Pre-service Teachers' Beliefs about Using Vee Diagrams as a Report Schema in Science Education Laboratories

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Abstract

The purpose of this study is to investigate pre-service teachers' beliefs and thoughts about using Vee Diagrams or Vee Maps in science education laboratories. The study's sample consists of 54 students (42 girls and 12 boys) from the elementary school education department in the science education division of Çanakkale Onsekiz Mart University in Turkey. Data were collected from the study "Beliefs scale for the Use of Vee Diagrams of pre-service teachers" consisting of 20 Likert-type questions,and "Open-ended Questionnaire about the Use of Vee Diagram in science education laboratories," which includes 10 open-ended questions. First, the students were taught about Vee maps and diagrams for one week, and then some students volunteered for the scale, questionnaire and interview-application. Data were obtained for the quantitative and qualitative parts of the study. A-mixed methods design was used. Results indicate that pre-service teachers have positive beliefs towards the use of Vee diagrams in science education laboratories and there is a cross-relation between their beliefs and correct drawings for Vee diagrams.

Keywords: Attitudes**,** beliefs, pre-service teachers, science education laboratories, thoughts, Vee-diagrams

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Introduction

Science education has developed rapidly over the last century. Many new scientific innovations have emerged, and more are emerging every day. After the last five decades, we the educators and our students need so much subject matter knowledge instead meaningful learning. Especially at the laboratories, students need to acquire basic proficiency in the scientific process. Laboratories must be equipped with new tools in order to become better places of meaningful learning. In this respect, the factors that negatively affect students' learning must be eliminated by educators. In common new science education horizons got new tools for achievement at laboratories as concept maps and Vee diagrams.

From approximately the middle of the nineteenth century until today, science has gradually found a more secure place in school curriculums, and new ideas about science education have emerged for science teachers and educators. After some implications, the goals of science education are identified by the associations. As the literature reviews we can give main subject names as follows;

1- Basic science-oriented studies
2- Educational methods for science teaching
3- Reorganization of science education issues with the scientific development
4- Curriculum reforms over the decades
5- New horizons for today's science education and future progress
6- New and effective tools for meaningful learning in science education laboratories.

The history of science is not just a collection of books and articles waiting to be pulled off the shelf and plugged in the curriculum. Over the last 50 years, the history of science has transformed from a subject studied seriously by only a few scholars (though widely used in science teaching) into a well-established academic discipline somewhat isolated from scientific community (Brush, 1989). Consequently, we have developed a huge amount of content over the last two decades in the discipline of science education. Accordingly, science education laboratories must also provide meaningful learning of subject knowledge. After educators had explored the importance of tools for the laboratory, literature came out on the tool called "Gowin's Vee" in 1977.

Literature changes from decade to decade, but students' and teachers' beliefs and attitudes have become important for the science education literature. Pajares (1992) claimed that "the difficulty in studying teachers' beliefs has been caused by definitional problems, poor conceptualizations and differing understandings of beliefs and belief structures." His article aimed to examine the meaning that prominent researchers have given to beliefs, and how this meaning differs from that of knowledge. His research provides a definition of belief that is consistent with the best work in this area, explores the nature of belief structures as outlined by key researchers, and offers a synthesis of findings about the nature of beliefs. It has been long understood that some beliefs are more important than others to individuals, and the more important the belief is, the more difficult it is to change. It is also generally understood that if a central belief is changed, other beliefs within the person's belief system are affected. It has been argued that beliefs which are linked closely to their ego (i.e., sense of self) are more important than any others (Rokeach, 1968, pp. 3-4). Beliefs about teaching are very classic and therefore highly resistant to change. Literature about the beliefs of teacher support that both teacher attitudes and beliefs drive classroom actions (Nespor, 1987; Richardson, 1996).

Over the years, educational researchers have explored a variety of constructs pertaining to teachers in order to help improve the structure and impact of teacher education programs. Areas of study include teacher practices, teacher attitudes, teacher knowledge, and teacher beliefs (Luft, & Roehrig, 2007). Those who have written about beliefs acknowledge their unique composition and cognitive affiliation (e.g., Fang, 1996; Fishbein & Ajzen, 1975; Pajares, 1992; Richardson, 1996). To these researchers, beliefs are clearly personal constructions, entities belonging to an individual. Yet, additional descriptions reveal varied notions of beliefs. For instance, Fishbein and Ajzen suggest that "a belief links an object to some attribute - the object of a belief may be a person, a group of people, an institution, a behavior, a policy, an event, etc. and the associated attribute may be an object, trail property, quality, characteristic, outcome or event (p. 12)." Nespor (1987), on the other hand, describes beliefs as episodic, highly personalized, and containing affective and evaluative components.

