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Learning With Maps and Texts: An Overview

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This paper serves as an overview of the research done on learning with geographic maps that are presented in conjunction with a related text. First, the review looks at a model of map and text learning and the factors such as prior knowledge and individual differences that affect the model. Second, the review examines how the location of features on a map has a significant effect on what is learned from the map; namely, that features located on the edge of a map are learned and remembered more often and at higher rates than those features located in the interior of the map. Next, the review looks at several ways maps can be used effectively in classrooms. The order of presentation, situated cognition, and the use of technology to improve map learning in classrooms are all discussed. Finally, the review looks at the future of learning from maps and texts.

KEY WORDS: maps; texts; spatial cognition; conjoint retention.

Organized spatial displays in general, and geographic maps in particular, are commonly used as teaching aids in schools from early childhood through higher education. Teachers use maps to show their students far away places, to point out historical landmarks and locations, and to provide background information that when used with a related text improves learning. Over the past 20 years researchers from both Psychology and Education have studied how students use geographic maps to help them learn and remember related text information. This paper reviews the research in this area.

Davis and Hunkins (1968) found that when students are shown a map with a text, students use the map as either a primary message, as an organizer

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or reinforcer of information, or simply as decoration. Recently, teachers, other developers of curriculum, and designers of instruction have used maps in an attempt to help students learn. Yet, because of the problems that often exist with both the design and use of maps in the classroom, maps have not aided learning as much as possible. Experts, such as Tyner (1992), believe that maps found in classrooms and textbooks serve no real educational purpose but function as visual decoration for the learner. Yet, Schnotz and Kulhavy (1994) contend that when created with a purpose and used correctly in classrooms, graphics, such as maps, can serve as instruments that support learning and enable the learner to acquire meaningful and important information. In doing so, maps can and do serve an important instructional function.

In the review presented here, we look at a model of text learning using organized spatial displays that enhance student learning of both the map and the text. Although organized spatial displays include several types of graphics, including diagrams, advance organizers, and many more, in this review, we limit our discussion to geographic maps. These are maps and related graphics that can be treated as maps by the learner. In addition, we look at other factors that influence the learning from maps such as prior knowledge and individual differences. Next, the review examines how maps can be constructed and designed so that they are more efficient tools for learning. Finally, we look at how a model of text learning using organized spatial displays can be applied to classrooms so that students of all ages can benefit by using maps in conjunction with texts. It should be noted that because the focus of our review is on instruction, the review deals mainly with studies that used texts that contained actual facts, instead of route texts or verbal description texts, inasmuch as factual texts are more like the types of texts found in classrooms.

A MODEL OF TEXT LEARNING USING GEOGRAPHIC MAPS

In the past 20 years and in numerous studies (e.g., Kulhavy *et al.*, 1993a–c), a model of text learning using organized spatial displays including geographic maps has emerged in both the psychological and educational literature. The model based on Kulhavy's conjoint retention theory (Kulhavy *et al.*, 1985) and Paivio dual coding theory (Paivio, 1986) posits that organized spatial displays, such as geographic maps, provide a visual that students can use to acquire and store information found within the map. In addition, when using a map in conjunction with a text, students are able to make cross-code connections that enable them to use information stored in one code as a retrieval cue for information stored in the other code. These connections increase the amount of information learned from both the map and the text.

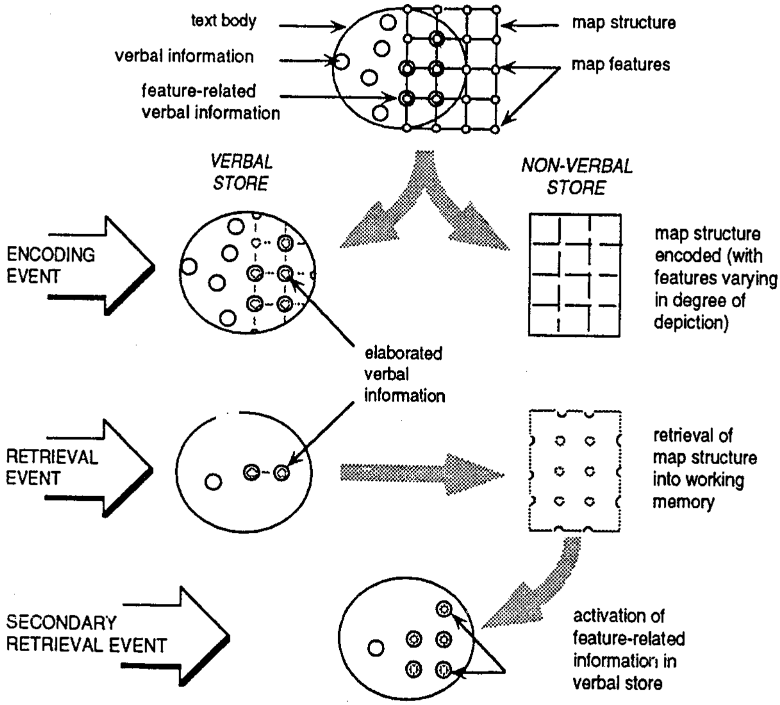

Fig. 1. A pictorial representation of the model of map learning using a related text.

