Using Adapted Frayer Model as Graphic Organizer for Graph Vocabulary

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In this study I investigated the use of an adapted Frayer model as a graphic organizer to improve the vocabulary comprehension of Japanese university students. The Frayer model was adapted to help explain graph vocabulary, which is less concrete than the language the model was originally used for. Students were separated into test and control groups. Pre- and posttests on graph vocabulary comprehension were administered to both groups. The test group alone used model cards with the adapted framework, but both groups completed the assigned graph exercises. Results showed improvement in both groups, but the test group showed a greater improvement in the mean score on a test measuring understanding of graph vocabulary. A questionnaire was administered to assess student feelings about the adapted model's usefulness. Results indicated that the model was helpful in understanding and applying graph vocabulary.

本研究では、日本人大学生の語彙の理解を高めるためのグラフィック・オーガナイザーとして、Frayer modelに手を加えたものの使用について調べた。Frayer model は、グラフ用語という、本来Frayer modelの使用が意図された言語に比べると抽象的な言語を説明できるよう修正した。学生を試験群・対照群に分け、両群に対し事前と事後にグラフ用語の理解度を測定するテストを実施した。両群はグラフ用語を学ぶための同一の演習を行ったが、試験群の学生だけが修正された枠組みに従ってモデルカードを使用した。演習終了後、両群ともに理解の向上が認められたが、グラフ用語の理解度テストの平均値は、試験群においてより大きく上昇した。本モデルの有用性に対する学生の反応を調べるためにアンケートを実施した。これらの結果から、修正されたFrayer modelがグラフ用語を理解・使用するのに有効であることが示された。

The impetus for this research study came about after teaching graph vocabulary in an English technical writing class to Japanese university chemistry students. Although considerable class time was spent on developing a deeper understanding of the technical vocabulary in their field—in this case, graph vocabulary—to improve their technical writing skills, students showed little progress in their acquisition of the targeted graph terms. In general, most students were only able to produce vague and partial definitions of words that had been taught.

These results presented a challenge: The students were not meeting expectations regarding their knowledge of the graph vocabulary and, as a result, were unable to use the terms effectively in their technical presentation and examination. A new teaching approach was sought to improve comprehension of graph vocabulary. The use of a *graphic organizer* as a tool to increase vocabulary and demonstrate the interconnections between concepts was implemented.

The goal of this paper is to report on the use of an adapted Frayer model as a graphic organizer and my attempts to determine if it would be a useful way of improving student comprehension of graph vocabulary.

Literature Review

What can a student know about a word? A student can know, among other things, how it is spelled, and how it appears grammatically. However, what does it mean to *fully* know a particular word? To Nation (2001), there are 18 aspects to this question: both productive and receptive knowledge of (a) form (spoken form, written form, and word parts), (b) meaning (form and meaning, concept and referents, and associations), and (c) use (grammatical functions, collocations, and constraints on use) (p. 27).

Nation (2001) refers to both implicit learning—in which "learners are required to induce rules from examples" (Ellis, 1994, p. 642)—and explicit learning—in which "learners are given a rule which they then practice using" (Ellis, 1994, p. 642)—in dealing with the aspects in knowing a word (pp. 33-35). However, which aspects apply to implicit and explicit instruction? Nation indicates that students learn implicitly the aspects which are related to form and use of grammar and collocations, but students can learn aspects linked to meaning and constraints of use more explicitly (p. 35).

In light of the above, which strategies should be employed to promote the learning of vocabulary? Several researchers have outlined vocabulary learning strategies (Gu & Johnson, 1996; Schmitt & Schmitt, 1993). Nation (2001), however, divided ways of learning into four categories and provided example learner strategies for each category: those linked to direct teaching (e.g., teacher explanation, peer teaching); direct learning (e.g., word cards, dictionary use); incidental learning (e.g., guessing from context, communication activity use); and planned encounters (e.g., graded reading, vocabulary exercises) (p. 16).

Of the categories and example strategies mentioned, Nation (2001) pointed to direct learning as a valued means of learning words (p. 302) and the use of simple word cards—in which the word is written on one side of the card and its meaning is written on the other side—as "the most important deliberate vocabulary strategy" example (Nation, 2013, p. 99), for it helps facilitate a more profound understanding of lexical items (Nation, 2006; Oxford & Crookall, 1990). Indeed, in considering the 18 aspects of word knowledge, Nation (2001) noted that simple word card usage covers many aspects related to form (e.g., written form), meaning (e.g., form and meaning as well as concept and referents), and use (e.g., grammatical functions and collocations) to varying degrees (p. 300).

