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The Vee Diagram as a Problem Solving Strategy: Content Area Reading/Writing Implications

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ABSTRACT

Teachers are in an ideal setting to enhance students' inquiry skills in scientific and mathematical investigations. Even the most ideal learning environment will prove to be fruitless, however, if students fail to understand how to learn. The Vee Diagram, an educational heuristic, fortunately, is an ideal teaching/learning strategy for enabling students to acquire such knowledge. This article, accordingly, will discuss the components of the Vee Diagram, apply it to a sample problem in probability, incorporate it with writing, and provide implications for its use beyond mathematics and science.

Introduction

When students choose, ask, and pursue their own questions, they not only assume ownership of their problems but also feel responsible for their solutions (Tobin, 1990). Unfortunately, school learning situations sometimes render students less reflective about their own problem solving assignments because they must deal only with problems that are quite narrowly defined in the typical school learning setting. Moreover, students lack control over these problems and the freedom to select their own problem-solving processes (Lave, 1988). School curricula, however, should provide students with real life opportunities that extend beyond the classroom and with situations that allow them to formulate and solve self-selected problems. Furthermore, said curricula should encourage students' initial ventures into uncharted territory. Teachers, functioning as seasoned guides, are in an ideal setting to enhance students' inquiry skills in scientific and mathematical investigations (Hawkins & Pea, 1987; Schön, 1987). Even the most ideal learning environment will prove to be fruitless, however, if students fail to understand how to learn. The Vee Diagram (sometimes referred to as the Vee), fortunately, is an ideal teaching/learning strategy for enabling students to acquire this knowledge (Novak & Gowin, 1984).

Components of the Vee Diagram

The Vee Diagram is essentially a pedagogical technique, or heuristic, whereby learning occurs via student-directed, constructivist, and inquiry-based discoveries (Roehrig, Luft, & Edwards, 2001). It is an ideally suited tool for enabling students to understand how events, processes, or objects are meaningfully related because its overall purpose is for students to perceive the interplay between what is familiar and what has yet to be known and understood in scientific or mathematical investigations (Gowin, B., & Alvarez, M.C., 2005).

The Vee Diagram, whose name is derived from its diagrammatic shape, structurally and visually relates an activity's methodological aspects to its fundamental conceptual aspects by converging on the concepts' salient role in learning and memory. Figure 1 displays each of the labeled components of a Vee Diagram. The Vee, first and foremost, has two sides: a conceptual (knowing) side and a methodological (process) side. Both sides are interactional and interdependent because of the focus question(s) that is directly related to the events and/or objects. The events, and/or objects, located at the point of the Vee, are paramount for formulating the inquiry's focus question(s) and, hence, the subsequent interaction amongst the components associated with the conceptual and methodological sides.

Events (e.g., a game, a recital, blizzards, and mathematical proofs) and/or objects (e.g., a bridge, computers, black holes, and a solar eclipse) basically tell us what we did to derive answers to our focus question(s). On the other hand, focus questions, located at the top of the Vee, reveal what we hope to find out and need to know. In addition, they must zero in on an event and the objects related to the events.

Concepts (word list) and concept maps/ graphic organizers are located on the left (conceptual) side of the Vee, whose goal is to answer the focus questions. The concepts express the prior knowledge students currently have regarding the focus questions and include words pivotal when searching for more information. The graphic organizer demonstrates how the concepts are connected.

Data and transformations/ interpretations, knowledge claims, and value claims are situated on the right (methodological) side of the Vee, whose goal is to relate the data to the events. Data and transformations/ interpretations typically require that the data be reorganized or rearranged. As such, charts, graphs, and tables may need to be constructed to facilitate the derivation of conclusions. The knowledge claims answer the focus questions and are the products of the interactive nature of the components of both sides of the Vee. Moreover, the relationship between the concepts and the events is fundamental. Finally, value claims express one's feelings relative to the knowledge claims or of the process that led to these claims.

Application of the Vee Diagram

This section of the article will describe the use of a probability problem to model the Vee Diagram and to use its results for a writing activity. Although the Vee Diagram is an excellent heuristic for use by both teachers and students, this article will emphasize its use as an educational method for improving students' abilities to shape and steer their own thinking regarding not only the procedural aspects of solving the probability problem, but also the problem solver's knowledge construction due to the intermeshing between interrelated concepts and the probability problem solving activity. This section will also show how the Vee can integrate writing with students' problem solving skills.