A visual representation of this phenomenon was first presented in an article by Kulhavy *et al.* (1993a) and is presented here in Fig. 1.

Control Processes

When presented with a map and a related text, a student must decide how best to use the information presented. It is at this point that a student's cognitive factors known as *control processes* come into play (Kulhavy and Stock, 1996). Nelson and Narens (1990) believe that these control processes are in reality elements in a general metacognitive system that each learner maintains. One such element, prior knowledge, plays a large role in determining how students learn and process a map. The learner's prior knowledge helps determine what processes are used to handle the learning task facing the learner. Moreover, prior knowledge gives the learner a schema to orient his or her thinking and help make connections to what is already known. (A detailed discussion of the importance of prior knowledge is given later in this review.)

A second control element is the task demands that are brought about by a learner studying a map. These task demands may include the study strategies employed by the learner, the allocation of the learners' attention, and how much study time a learner chooses to allow for learning the material (Kulhavy and Stock, 1996). Taylor and Tversky (1992) found that the spatial representations recreated by the participants from studying a survey description, a route description, or an actual map were functionally equivalent. Kulhavy *et al.* (1992) used think-aloud protocols to show that it was the familiarity with using maps that enables people to encode, process, and create functional images of maps so well. This familiarity explains why expert and novice map users show little, if any, difference in their ability to learn map information, except for the less common technical information found in some maps (Kulhavy *et al.*, 1992; Thorndyke and Stasz, 1980).

Yet, the control processes are only half the story. The information found within maps and how students use that information in learning also play a large role in the model of map learning. In looking at geographic maps there are two types of information, feature and structural, that play an important role in the map learning process.

Feature Information

Kulhavy and Stock (1996), in their extensive review of map learning, define feature information as individual icons and words used on the map to convey and facilitate memory for "what happened there." Bertin (1983) believes that feature information also includes the retinal variables of color, size, and shape that map learners can use to help identify and process the features found on the map. Moreover, it is the feature information found on maps that help students to activate their prior knowledge so that meaningful learning can occur. This happens when the feature information matches the learner's prior knowledge, which in turn activates the necessary schema to learn the material.

Recent research has shown that feature information is most effective when it is a quality representation of what the feature represents in the real world. For example, Guelke (1979) demonstrated that symbols found on a map are good only if they have a broad appeal to the familiar; that is, that the learner can use the symbol as a viable representation of its real-world counterpart. Downs (1981) found that maps are analogies for the real world and that the more the feature represents the real world, the better learners are able to use the map information found on them. More recently, the qualities of the features used on maps have been investigated. Webb *et al.* (1992) conducted an experiment in which students were asked to study a map with various features, draw a version of the map, and then read a related text about the map. Finally, students were asked to recall as much as they could from the text that they had read. The researchers concluded that an important factor in successful recall of the text was the quality of the representation of the features presented. The higher the quality of the features, the better text recall became. Johnson and her associates conducted a more definitive work on the question of quality of features. Johnson *et al.* (2000) conducted an experiment that tested whether or not a distinctive feature on a map produced better recall than a nondistinctive feature. Two levels of feature type (distinctive, those that looked like the feature it represented, vs. nondistinctive, those that were symbolic representations) were crossed with two levels of map labels (present vs. absent), resulting in four experimental conditions.

Students examined one of the four experimental maps (distinctive features with labels, distinctive features with no labels, nondistinctive features with labels, and nondistinctive features without labels) and then read a related text. Next, students were asked to recall all the information they could from the text that they had read and to reconstruct the map. Students were given equal study time for both the map and the text. The results of the study showed that the distinctive quality of the features presented plays an important role in a student's ability to use the map and learn the related text. Students recalled more features from the map, more facts from the text, placed more features on their reconstruction, and did so more accurately when they viewed maps with distinctive features as opposed to nondistinctive features. In addition, when words were present, students were then able to recall feature names and text facts at a higher rate regardless of whether the features were distinctive or nondistinctive when compared to the students who viewed maps with only features present. Finally, the researchers found an interaction for both pictures and words. That is, students were able to do substantially better at recalling both map and text information when they viewed maps with distinctive pictures and words than any other type of map. In short, the condition (distinctive pictures with an appropriate word label) resulted in the best recall for both map and text information.

Structural Information

The second type of information found on maps is structural information. According to Kulhavy and Stock (1996) "Structural information refers to the spatial network within which map features are embedded" (p. 131). In addition, structural information refers to the actual distances between each feature found on the map and the distances between those features and the border of the map. Several studies (Kulhavy *et al.*, 1993b,d; Schwartz and Kulhavy, 1981) have consistently shown that recall of map and related text information is increased when the features on the map are spread across the map space, thus increasing the structural information found within the map. Stamm *et al.* (1999) recently suggested that the definition of structural information should be extended. Stamm and her associates found that learners use internal markings, such as internal lines that represent rivers, to "hook" feature information to and hence increase the amount of structure found in a map. The researchers found that participants recalled facts from a related text that were associated with features on internal lines better than features not on the lines. In addition, students' performance on reconstructing the map they had seen and accurately placing those features was greatly increased for on-line features. Therefore, the definition of structural information should be extended to include those internal elements of the map, such as internal lines, that help students create boundaries that can be used to help judge distances between features.