However, why not consider dictionary use, as it is also a direct learning technique? Although it is true that dictionary use, like word card use, covers several aspects related to form, meaning, and use (Nation, 2001, p. 292), Nation noted that word cards, in contrast to dictionary use, help learners better understand an important aspect of word knowledge: the "underlying concept of a word through its related uses" (p. 302). The *Oxford* dictionary, for example, separately notes various uses of the word *hit*, but a simple word card could visually show how the word *hit* basically means the same in *hit me in the stomach* and *the sun hit my eyes*. Consequently, the learner recognizes the underlying meaning of a word from its multiple uses on one card and, as a result, has fewer words to learn (Nation, 2001, p. 302). Therefore, learning from word cards would seem a useful, meaningful, and efficient way of addressing many aspects of knowing a word.

What Is a Graphic Organizer, and Why Use It?

A graphic organizer is defined as a two-dimensional visual framework that presents conceptual relationships (Rice, 1994; Vaughan, Vos, & Schumm, 2007). In other words, it allows a great deal of information to be arranged so that the learner can describe concepts and recognize connections between them. The basic structure of an organizer has boxes or circles, or both, with connecting lines that can visually represent the ways in which ideas link with one another and how words can be classified and described. Typical examples are word maps, Venn diagrams, and the Frayer model word cards (Nessel & Graham, 2007; Schwartz & Raphael, 1985).

Despite the abundance of available organizers, one question must be raised: Why use them? There are two cognitive theories that support the value and use of graphic organizers. One theory is schema theory, which asserts that our memory is like an organized, schematic network that stores information hierarchically and links information with prior knowledge (Dye, 2000). So, just as an individual stores and retrieves information for later use to link what is new to what is known, graphic organizers make it easy for learners to link what was previously learned with new concepts or ideas (Guastello, Beasley, & Sinatra, 2000). Another theory is cognitive load theory, which claims our working memory can only deal with a limited amount of information; if one's working memory capacity were overloaded, processing of information would be negatively affected (Adcock, 2000). Consequently, graphic organizers will put less demand on working memory so that learners are able to take in and learn new information at higher levels of complexity and sophistication (Wills, 2005).

Defining and Assessing the Frayer Model Word Card as Graphic Organizer

The Frayer model word card is one type of graphic organizer. It assists students in describing vocabulary in detail. The model (see Figure 1) is a large square made up of four quadrants with a circle in the middle. Inside each quadrant is a category by which the given word can be described (Greenwood, 2002; Nessel & Graham, 2007), and these categories help explain which characteristics relate and do not relate to a concept (Frayer, Frederick, & Klausmeier, 1969).

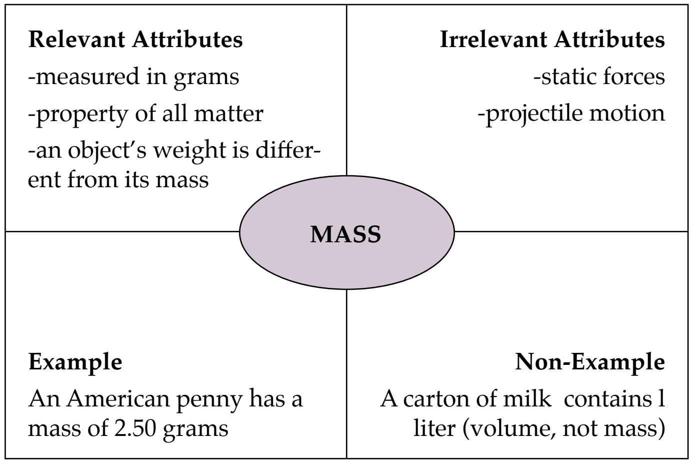


Figure 1. Example of original Frayer model.

The benefits of using the original Frayer model as a graphic organizer have been debated. Greenwood (2002) stated that the Frayer model is "the most time-consuming and labor-intensive" (p. 261). In addition, Rekrut (1996) stated that the model is best suited for the teaching of complex concepts. Although there is truth to their claims, other researchers, such as Beck, McKeuwn, and Kucan (2002), have seen it as a highly effective tool of vocabulary instruction.