Probability Problem

This problem focuses on intrinsic aspects of probability theory, has common applications in our everyday world, and provides an excellent opportunity for students to exercise their problem solving skills. Table 1 is but one way to illustrate how a Vee Diagram can be constructed regarding this specific probability problem.

When deciding how to proceed when applying the Vee, Gowin and Alvarez (2005) advise readers to initially begin with the events/objects, followed by the focus question(s). Their rationale for doing so rests with their belief that events are paramount for articulating the inquiry's focus question(s) and for generating the subsequent interaction amongst the Vee's conceptual and methodological components. Hence, from the students' perspective, the probability problem would proceed as follows: First, commence with the events/objects associated with the probability problem. For this experiment, the students were to employ a Random Integer Generator found at www.random.org to generate 100 integers having a value between 1 and 5, inclusive, and to format the results in five columns. They were also to use two other websites as tutorials:http://tutors4you.com/probabilitytutorial.htm and http://www.mathgoodies.com/lessons/vol6/intro_probability.html.

Second, based on the events/objects, students would formulate the following focus questions relative to the problem at hand: If a Random Integer Generator generates 100 random integers having a value between 1 and 5, inclusive, what is the probability of selecting each of the five integers (1,2,3,4,5) at any given time? How many times should each of the five integers (1,2,3,4,5) occur in this batch of 100 randomly generated integers? Third, based on both the events/objects and focus questions, students would then ascertain which associated concepts (word list), or prior knowledge, they currently possess concerning their inquiry. The students would also use a graphic organizer to connect these concepts. Fourth, students would then proceed with the collection of numerical data, located in the data and transformations section of the Vee, and determine how best to represent this data (e.g., chart, diagram, graph, table). Fifth, at this stage, students are now ready to focus on the Vee's remaining components by generating knowledge claims via information derived from transformed data to answer the problem's research/focus question(s). Knowledge claims, furthermore, should reflect the interaction between the Vee's conceptual and methodological components. Sixth, value claims, statements of self-worth, assert the students' perceived significance of the knowledge claim or the process leading to the inquiry's findings.

Incorporating the Writing Component

At this stage, having completed all components of the Vee Diagram and having read their math text and material from the tutorial web sites, students are then ready to write their group research report by utilizing information derived from the Vee's components. This writing task involves three steps: first, students should describe the preparation and organization of their investigation by concentrating on the events, focus question(s), concepts, graphic organizer, and data collection. The second step revolves around knowledge claims, based on information derived from their transformed data, and value claims. In the third and final step, students discuss their findings, contingent upon their knowledge claims and value claims, and suggest future research significance.

Content Area Reading/Writing Implications

As previously stated, the Vee Diagram is an exemplary strategy for augmenting students' scientific and mathematical problem solving skills because learning evolves through student-centered, constructivist, and inquiry-based discoveries (Roehrig, Luft, & Edwards, 2001). Hence, it facilitates students' grasp of the meaningful relationship that exists amongst events, processes, or objects by enabling students to perceive the interplay between what is currently known and what is still unfamiliar and yet to be understood.

It should be noted that the Vee Diagram is intrinsically suited for simultaneously incorporating collaborative problem solving, reading, and writing in the classroom. More specifically, students must read their traditional core text material, supplementary material, and electronic print in order to commence applying the strategy, itself. Students, as a group, are also able to write their research paper after having addressed all components of the Vee.

Students can also be assigned to read, analyze, and critique research articles germane to the topic or chapter under discussion. In doing so, they are trained to use the Vee's components to skillfully identify, analyze, and critique the various elements that should have been addressed by the article's author(s). The ability to evaluate research articles, in addition, is an integral component in the process of preparing minds for handling information at higher levels of complexity, especially in the 21st century.

The Vee, though apropos for science and mathematics, is sufficiently versatile to be utilized in other disciplines, too, especially when doing so involves the manipulation of mathematical or empirical data. For example, it may be applied to art. Students could discuss the differences and similarities, regarding hues, of either a painter's works or between/amongst various painters' works. In English, they could address the following topics: T-units, meter, and grammar. The social sciences are also ideal candidates for using the Vee Diagram. For example, in history, the Great Depression and WWII would be ideal topics. In psychology, for instance, students could use the Vee when dealing with brain research or drug addiction. And in sociology, census data and surveys would be most applicable. In music, students could study the differences and similarities, regarding musical notes or patterns, of either a composer's works or between/amongst various composers' works.