When examining the role structural information plays in students' ability to learn related text information in conjunction with a geographic map, it is clear that this role is an extremely important one. Learners use the structural information found within the map to create intact images of the map that they can store and use at a later time (Kulhavy *et al.*, 1993b). The creation of these images allows students to hold the map in working memory and use it to create associative links between the features on the map and the associated passage in the text (Verdi *et al.*, 1997). This process is accomplished without exceeding the limits of working memory, inasmuch as students are able to shift attention across the intact image of the map without using all the processing capacity of working memory (Larkin and Simon, 1987). This ability to hold the intact image in working memory without using all of working memory capacity allows learners presented with both a map and a related text to hold both simultaneously in working memory and hence increase the recall of both. The associative links that are created between the map image and the text give learners an additional set of retrieval cues to use when they are asked to recall information at a later time, thereby increasing the amount of learning of both the map and the text.

FACTORS INFLUENCING THE MODEL

Prior Knowledge

Feature and structural information are only two of the factors that help students learn from maps. According to Schwartz (1997), "Maps are not simply encoded into long term memory as images, verbatim. Indeed, one of the things learners do when processing a map is to relate what they know about the area's geographic space to the stimulus map" (p. 99). In short, a person's prior knowledge about the area or subject depicted on a map plays a large role in how the learner processes the map. Lowe (1993) had 16 meteorologists and 16 nonmeteorologists study weather maps and then copy and recall the markings found on the maps. The results of the study found that meteorologists had superior recall of both the number of markings and their accuracy when compared to the nonmeteorologists. In short, prior knowledge improved map recall. In a recent study, Schwartz (personal communication, April 2001) describes how college students studied 1 of 16 variations of a map of the town where they lived and were familiar with. Schwartz found that when the learners' prior knowledge about the area depicted was inconsistent with what was displayed on the map, map learning was dramatically reduced. Allen *et al.* (1998) found that when participants had prior knowledge of the geographic domain discussed in the passage, the presence of a geographic map played a small part in the students' ability to recall the passage. In short, when given a choice, students choose to study what is most familiar and therefore easier to learn.

Work was next undertaken to assess how large a role prior knowledge plays in the map and text learning phenomenon. In a series of studies that extended the work previously done by Schwartz *et al.* (1998, submitted), had students from both America and Australia study maps of either Australia, the United States, or the imaginary country of Novadocia. Next, a passage about Cricket, a game quite popular and familiar to most Australians, was given to the students in the study to read. Finally, students were asked to recall information from both the map and the text.

In the first experiment, the familiar maps helped learners to remember the locations of the features but did not always help learners to associate these features with the text. In the second experiment, it was found that familiar maps led to 33% more feature recall but again did not help students recall related text information. In both experiments, recall of text facts was increased when students viewed a familiar map. When learners were familiar with both the map and the passage, recall was at its highest level. In short, prior knowledge plays an important role in helping students learn the map by providing a schema from which learners can make interpretations and come to understand the information being presented.

Individual Differences

A second factor that greatly influences a learner's ability to learn the map is the individual differences found in learners themselves. Several studies have tried to show that gender plays a role in students' ability to learn using maps. Beatty and Bruellman (1987) found that males and females acquire knowledge of locations from maps at similar rates for immediate and delayed recall tests. Thus, in this study, there was no difference attributable to gender in students' map learning ability. Recently, Schwartz and Phillippe (1991) did find that females outperformed males in remembering map features and did so by being able to encode the map by means of the map's semantic features or how those features were related to each other. However, the researchers also found that a person's cognitive style had an effect on map learning ability. Schwartz and Phillippe (1991) found that field-independent learners were able to recall considerably more actual and related map information than those students who were classified as field-dependent learners. Rittschof *et al.* (1998) also conducted a study involving cognitive styles. They had students study one of four types of maps and then read a related text. The maps (a choropleth-shaded map, a proportional symbol map, a numerical data map, and a control chart) depicted book reading in southwestern Oklahoma. The text students read was related to the displays. Following the study of the materials, students were asked to recall what they could from the text and then to answer inferential questions concerning the map. The results of the study were quite robust and interesting. Students viewing one of the three maps as opposed to the control chart recalled 17% more county names and 45% more relative information. Moreover, more related text information was recalled than unrelated text information. In looking at the question of field-independence versus field-dependence, results similar to those of the Schwartz and Phillippe study were found. Field-independent students in the Rittschof study were 17% more accurate on map labeling tasks and 16% more accurate on text recall when compared to the field-dependent students in the study. Finally, the field-independent students had more plausible answers to the inference questions asked to them when compared to the field-dependent students. Therefore, it is clear that several factors including prior knowledge and cognitive style are important elements in the model of text learning using maps.