Chrobak (2001) agrees that meaningful learning must be the most important priority for teachers. His study attempts to analyze the possible contributions of metacognition and makes some progress towards the elaboration of a scientific instructional model based on theories of human learning and their application to the classroom experience. As he mentioned, numerous metacognitive tools have been developed that draw upon human learning theories; however, the effective use of these tools is not fully understood by most educators. The study's objective was to gather valid arguments confirming the benefits of the use of metacognitive tools (e.g., concept maps and the Gowin´s Vee) for the achievement of students´ meaningful learning.

Cobern (1991) described a worldview as "the foundational belief, i.e., presuppositions, about the world that support both common sense and scientific theories" (p. 7). The personal experiences of teachers help form their educational worldviews, intellectual and educational dispositions, beliefs about self in relation to others, understanding of the relationship between schooling and society, and other forms of personal, familiar and cultural understandings. Ethnic, racial, and social backgrounds, along with gender, geographic location and religious affiliations, affect how individuals learn to teach as well as their actual teaching (Richardson, 1996). If we know how to change beliefs, and it is ethically appropriate to change the beliefs of teacher candidates when and if certain conditions were met, then the next question becomes "Which beliefs do we want to teach?" For example, we could ask candidates to respond to the following beliefs on a Likert-type scale, from strongly agree to strongly disagree (Raths, 2001). So, this research used a Likert-scaled beliefs questionnaire for questions on Vee diagrams.

Theoretical science knowledge must be accomplished through daily experience, and science laboratories can be used effectively toward this purpose. Laboratory concept and design is important for science education and science lessons. Vee diagramming is well suited for the teaching of concepts in laboratories. It has been found to be beneficial to the teaching and learning process in the following ways (Novak & Gowin, 1984; Wandersee, 1990).

- Vee diagramming helps learners to do better on tests requiring problem-solving skills, and their performance increases with time as they get more experienced in using Vee diagrams (Novak & Gowin, 1984; Wandersee, 1990).
- Since laboratory courses require preparation, they require students to do research, and they also provide a standard as an experiment report (Nakiboğlu & Meriç, 2000).
- Applying these two tools (i.e., concept maps and Gowin's Vee) helps all students in their task of learning how to learn (metacognition) and overcoming the epistemological ruptures students may have (Chrobak, 2001).
- One effective way to supply meaningful learning is to use concept mapping and Vee diagrams together (Özsoy, 2004).
- V-diagram-enhanced laboratory applications were found to have more positive effects on students' achievement and retention levels when compared to teaching carried out through laboratory method (Evren & Sülün, 2010) .

- The student groups that have been taught through the use of concept maps and V-diagrams are more successful than those who have been taught by the lecture method. Furthermore, misconceptions and incomplete knowledge were not found in the group that used concept maps and V-diagrams (Bahar & Özatlı, 2010).
- Vee maps provide a framework that allows learners to conceptualize their previous knowledge as they develop meaningful learning, utilizing the Vee map to guide their thinking throughout the process of experimentation. Previous research has shown that the use of Vee maps as a formative assessment tool positively affects students' content knowledge (Thoron & Myers, 2011).

Educators have some misconceptions about teaching in laboratories. They commonly believe that students learn only after acquiring theoretical knowledge, and then can manage to understand all levels of the experiments; however, in the real classical laboratory method, students are given only experiment manuals that provide descriptions of all the steps. Students don't have to think about the process, they only repeat the standard information and replicate the process. Thus, they are unable to experience meaningful learning of the science content. As the article stated, pre-existing knowledge, in the form of naive theories, is a pervasive feature of children's early understanding of science (Pine, Messer, & St. John, 2001).

When children experience formal science knowledge, usually in the second grade, the topics that teacher choose are unfamiliar to them. Our national curriculum has primary school children study experimental and investigative science, which deals with life processes and living things, materials and their properties and physical processes. Lessons are likely to be based around the concepts that the children have previously experienced in some form in their daily lives.

Much school learning consists of rote memorization of facts with little emphasis on meaningful interpretations. For example, students are often asked to solve scientific problems and conduct laboratory experiments by rote rather than in a meaningful way (Novak, 1988, 1990).