The Vee Diagram's versatility also extends to yet another critical dimension: namely, educational level. Students enrolled in grades 7-16 are cognitively able to capitalize on the Vee's intrinsic learning attributes, relative to, and proportionate to, their respective educational level.

Finally, although the Vee Diagram has been applied primarily with students for purposes of this article, it is also extremely useful for teachers as a pedagogical tool to hone their professional skills relative to the conveyance of information in the classroom for purposes of facilitating and increasing students' comprehension and retention—the two foci of learning.

Figure 1: Components of a Vee Diagram

Focus Questions(s)
What is being sought?
What needs to be known?

Conceptual (Knowing)
(Process)

Methodological

Concepts (Word List)
From a prior knowledge perspective, what key concepts or words/phrases can I use to derive background information that will enable me to generate a focus question(s), pursue my inquiry, and generate my conclusions?

Concept Map/Graphic Organizer:
How are the topical ideas interrelated?

1. What is my pivotal idea?
2. How can I relate and cross-link these ideas/concepts?
3. Did I clarify all terms?
4. Do I have a sufficient number of ideas/concepts?

Active Interplay/ Interdependence

Value Claims:
What is the worth or value of the inquiry or observations based on knowledge claims?

Knowledge Claims:
What do my observations and measurements mean?

1. Based on the data, what conclusions can be made relative to the focus question(s)?
2. What are the implications of the findings?
3. Does the data suggest additional unanswered questions?
4. What are the limitations/errors of this inquiry?

Data and Transformations/Interpretations:
What was observed and measured?

1. How will the data be represented: tables, charts, graphs, diagrams?
2. Can the data be more effectively graphed?
3. Can any trends be identified?

Events and/or Objects:
What was done to answer the focus questions(s)?

1. On a step-by-step basis, how was the inquiry set up and conducted?
2. What equipment was employed?
3. How did you collect the data?

Table 1: Randomly Generated Numbers

Focus Questions(s)

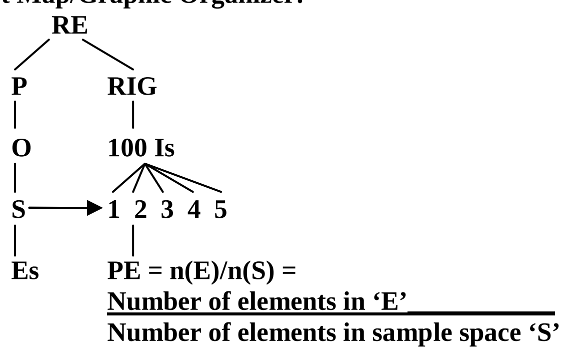
What is the probability of selecting each of the five integers at any given time?

How many times should each of the five integers occur in this batch of 100 randomly generated integers?

Conceptual (Knowing)

Concepts (Word List)
Random Integer Generator (RIG)), integers (I): (1,2,3,4,5) , random experiment (RE), outcome (O), sample space (S), event (E), probability (P), probability equation: P(E) = n(E)/n(S)

Concept Map/Graphic Organizer:



Active Interplay/ Interdependence

Events and/or Objects:
We used a Random Integer Generator to generate 100 integers with values between 1-5, inclusively, formatted in ten columns. We also used two probability tutorials websites.

Methodological (Process)

Value Claims:
This experiment has shown me just how applicable probability is on a daily basis.

Knowledge Claims:
Each integer generated had a probability of 1/5, but each integer was not generated 20 times. Perhaps generating more batches of 100 integers, or batches much larger than 100 integers, would result in a more equitable distribution of integers. A batch of only 100 integers was a limitation of this study.

Data and Transformations/Interpretations:
Here are your random numbers:

1	1	1	4	5	1	3	1	3	3
2	3	2	5	4	2	4	5	2	3
2	2	5	3	2	3	4	5	4	1
4	1	5	2	1	5	2	1	2	5
2	2	2	3	2	4	4	4	4	1
5	4	2	5	3	2	2	1	1	4
1	4	4	2	1	5	5	5	1	3
2	5	2	3	2	4	1	5	2	4
3	1	4	2	5	4	2	3	3	3
3	4	5	1	1	5	5	3	4	4

Timestamp: 2009-01-18 15:45:11 UTC
Note: 1 = 19, 2 = 24, 3 = 17, 4 = 21, 5 = 19
Each integer (1,2,3,4,5) had the same probability of occurring at any one time; the hundred integers generated were not evenly distributed amongst the five integers.
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