Learning With Nontraditional Map Types

No discussion of the factors affecting the model of map and text learning can be complete unless the types of maps used and how they affect learning is included. Several studies (Rittschof *et al.*, 1994, 1998) have used maps other than traditional geographic reference maps to study map learning. These studies revealed that students are able to use various types of maps from cartograms to choropleth maps as aids in learning related text and in making inferences from the maps learned. However, the research using nontraditional maps has suggested some additional learning outcomes that may occur when these types of maps are used. Rittschof and Kulhavy (1998) found that college students could reconstruct similar amount of map information from any of the four types of maps included in the study. More importantly, Rittschof and Kulhavy found that text recall from a fact-based text was not facilitated by the structure of the map but instead by the themes presented on the thematic maps. It should be noted that in this case the authors used actual facts but placed them randomly with a given location. An example of a paragraph read by participants in the Rittschof and Kulhavy study follows:

> The United States has a colorful history and an interesting character. Several of the country's fifty states have some curious, lesser know facts. For example, New York is where a grasshopper plague wiped out many crops. Arizona is one of the largest producers of dairy products. In Wisconsin, wild turkeys can be found. (Rittschof and Kulhavy, 1998).

A second difference found in map learning can be seen when one studies maps that have an element of dimensionality to them. Most maps used in textbooks and classrooms are considered to be "flat" or zero-degree maps. However, several studies have looked at map learning when using maps that have an added dimension to them. Eley (1992) found that when participants viewed a three-dimensional map, they had better and faster map study but slower land-surface judgments. It was concluded that this phenomenon was due to the increased topographical information found in a three-dimensional map. In short, the increased dimensionality affected the way participants viewed and learned the map. Johnson *et al.* (1995) had participants view one of three maps of the ancient city of Rome. The first was a flat plan map, the second map was a two-dimensional version of the first, and the third was a flat map with the features removed. The third map acted as a control for this study. Copies of the flat map and the two-dimensional map used in this study appear in Figs. 2 and 3. After studying one of the maps, students listened to a related text about Rome. (It should be noted that Abel and Kulhavy, 1986, showed that there are no differences in the amount of learning of map and text information when the text is read or heard by the participants.) Next, students were asked to recall the text and to reconstruct the map. The results of the study showed that students viewing one of the two experimental maps increased their recall of information when compared to the control group. However, there was no difference between the two experimental map groups in the amount of information each could recall. This finding is consistent with most map–text learning studies. In addition, the researchers also studied the scanning patterns of the participants as they studied the map. The results showed a different scanning pattern for those viewing the perspective maps. It has been established that when students view a flat map they do so in