Piaget, too, claimed that cognitive conflict would create disequilibrium and that, with maturation, misconceptions would fall by the wayside (Piaget, 1977). It seems that an important role of an elementary school teacher when teaching science is to aid students' ability to reflect upon what they know about a given topic and make available strategies that will enhance their conceptual understanding of text and science experiments (Alvarez & Risko, 2007). The literature describes both primary and preservice teachers' conclusions and beliefs about the importance of laboratory and useful tools for science education.

Thus, this study aims to gain into the beliefs about using Vee diagrams in science laboratory education. How do the diagrams affect meaningful learning and retention of knowledge? What are the students' beliefs about the usefulness of Vee diagrams in comparison to classical lab reports? Many current characterizations of the process of conceptual change focus on the conflict between two sets of knowledge, where the child's misconceptions are finally abandoned in favor of the teacher's more correct conceptualizations (Posner, Strike, Hewson & Hewson, 1982). And as the literature points out, Vee diagrams could affect concept learning and conceptualization in the teaching process.

Laboratory instruction is essential to science education (Roth, 1990). One common laboratory instruction tool is the classical written lab report. Traditional reports provide a context through the details of the title, purpose, steps required, data collected, findings, and concluding questions. The grades for traditional lab reports assess the students' ability to follow directions, collect data, and provide correct answers to questions. An evaluation tool for new directed laboratories is needed. One teaching tool that is both teacher- and student-friendly is the Vee map or V-diagram, first developed by Gowin in 1977.

Transforming laboratories into meaningful learning environments is extremely important for science education. V-diagrams are one of the important tools in science education, as the literature review shows. The main subjects of my study are why the V-diagrams are such important tools for laboratory learning, how they integrate theoretical knowledge with laboratory observations, and how the V-diagrams prepared. One of the most important findings of cognitive/developmental research is that a student does not come to the science learning task as a 'tabula rasa' but has acquired rich knowledge about the physical world based on their everyday experiences (Vosniadou & Ionnides, 1998). So, the knowledge they have gained before the laboratory and experiments is vital for educators to know about. The Vee map is the main tool for finding out what theoretical knowledge students' already have. The V-diagram has two sides. The left side is the conceptual part, and the right side is the methodological part. The conceptual part is important before the laboratory, and the students' must research the main concepts and experience some meaningful learning before this step. Thus, the Vee map can be utilized as a useful tool for all educators in science education field.

Scientists have been discussing constructivist educational theory since the early 1980s (e.g., Gowin, 1981; Novak & Gowin, 1984; Novak, 1984, 1998, 2002). The Vee diagram was devised in the early 1980s by Cornell biology professor D.G. Gowin. He was concerned about the gap between his students' ability to undertake laboratory experiments and their awareness of what they were doing, especially in relation to the experiment's theoretical underpinning (Fox, 2007).

Passmore (1996:19) conducted a literature review about Vee diagrams (e.g., Novak, 1984, 1990a; Novak & Gowin, 1984; Barba & Rubba, 1992; Wandersee, Mintzes, & Novak, 1994; Rorh, 1990; Roth and Roychoudhury, 1993; Narode, Heiman, Lochhead, & Slomianko, 1987) and abstracted the specialties of the heuristic at the continued part. The Vee heuristic represents a constructivist tool for building knowledge structures. The Vee relates the knowledge developed, or discovered, from procedural activities in laboratory to the concepts and theoretical ideas that guide scientific inquiry. The Vee helps the learner to "see" the interplay between the structural knowledge (schemata) that they possess as they go into the laboratory, the methodological (procedural) knowledge they develop during the laboratory, and the conceptual (declarative) knowledge they produce from the investigatory processes. The Vee heuristic encourages meaningful learning as the learner constructs new cognitive structures and concept maps based on this interplay among structural, methodological, and conceptual types of knowledge. The Vee heuristic was developed by Gowin (1981) to help students understand the structure of knowledge (e.g., relational networks, hierarchies, combinations) and the process of knowledge construction. Gowin's fundamental assumption is that knowledge is not absolute, but rather depends upon the concepts, theories, and methodologies by which we view the world. To learn meaningfully, individuals must choose to relate new knowledge to relevant concepts and propositions they already know (Alvarez & Risko, 2007).