A key benefit of the Frayer model is that it helps provide students with a more thorough, deeper understanding of a particular concept. In terms of Nation's (2001) aspects of word knowledge, the Frayer model word card not only helps learners understand the written form of a word and make connections between the word form and its meaning but also, with the inclusion of examples and attributes, helps to uncover the word's related meanings. In addition, Peters (1974) reported that using the word cards helped students grasp difficult concepts and score better on social science comprehension tests than when using their standard textbook alone. Monroe and Pendergrass (1997) found that using the Frayer model was more effective in learning complex math terms than simply studying definitions.

Earlier studies focused on math and social science terms that are abstract—i.e., intangible, more conceptual, and have no physical referents (Clark, 2003). When used in the original model, the irrelevant attributes and non-examples of a math concept (such as *yard*) or a social studies concept (such as *states' rights*) were found to be as useful for student comprehension as the term's relevant attributes and examples (Monroe & Pendergrass, 1997; Peters, 1974). However, the same model does not entirely apply to abstract graph vocabulary, such as *slightly*, because many possible non-examples and irrelevant attributes of a graph word could exist—for example, the representation of the concept *slightly* may vary based on perception (Wiemer-Hastings & Xu, 2005). Therefore, the model would not necessarily promote a clearer, deeper understanding of the targeted graph vocabulary. It seemed that the original Frayer model may be somewhat incompatible with abstract graph terms, and so a modified form was deemed more appropriate.

The Study

The purpose for developing an adapted Frayer model was to find an effective way of helping students comprehend abstract graph vocabulary. In this adapted Frayer model, new headings were assigned to each of the four quadrants. That is, the adapted model retains the original box-like structure of the original, with a circle in the middle, but the categories in each box differ (see Figure 2).

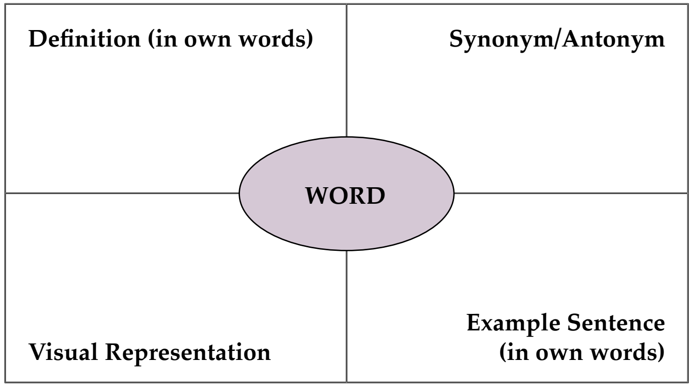


Figure 2. Example of adapted Frayer model.

Changes to headings of each of the new model's four quadrants were made to help the student gain a deeper understanding of the graph vocabulary. Based on Nation's table of aspects of word knowledge (2001, p. 27), the adapted Frayer model more fully addresses productive and receptive aspects (of form, meaning, and use) involved in knowing a particular graph term than the original one did. The original Frayer model could both (a) explain well a graph word's written form and its form and meaning productively and receptively and (b) partially explain a graph term's concept and its collocations. However, the adapted model could cover even more: It could explain well (a) both productive and receptive aspects related to the underlying concept of the graph word, (b) its related associations, and to some extent, (c) constraints on its use.

Research Questions

1. What effect would the adapted Frayer model have on student comprehension of graph vocabulary?
2. Would the students find the adapted Frayer model useful?

Context

The study was conducted in two English Technical Writing classes for 1st-year Masters chemistry students at a university in western Japan. The students met once a week for 90 minutes. Research involved a total of 36 students divided equally into two classes at roughly the same, relatively low English proficiency level. The study took place near the end of the second half of the term during the 2-week unit on describing graphs.

Procedure

For the purposes of the study, students were divided into two groups: the test group and the control group. Twenty graph vocabulary items (Figure 3) were chosen for the study. The targeted words were selected because they were required terms for the final exam and were neither used nor discussed in any previous units in the textbook (Mann & Wever, 2007). All vocabulary items were chosen to have the same relative language burden for students (see Nation, 2006). One way to assure this is to restrict the words by grammatical category (Dodigovic, 2013), so verbs and adverbs were chosen.

swiftly	considerably	fluctuate	collapse
substantially	dramatically	climb	plunge
abruptly	gradually	soar	crash
steadily	significantly	flatten out	bounce back
moderately	slightly	shoot up	level off

Figure 3. List of graph vocabulary words

Both the control group and the test group were given the same multiple-choice test on the targeted words before and after the graph unit (see Appendix). Between these test sessions, the instructor gave both groups identical graph description exercises to learn the graph vocabulary. In addition, both groups were given the time and encouragement to study the targeted vocabulary.