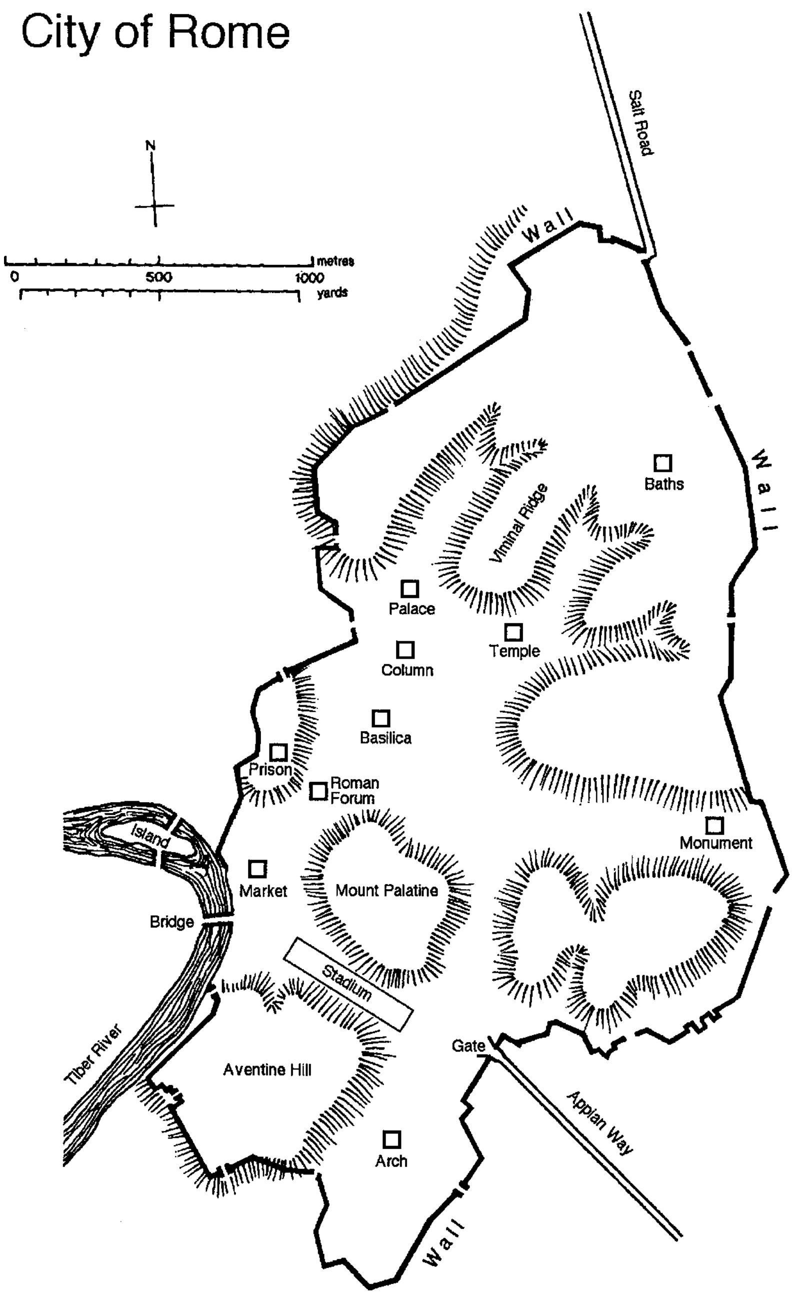

Fig. 2. The flat map of the city of Rome used in Johnson *et al.* (1995, Experiment 2).

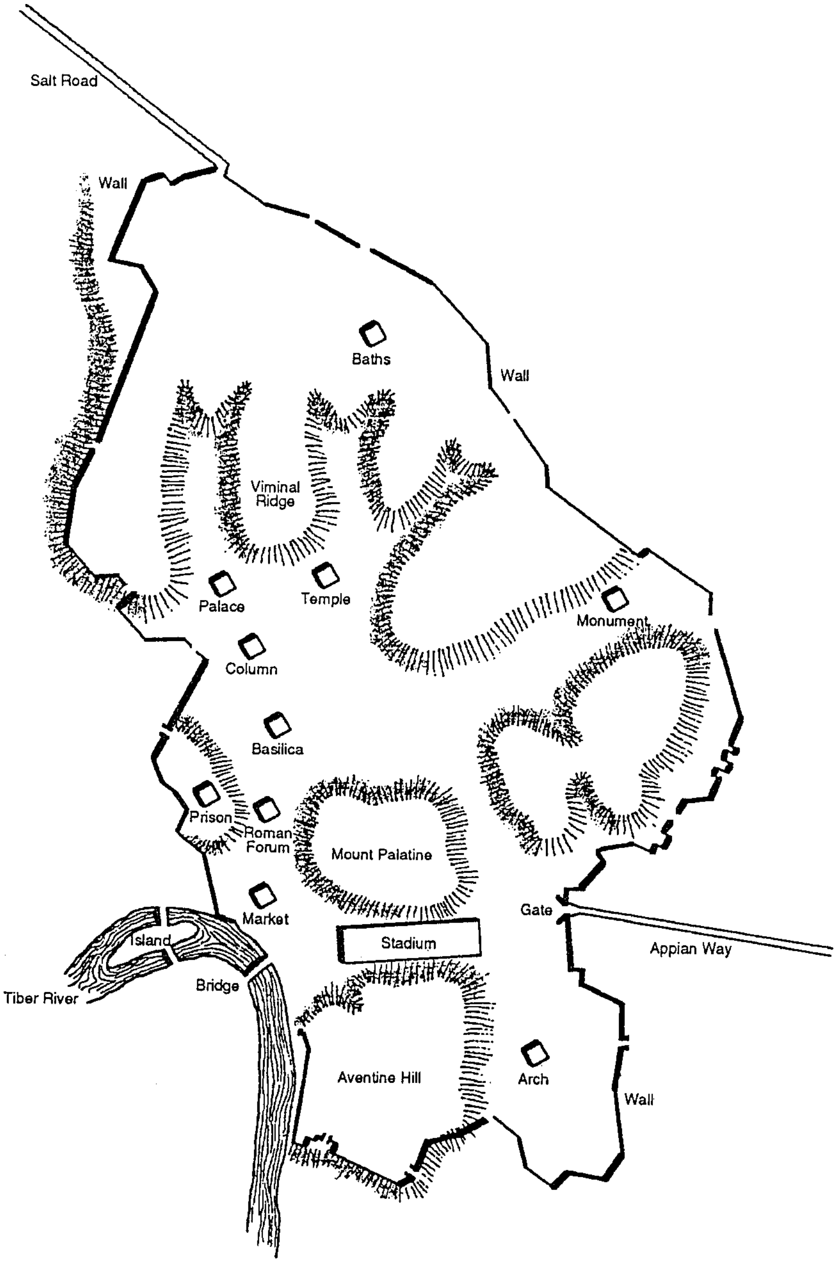

Fig. 3. The two-dimensional map of the city of Rome used in Johnson *et al.* (1995, Experiment 2).

a top–down, left-to-right order as one would read a book (Winn, 1991). However, in looking at the scanning pattern of those students viewing the perspective maps, a different scanning pattern was found. Students viewing the two-dimensional perspective map scanned the map from the bottom to up and not in the traditional top–down manner. According to Johnson *et al.* (1995), "In this case subjects may have given the bottom of the map, now functionally the front of the display, greater processing precedence" (p. 463). In short, learners studied and processed a dimensional map in a different manner than they did a flat map, suggesting that the type of map presented has an effect on how a learner approaches the viewing of the map.

