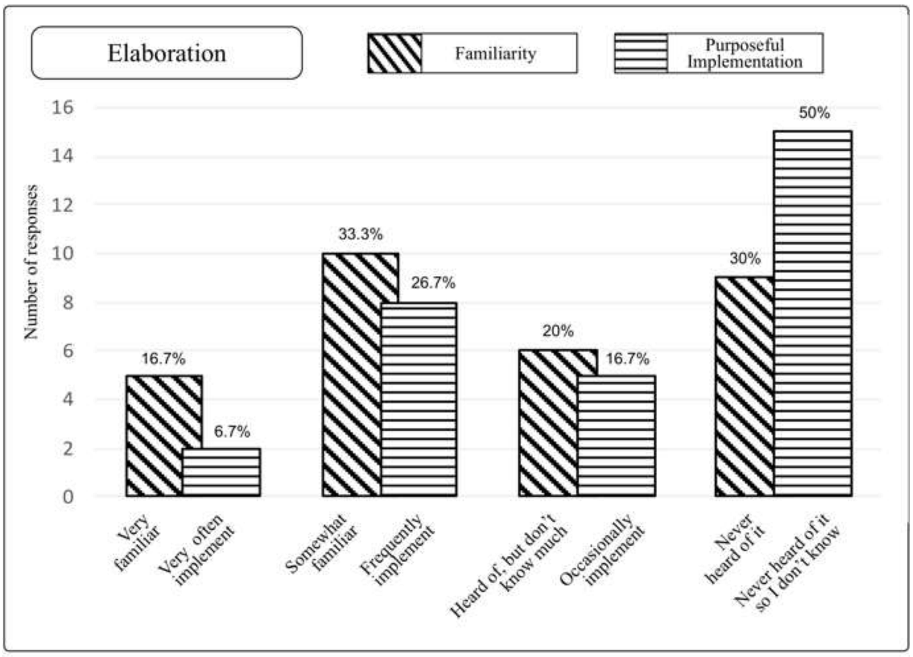

Figure 9. This histogram shows the levels of familiarity (diagonal stripes) and implementation (horizontal stripes) for elaboration.

4.4 Interleaving

Using a chi-squared test, familiarity with interleaving was found to not be evenly distributed across the four values with χ^2 greater than C. (χ^2 (3) = 38.533) with C @5%= 7.815; the *p*-value was <0.001. Purposeful implementation of interleaving was not evenly distributed across the four values with χ^2 (3) = 48.667, so it was greater than C with C @5%=7.815; the *p*-value was <0.001. As can been seen from the histogram (Figure 10), both the familiarity with and purposeful implementation of interleaving was very low. Eighty percent of respondents stated that they do not purposefully use interleaving practice in their classes.

4.5 Concrete examples

Using a chi-squared test, familiarity with concrete examples was determined to not be evenly distributed across the four values with χ^2 greater than C. (χ^2 (3) = 23.6) with C @5%= 7.815; the *p*-value was <0.001. Purposeful use of concrete examples was not evenly distributed across the four values with χ^2 (3) = 14.533, so it was greater than C with C @5%=7.815; the *p*-value was <0.001. As can been seen from the histogram (Figure 11), both the familiarity with and purposeful implementation of interleaving was very low. Eighty-three percent of respondents stated that they purposefully use concrete examples in their classes.

4.6 Dual coding

Using a chi-squared test, familiarity with dual coding was found to be evenly distributed across the four values with χ^2 not greater than C. (χ^2 (3) = 5.467) with C @5%= 7.815; the *p*-value was 0.141. Purposeful implementation of dual coding was not evenly distributed across the four values with χ^2 (3) =19.6, so it was greater than C with C @5%=7.815; the *p*-value was <0.001. As can been seen from the histogram (Figure 12), dual coding is seldom used with 73% of respondents choosing that they either *occasionally implement* or *never implement* dual coding in their lessons.