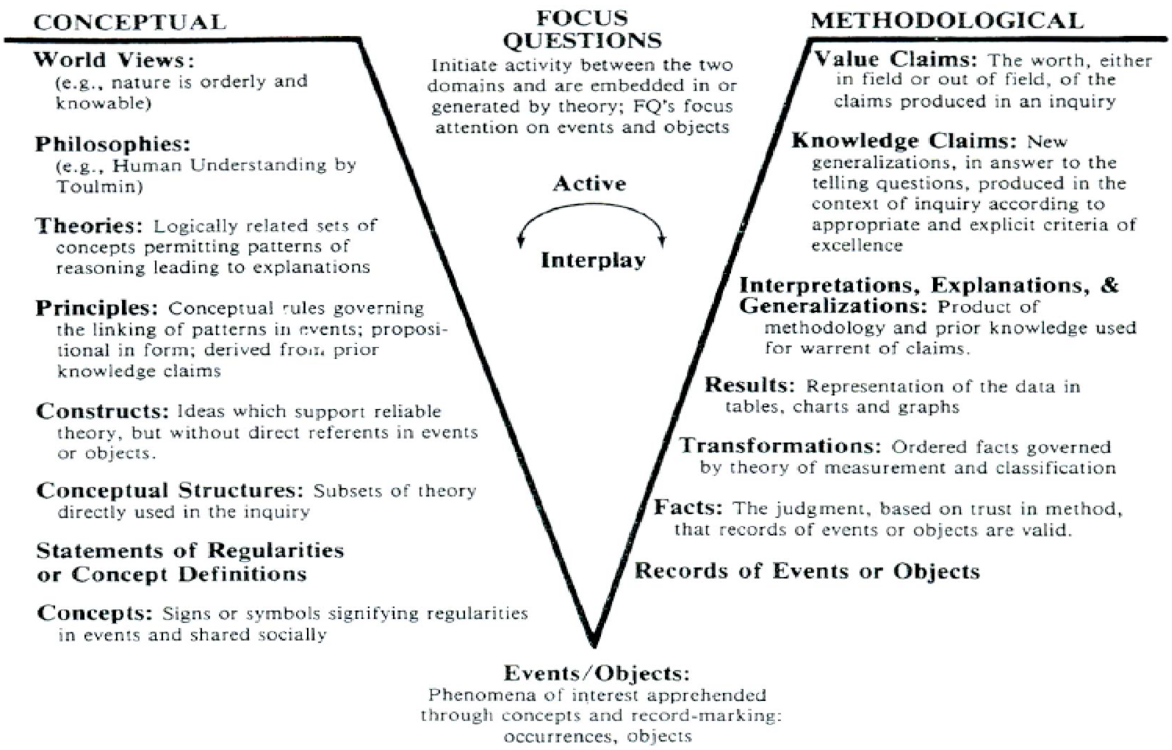
Thus, the concept of the V-diagram was developed to gain insight into the cognitive states of students during laboratory works and to eliminate the difficulties they face. Gowin built the concept of the V-diagram on five basic questions (Q5 technique) that can be used to exhibit a state or information (Evren & Sülün, 2010).

These questions are as follows (Alvarez & Risko, 2007):

1. What is the telling question? What does is it about?

2. What concepts are needed to ask the question?
3. What methods/procedures are useful in answering the question(s)?
4. What answers are produced?
5. What value do these claims have?

The purpose of these questions is to guide students in organizing the components of the V-diagram within the context of the study. The V-diagram can help with thinking or working on any study, experiment or situation. V-diagrams could be used as a beginning tool before the laboratory, and they can be a used as an exam format after the laboratory has ended. V-diagrams again can be useful to abstract lessons from a unit after the teacher has taught the lessons, and many different formats can be added with different articles from the literature. So, Gowin's Vee is essential for science education laboratories. We must again explore the V-diagram for new challenges with conceptualizations of new subject knowledge for laboratory basics in science education. Also, Vee diagrams can help prevent misconceptions in science education laboratories. Below, the format of a V-map is shown from the literature. This is the format first developed by Gowin in 1977 and later modified by Thiessen (1993), Meriç&Nakiboğlu (2000), Luft et al, (2001), and Afamasaga-Fuata (2004).



As explained by Ayranci (1986), a Vee diagram consists of three main parts. Drawing a large V is first step. Then, you place the focus question in the middle. The focus question is a bridge between the methodological part and the conceptual part. On the left is the conceptual. In the middle is the focus question, which is written before the lesson. And on the right is the methodological part, which is filled in after the lesson and experiments.