The Edge Effect

The study of map perspective has enabled researchers to begin to examine what elements in the map are used to process and learn the map. This research has resulted in what the literature now calls "the edge effect." The edge effect refers to the phenomenon that subjects learn more features found at the edge of a map than in the interior. Several studies have examined why and how this occurs. Rossano and Morrison (1996) ran a series of five experiments that examined how information is acquired from viewing a map. In a typical experiment, participants were asked to study an experimental map for 10 min. At the end of the study period, participants were given a blank piece of paper and asked to redraw the map they had just studied. One week later, they returned and were asked to draw the map again. The results of the studies showed that border features, those close to the edge, were remembered more often and more accurately than interior features. In addition, the researchers found that participants learned and remembered the maps in an outside-in pattern. Namely, features located along the border of the map were learned and remembered before features in the interior. One exception was found when interior lines were present. In these cases, these interior lines served as a border and these features were learned along with the edge features.

Johnson *et al.* (submitted) found that the stronger the edge of a visual display (such as a map) is enhanced, the better those features located near those enhancements are learned. In addition, learning these features enables students to make appropriate connections with the facts associated with those features within a related text. Finally, Verdi *et al.* (2001, Experiment 2) had participants view one of four experimental maps of Tasmania. Two levels of border (present vs. absent) were crossed with two levels of feature location (edge vs. interior) to form four experimental groups: border present with edge features only, border present with interior features only,

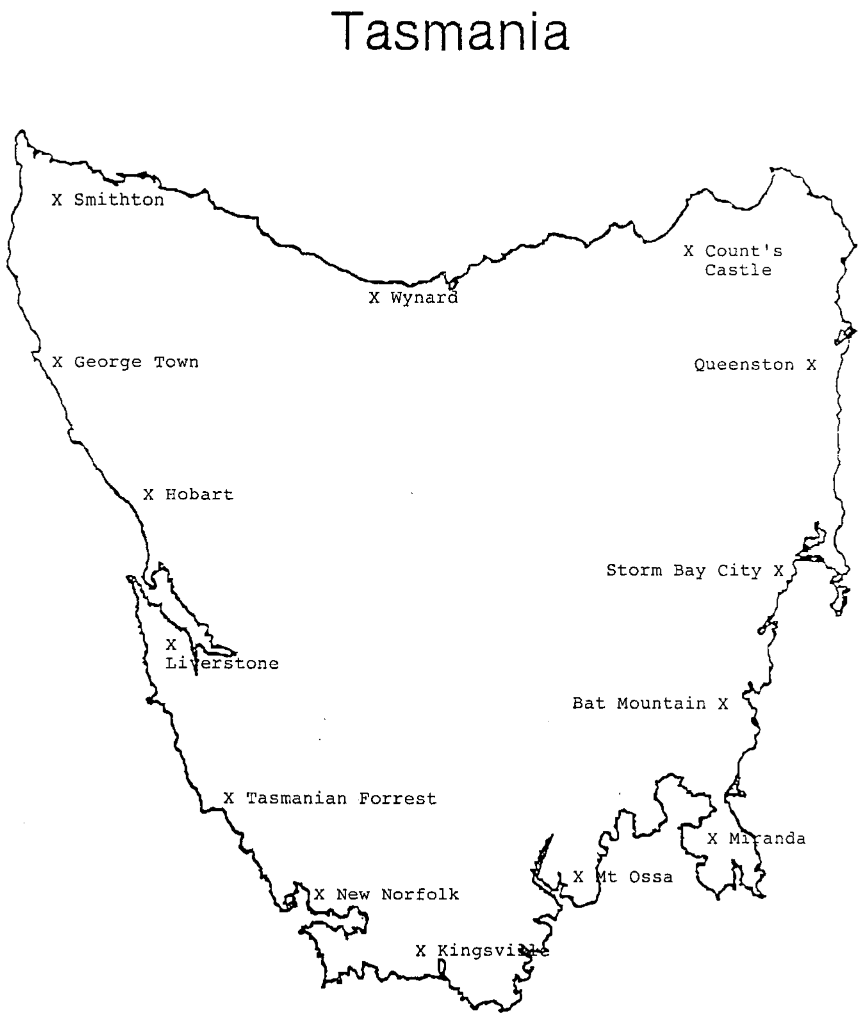

Fig. 4. The "edge map" with borders of Tasmania used in Verdi *et al.* (2001).

no border present with edge features only, and no border present with interior features only. Copies of the Tasmania maps with borders and features located along the edge and features located in the interior can be seen in Figs. 4 and 5.