After the pretest, each student in the test group was given 20 adapted Frayer model word cards, on each of which was written one of the targeted graph terms. These students were instructed to fill out the cards. They were also encouraged to write L1 equivalents on the cards (in the *Definition* quadrant), as it would support a form-meaning link between the L2 word and the L1 word already present in memory (Nation, 2001). Once completed, the cards were examined by the instructor to check that all quadrants were filled. Upon examination, all test group students had written information in each quadrant. However, some only wrote single-word entries for three of the four quadrants (excluding visual representation), while others provided more details (e.g., short lists). For each graph exercise over the course of the unit, these students were then told to use their cards to complete the exercises.

At the end of the unit, a multiple choice posttest was administered to both groups. The questions on the posttest were identical to those on the pretest. Afterwards, a questionnaire was distributed to all test group students to determine if they felt the model cards were useful.

Results

Research Question One

Table 1 shows the results of the pretests and posttests of 36 test and control group students.

Table 1. Results of Pretests and Posttests Evaluating Graph Vocabulary Comprehension

Group	*n*	Test	*M*	*SD*
Control	18	Pre	9.72	2.78
		Post	14.94	2.78
Test	18	Pre	7.72	2.08
		Post	13.78	3.49

Note. Tests were on 20 multiple-choice vocabulary items.

According to the results of paired sample *t* tests, carried out to judge whether the students improved their comprehension with or without the adapted model, the mean scores of both the control group and the test group indicated a statistically significant increase: $t(17) = 0$, $p < .001$ for the control group and $t(17) = 0$, $p < .001$ for the test group.

Although the test group's pretest and posttest mean scores were lower than those of the control group, there was a larger gain in mean score on the posttests by the test group than by the control group. This is further evident after examining the test data in histograms (Figures 4 and 5), which show a greater positive shift in mean test scores for most of the students in the test group compared to the control group.

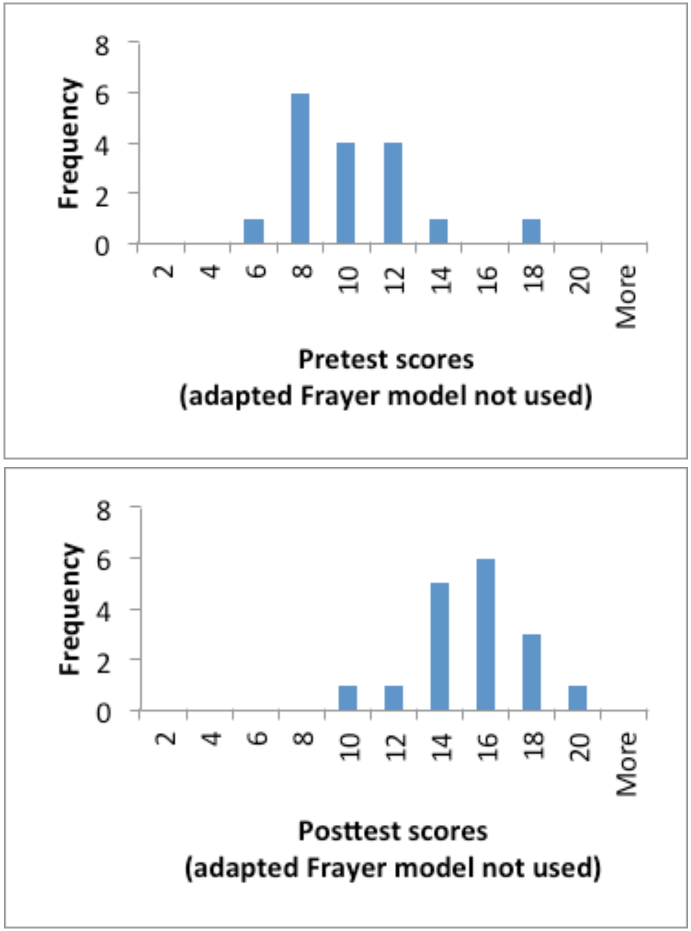
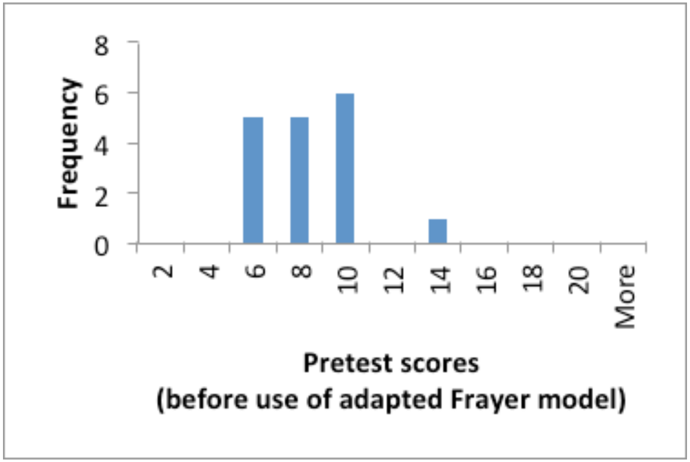


Figure 4. Pretest and posttest scores of control group ($n = 18$).