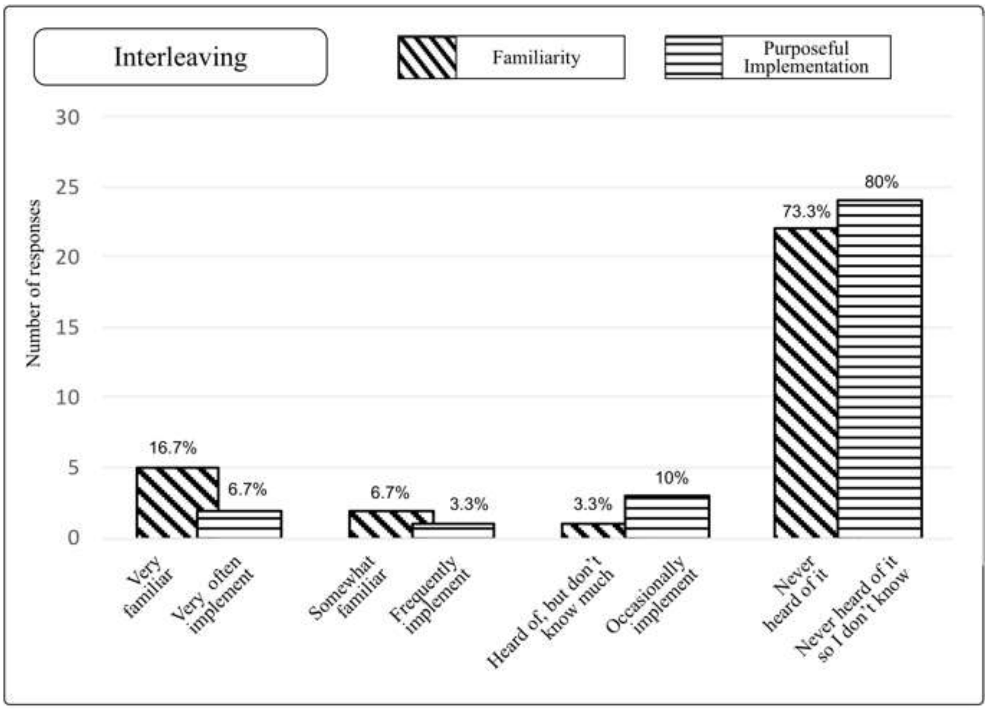

Figure 10. This histogram shows the levels of familiarity (diagonal stripes) and implementation (horizontal stripes) for interleaving.

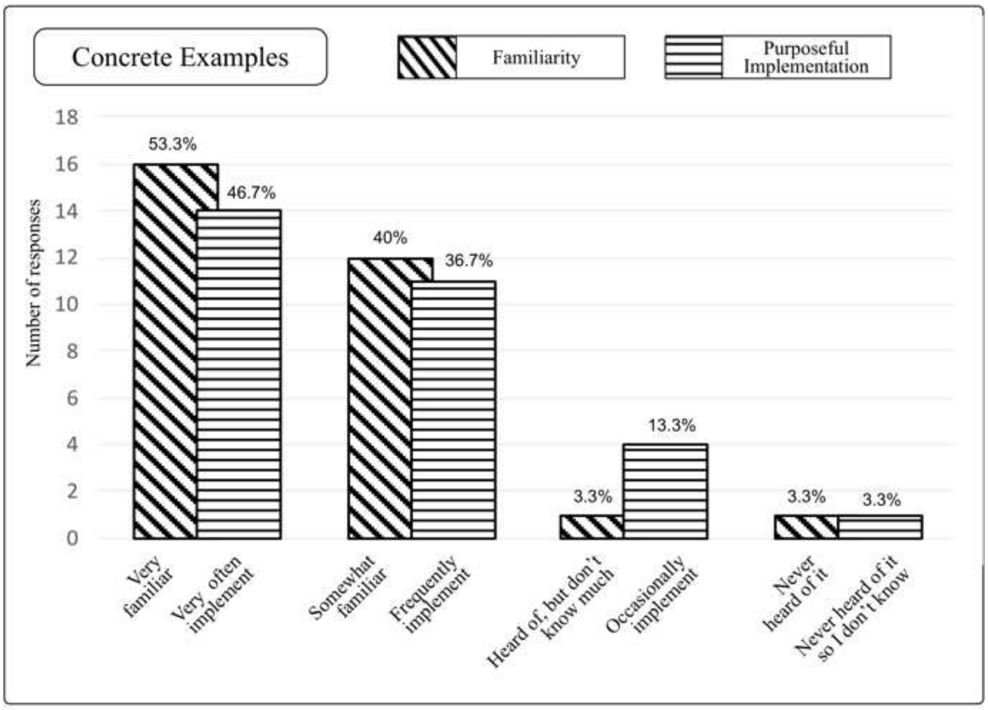

Figure 11. This histogram shows the levels of familiarity (diagonal stripes) and implementation (horizontal stripes) of concrete examples.