Participants in the study were asked to view one of the four maps and then read a related text. Following the reading period, participants were asked to recall all they could remember from the text and reconstruct the

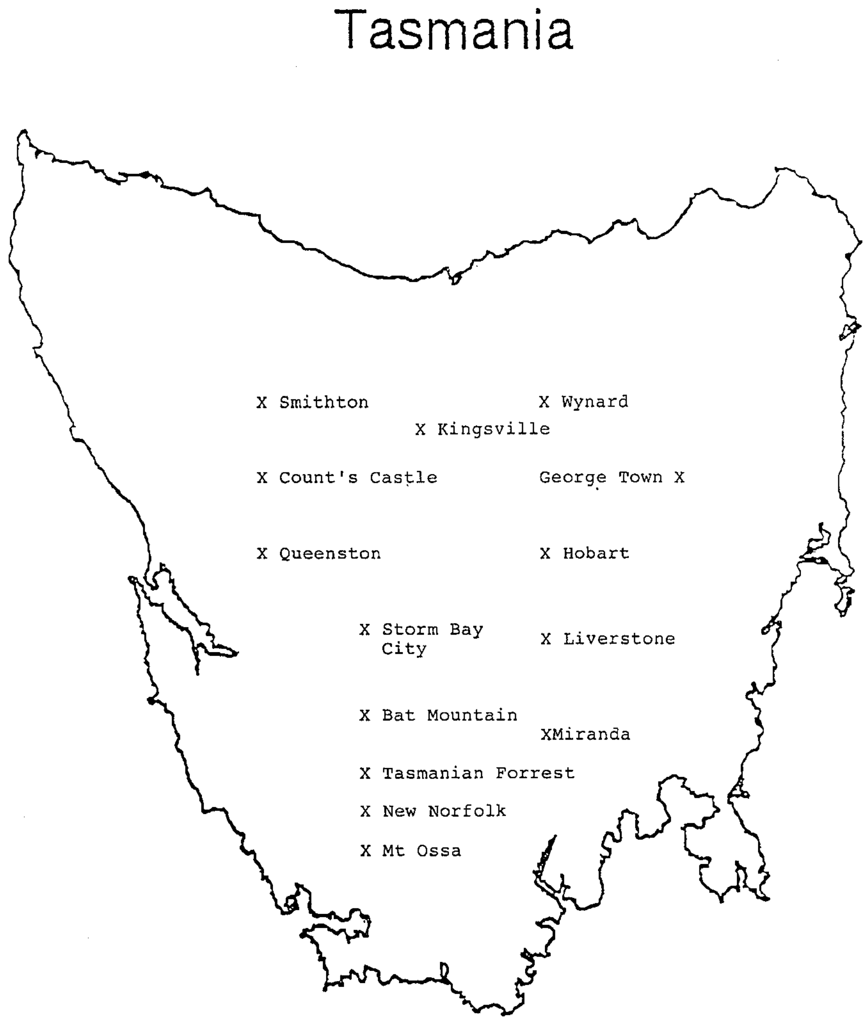

Fig. 5. The "interior map" with borders of Tasmania used in Verdi *et al.* (2001).

map. The results of the study showed that students were able to learn more features, accurately recall more facts from the text, and were better able to reconstruct the map when they viewed maps with features located along the edge than within the interior. There was little difference in those students viewing a map with a border and those viewing a map without a border. It should be noted that this border versus no border finding is contradictory to most other findings in similar situations (e.g., Johnson, 1996). This was due to the fact that the arrangement of features in this study allowed for students to create borders when they were not present, and therefore, the missing border did not affect the participants' ability to create images. (A complete explanation of this phenomenon can be found in Verdi *et al.*, 2001.)

Schwartz (1997) asserted that it is the intactness of an image that enables students to use the image as a vehicle to aid in learning related text. The research presented here supports the position that it is the edge effect that makes maps viable for forming images.

APPLICATIONS FOR MAP LEARNING RESEARCH IN THE CLASSROOM

Geographic maps are often used in classrooms as aids to learning material found in textbooks. Yet, in most cases, the way maps have been used in a typical classroom have not supported students' learning. Recently, research has provided teachers and designers of classroom materials ways to use maps effectively in the classroom. In several studies (Stamm *et al.*, 1999; Stock *et al.*, 1992) findings show that the order the materials are presented to students play a large role in their ability to learn the material. In these studies, participants were shown a map and then a text or the same materials in reverse order. In each case, students learned more features from the map, and facts from the text, and did so more accurately when the map was studied before the text. When students view the map first, they are able to create economical intact images, which they can then use to help learn the text (Kulhavy and Stock, 1996). However, this is not the case when students read the text prior to viewing the map. In this case, students must process the text in a serial fashion, which requires most, if not all, of working memory (Van Dijk and Kintsch, 1983). When asked to view the map, students reading the text prior to the map do not have the needed working memory space to process the map. Therefore, they are forced to make a choice between learning the map and studying the text. If they choose to study the map, then they lose the text being held in working memory. On the other hand, if they choose to ignore the map and continue processing the text, then they lose the advantages gained from learning the map (Verdi *et al.*, 1997). Either way, learners are at a cognitive disadvantage when reading a text prior to studying the map. The results of these studies show a clear indication that when teachers use maps in conjunction with text, the map should be presented first followed by the text if the maximum amount of map and text learning is to occur.