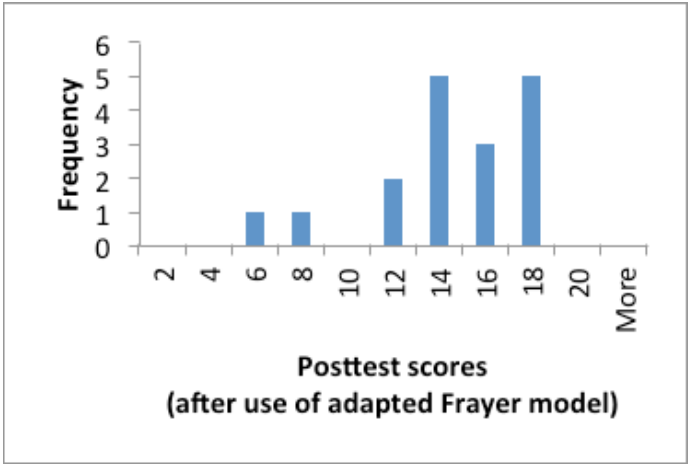


Figure 5. Pretest and posttest scores of test group ($n = 18$).

As for the standard deviation of both groups, the test group experienced a greater deviation from the average score on the posttest than the control group, implying that some students in the test group scored much better or worse than the average. In fact, two-thirds of the test group students made significant improvement gains (50% or higher) on their test scores, while the rest made smaller increases or none at all (see Table 2).

Table 2. Results of Individual Test Group Pretest and Posttest Scores

Student	Pretest	Posttest
1	6	14
2	6	17
3	6	15
4	7	14
5	5	13
6	9	15
7	10	17
8	10	18
9	7	5
10	7	14
11	13	13
12	7	18
13	9	12
14	8	11
15	9	13
16	8	15
17	6	17
18	5	7

Research Question Two

Table 3 shows the results of a two-part student feedback questionnaire, completed by test group students only at the end of the graph description unit. In answer to the first question, all students in the group affirmed they had a better understanding of the vocabulary. As for the second part, all feedback on card use was positive, mainly focusing on the card's usefulness in aiding comprehension and recall of the graph vocabulary.

Table 3. Questionnaire Feedback From Test Group on the Use of Adapted Model Cards

Question		Yes	No
1. Have you a better understanding of the vocabulary using the cards?		18	0
2. Write feedback on the use of the graph cards.	Sample feedback: • Definition and illustration are useful for me • Graph cards (have) many words, so I can explain graph details • I can also understand synonyms • I understand meaning of graph vocabulary • Easy to remember using graph cards • I can study not only definitions (of the word) but also synonyms		

Discussion

Results from this study provided evidence to help answer the two research questions. The first question was about the effect an adapted Frayer model would have on the learner's understanding of the graph vocabulary. Results revealed that based on posttest mean scores, the test group using the adapted Frayer model with graph-related textbook exercises did not do better in comprehending concepts than the textbook-focused control group. Yet, in considering *the rate of improvement* between the two groups, the test group showed slightly more improvement in mean score than the control group, lending at least partial support to Peters's (1974) claim that the Frayer model helps facilitate the understanding of concepts (p. 108).

Many test group individuals, however, greatly outperformed their fellow test group students on the posttest. Interestingly, it was the students who had written many details on their cards that reported sharp gains in their test scores and the others, who had written few details in each card category, made much smaller gains or none at all. As the instructor had given advice to all test group students to provide detailed and relevant lexical information for each card category, teacher feedback and the amount of student effort may have affected individual test group posttest scores.

The second research question was about whether the students found the adapted model to be useful. The students responded well to the adapted model and appreciated its usefulness in deepening their knowledge of the vocabulary, and this matched teacher expectations. What may have accounted for this positive feedback was that that each student's set of model cards was developed by the student him- or herself, and that they were encouraged to use, share, and discuss card information with other students while doing graph-related activities in class.