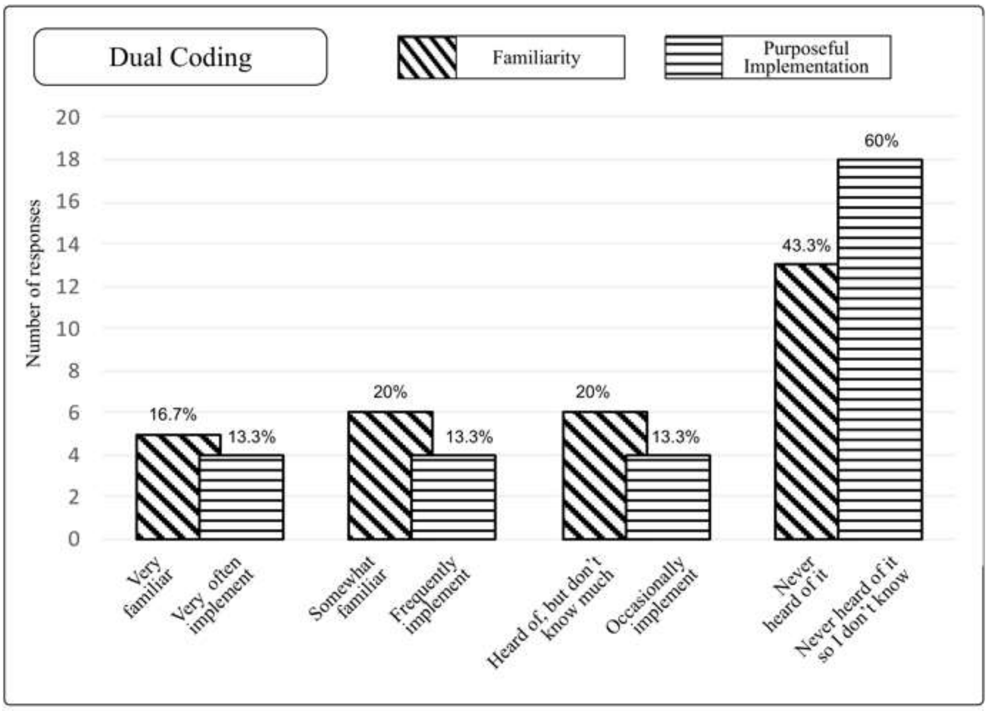

Figure 12. This histogram shows the levels of familiarity (diagonal stripes) and implementation (horizontal stripes) for dual coding.

5. Discussion

5.1 Discussion of the Results

Overall, the results of the data collected strongly suggest that teachers in Japan are not familiar with the six empirically verified effective strategies. Of the six, using concrete examples was the most well known and most frequently employed learning / teaching strategy with a *very familiar* score of 53.3% and a *very often purposefully implement* score of 46.7%. According to the literature (Karpicke & Blunt, 2010), elaborative learning strategies are the most often used; however, in the current study, the strategy of elaboration had a *very often purposefully implement* score of 6.7%. This is not a go-to strategy for teachers in Japan. This may be related to language difficulties. Elaboration is a language-based activity, and this may present some challenges for students and teachers whose native languages differ. This may also explain why using concrete examples is the most common strategy. Concrete ideas can circumvent linguistic challenges. Dual coding could also prove useful to support linguistic difficulties. The familiarity scores for dual coding saw 16.7% being very familiar with the strategy but 43.3% saying that they have never heard of it. Of course, as was stated previously, that the respondents did not know the label for a given strategy does not mean that they do not use that strategy in their lessons. It does, however, suggest that they were not formally taught about dual coding as an aid to effective teaching in their teacher training classes. Dual coding has some aspects that are very intuitive (e.g., a picture communicates a lot and “is worth a thousand words”), but it also has aspects that are less intuitive (e.g., that a lot of detail in a picture has a negative impact on learning). Through formal instruction, already practiced strategies could be approached more effectively. One aspect of the data that did not show a correlation was in years teaching to awareness of the strategies. One may think that with time spent working as a teacher that the teacher would learn them through professional retraining seminars or through personal reading, but the numbers did not support that notion.

Group 3 of the research questionnaire (the fabricated teaching and learning strategies group) confirmed that the questions were not answered in a way that would seem to inflate the knowledge of the respondents. Only 0.5% of responses claimed any awareness or usage of the fabricated (and therefore unknowable) strategies.

5.2 General Discussion

Cognitive science has made great strides in understanding how people learn most effectively. Mountains of literature have been published on the subject of learning, but few teachers read it. This study demonstrated that, at the name recognition level, most teachers are unaware of the most effective ways to learn. Traditionally, this was understandable, as academic journals were not readily accessible to teachers who had finished their formal education. That excuse is no longer valid. Today, there are many freely accessible online repositories of information on effective methods of teaching and learning.

If teachers become more aware of the underlying mechanisms of learning, they can prepare better learning opportunities for their students. Moreover, they can communicate this understanding of learning to their students with the aim of improving student metacognition of what they are doing. In one study, first year students at a college were given a 'Learning-to-learn' course (Tuckmen & Kennedy, 2011). The students of that cohort did significantly better in each term and there was also a 50% higher retention rate. The students did not initiate the program. It was up to the teachers and school administrators to plan the course and provide the opportunity for students to improve all aspects of their learning. That is part of being involved in education.

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