A second approach to using maps in the classroom is using situated cognition. That is, the activities used in class should reflect, as closely as possible, the actual task students will use in the real world. In doing so, teachers are using authentic instruction to help students learn difficult information and skills. Griffin (1995) used a real world approach in teaching students how to use map-learning skills, including navigation. Using a map of the campus of Florida State University, one group was taught using traditional methods while a second group was taught using situated cognition. The traditional methods group was shown maps on the overhead and asked to fill in a blank map at their desk. In the situated cognition group, students were taught the map of the campus by using high level map learning skills and then were allowed to walk the actual paths shown on the map that they had learned earlier. The results of the study showed that students in the situated cognition group outperformed the traditional group on a posttest that tested the students on their ability to navigate the campus. In short, situated cognition appears to be a promising means of teaching high level map learning skills.

In addition, situated cognition also appears to aid in the learning of locations found on maps, even when these depicted locations are of far away places. Morris (1999) had students in a West Texas middle school classroom view maps of glaciers. Next, Morris had each student make a clay and sand model of the glacier as an aid in learning the geographical locations. In this way, the class was using a modified situated cognition technique, because an actual location was not available. The results of the study indicated that student learning was improved using this modified situated cognition approach. In short, situated cognition aids in the learning of both lower and higher level cognitive skills.

A final approach used in classroom is the use of interactive maps. Lin (1997) ran a 2-week experiment in which students did either traditional library research and then created a map or a poster, used the Internet for research and then created an interactive map, or worked only on teacher-prepared worksheets. Although groups were able to recall the test information equally, the interactive map group indicated that they enjoyed the experience much more than the other two groups. These findings demonstrate that there are several potential ways to teach map learning skills to students, but some are preferred over others.

CONCLUSION

Organized spatial displays, such as geographic maps, are one of the most common forms of supplemental curricular materials used in classrooms. Therefore, it is important to understand how learners use maps with a related text to help increase their learning. Kulhavy and his associates have proposed a model of map learning that facilitates the learning of a related text (Kulhavy *et al.*, 1993a,b). The model, based on Paivio's dual coding (Paivio, 1986) and Kulhavy's conjoint retention (Kulhavy *et al.*, 1985), states that it is the feature and structural information found in maps that aid in the creation of intact images, which in turn allow for increased text recall. However, recent research has shown that other factors including prior knowledge, individual differences, and the type of map used also have an effect on what is learned when using a map and a text.

Additional research has shown that the location of the features found on the map plays an important role in students' ability to learn from the map. Research has consistently shown that features located along the edge of a map or on internal lines found in the interior of maps are recalled at a superior rate than those features found in the interior. In addition, when paired with a related text, those facts associated with "edge features" are learned and remember better than those facts associated with interior features.

Recently, the research into how students learn using maps has turned from the theoretical to the applied. In short, research has begun to look at how maps can be used most effectively in the classroom. One such finding is in the order of presentation of maps and text. Studies have shown that when students view a map prior to reading a related text they are able to recall more information from both the map and the text and do so more accurately than when the same materials are studied in the reverse order. In addition, approaches such as thematic teaching, situated cognition, and using technology and the Internet to improve map learning are new ways maps have been brought to the classroom. These approaches have shown promise and provide a vehicle to continue the study of map and text learning in the future.

FUTURE RESEARCH

The future for research on map learning in conjunction with texts seems very bright. First, continued research in the area of situated cognition should lead to a more realistic approach to teaching map learning skills to students. Moreover, using the multiple intelligences approach as described by Gardner (1983) will enable geography teachers to teach map learning to their students in a way best suited to match the learner's primary intelligence. Early success in using this method is seen in studies by Gregg (1997).

Extending the research into thematic maps is also an area where research into map and text learning can and should be conducted. Rittschof and Kulhavy (1998) have shown that the themes present on the map influence the recall from a text. Future research should focus on how learning a thematic map influences other types of recall such as problem solving or making inferences. Moreover, when studying different types of maps that can be used with a related text, research into what additional information, other than feature and structural information, students learn from these types of maps is an additional area of future research.

Next, the research on the "edge effect" can also be extended to focus on how the boundaries of maps are structurally encoded into a learner's cognitive system. Moreover, additional work is needed as to what types of internal boundaries students are able to use to increase the amount of structural information found on the maps students are learning.

Finally, with the increased emphasis on the use of technology in school, research on alternative forms of map presentation must also increase. For example, having maps move from a traditional paper format to an electronic format that can be used in multimedia instruction as well as on the World Wide Web will allow for an increased understanding of how maps and text are learned and processed by students. Research that examines whether or not the properties associated with traditional paper map and text studies, such as the edge effect and the order effect, hold with electronic maps should add information to the model of text learning using geographic maps. Moreover, determining what additional information and advantage learners gain by using an electronic map is an area for future research.

In short, it is clear from this review that the research into map and text learning has a rich history, which has lead to many breakthroughs that have improved the learning of maps and text in classrooms. Hopefully, the future research of map and text learning will do the same.

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