There were some limitations to this study. First, the relatively low number of students and the relatively low student proficiency level would make it hard to infer that this adapted model is generally effective in improving vocabulary knowledge. Second, despite the test group showing greater improvement in mean score than the control group, it should be noted that the control group had a higher pretest mean score and did better on the posttest. Finally, the reliability of the findings based on the first question of the survey may be in doubt as the question's wording could have led students to feel pressured to answer positively.

Conclusion

The findings in this study suggest that the use of the adapted Frayer model cards as a graphic organizer to help students understand graph vocabulary has potential. In studying the adapted model's usefulness to students and its effect on their comprehension, it is fair to conclude that (a) the test group students found the adapted Frayer model useful, largely because this model aided them in arranging, describing and explaining, and remembering a great deal of known and new lexical information—in line with schema and cognitive load theories—about each graph word, that (b) the student group using the cards made relatively greater improvement in their comprehension of the graph vocabulary than the group using textbook exercises alone, and that (c) the test group students who made the greatest improvement on the posttests had written the most information in each quadrant on their word cards.

The Frayer model has been criticized as being laborious and using up student time (Greenwood, 2002), but such criticism about the adapted Frayer model would be misguided. As opposed to being laborious, I would call the model *student driven*, which surely is an aid in learning vocabulary—especially if the words in question are not concrete and are specialized or technical, like graph language. As for the model consuming student time, I would argue that this adapted model, compared to other learning strategies like dictionary usage, is more efficient in the long run because it helps the learner more quickly grasp the graph word's core meaning and its related uses. Moreover, the adapted Frayer model saves learners time and effort by neatly compiling valuable implicit and explicit information about an abstract graph word—related to several productive and receptive aspects of form, meaning, and use—on a single card.

Further research on this topic is warranted. The sample size in this study was small and the reliability of the survey is questionable. Further research should study larger student groups and then ask questions on the model's use that are free of possible bias. In addition, as the tests administered in this study tested receptive knowledge, research involving productive knowledge would be of use. Finally, the study's posttest happened not long after the pretest for both groups, so studies that include a much-delayed posttest would be advisable to find out if improvement in comprehension and long-term retention would result.

Bio Data

Michael T. Sullivan is an instructor for Nippon Steel & Sumikin Intercom, Inc. He currently lives in the Kansai area, and his research interests include vocabulary acquisition and learner autonomy.

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Appendix

Graph Vocabulary Comprehension Test

Graph Vocabulary Test Name: ____________________

Class #:____ Score: _____

Task: The following 20 words are used in describing graphs. For each of the words below, circle the definition that best describes its meaning.

1. Swiftly a. to move slowly b. to move quickly c. to move at a constant rate d. None of the above	11. Crash a. to decrease slowly b. to move up and down c. to decrease sharply d. None of the above

2. Fluctuate a. to move slowly b. to move up and down c. to move quickly d. None of the above	12. Soar a. to increase little by little b. to decrease sharply c. to increase sharply d. None of the above
3. Level off a. to move slowly b. to move up and down continuously c. to move quickly upward d. None of the above	13. Flatten out a. to move up and down continuously b. to go up slowly c. to go down quickly d. None of the above
4. Substantially a. to make a very large change b. to make a large change c. to make a small change d. None of the above	14. Dramatically a. to make a very large change b. to make a large change c. to make a small change d. None of the above
5. Abruptly a. to move sharply b. to move slowly c. to move at a regular pace d. None of the above	15. Shoot up a. to increase little by little b. to increase sharply c. to increase then decrease d. None of the above
6. Plunge a. to decrease sharply b. to increase sharply c. to decrease little by little d. None of the above	16. Moderately a. to make a very large change b. to make a large change c. to make a small change d. None of the above

7. Steadily a. to move up and down b. to move quickly c. to move slowly d. None of the above	17. Climb a. to go down slowly b. to go up c. to move up and down d. None of the above
8. Considerably a. to make a very large change b. to make a small change c. to make a large charge d. None of the above	18. Gradually a. to move sharply b. to move slowly c. to move suddenly d. None of the above
9. Slightly a. to make a small change b. to make a large change c. to make a very large change d. None of the above	19. Significantly a. to make a very small change b. to make a very large change c. to make a large change d. None of the above
10. Bounce back a. to increase slowly b. to move sharply c. to decrease sharply d. None of the above	20. Collapse a. to decrease sharply b. to move up and down c. to decrease slowly d. None of the above