The V diagram I used in this study was constructed by analyzing various V-diagrams in the literature. The literature review on the use of V-diagrams in an article by Afamasaga-Fuata'i (2004) is given as follows. Studies have been conducted in the use of c-maps/v-diagrams as meta-cognitive assessment tools of students' conceptual understanding over time in the sciences (Novak & Cañas, 2006; Brown, 2000; Mintzes, Wandersee & Novak, 2000; Afamasaga-Fuata'i, 1999), and as organizational tools for interview data (Novak & Gowin, 1984). They have also been used as good communication tools (Freeman & Jessup, 2004) and analytical tools to unpack students'/participants' perceptions (Pittman, 2002; Swarthout, 2001) and epistemological beliefs (Chang, 1994).

My aim is to investigate the effects of V-diagrams in science education laboratories as well as the beliefs of preservice teachers on for usefulness of Vee diagrams. To determine the beliefs and thoughts of my students, open-ended questions were used. After the study, it was found that V-diagrams had different effects on the beliefs of science teacher candidates; however, more of the students found Vee map to be essential in science education laboratories. Open-ended questions gave me more detailed answers about the preservice teachers' thoughts – most of them found Vs-diagram very useful in their laboratories as a report tool for experiments.

Method

Data for the study were obtained from 54 students (42 girls and 12 boys) students enrolled in the elementary school education department in the science education division of Çanakkale Onsekiz Mart University in Turkey. The participants took General Chemistry, Physics and Biology Laboratories and were still taking science education laboratories lessons in the fall and spring semesters of 2012–2013. Some students already gained experience with Vee diagrams from their laboratory lesson in the previous year. We had used the Vee report format for some experiments before.

The beliefs scale toward the use of Vee diagrams aimed to determine students' beliefs about Vee diagrams in laboratory use. A 20-item scale was developed by the author and administered to the students at the end of the semester. The reliability of the beliefs scale was shown to be 0.750 by SPSS 21. Statements representing positive beliefs toward the Vee diagram were rated, as follows.

- 5 points were assigned to "strongly agree"
- 4 to "agree"
- 3 to "undecided"
- 2 to "disagree"
- 1 to "strongly disagree"

The data for the main concept of the study assesses beliefs about the importance of V-diagramming. For affirmative results "strongly agree" and "agree" responses and "strongly disagree" and "disagree" responses were combined together. An open-ended questionnaire compromised of 10 questions about the use of Vee diagrams was developed in advance by considering the relevant literature (Nakiboğlu, and Meriç, 2000; Ramahlape, 2004; Demirtaş, 2006; Keles,and Özsoy, 2009). In a 45 minute period students answered the following:

1. What are the differences between the classical laboratory reports and Vee diagrams in terms of planning, practice, learning, evaluating?
2. What are your duties before, at lab time and after the laboratory process, when Vee diagram format is being used?
3. What aspects of Vee diagrams are attractive in your opinion?
4. What aspects of Vee diagramming do you dislike when using it in the laboratory process?
5. What do you think about the benefits of Gowin's Vee?
6. Would you chose to use Vee diagrams in schools, if you were given a chance? Why?

7. Did you gain any new skills during the new laboratory process? Do you think Vee maps your classmates' to gain new skills?
8. Do you think that Vee diagrams contribute to meaningful learning in science laboratories?
9. What difficulties do you encounter when preparing the Gowin's Vee?
10. What properties of Vee diagrams help you to understand the experiments and their subject matter?

My research was performed with my students in our science education laboratory lessons. The participants attended laboratory, for 16 weeks, and a total of 64 lessons. In the first week, I divided the students into groups of three. The pre-service teachers learned about Vee maps and how to bring about appropriate Vee's from the literature and by giving presentations to the group. After these presentations, the groups were provided theoretical knowledge, materials; and gathered data and were asked to prepare an example Vee diagram containing information about the experiment.

In the second week, pre-service teachers presented the Vee diagrams that they had prepared to their classmates. Groups the deficiencies in each others' studies. After presentations, groups were shown an ideal Vee diagram of the experiment, which had been prepared by the researcher and were asked to compare it with their diagrams and eradicate any deficiencies. In this study, I chose the Vee diagram format that, was modified by Afamasaga-Fuata'i (1998).

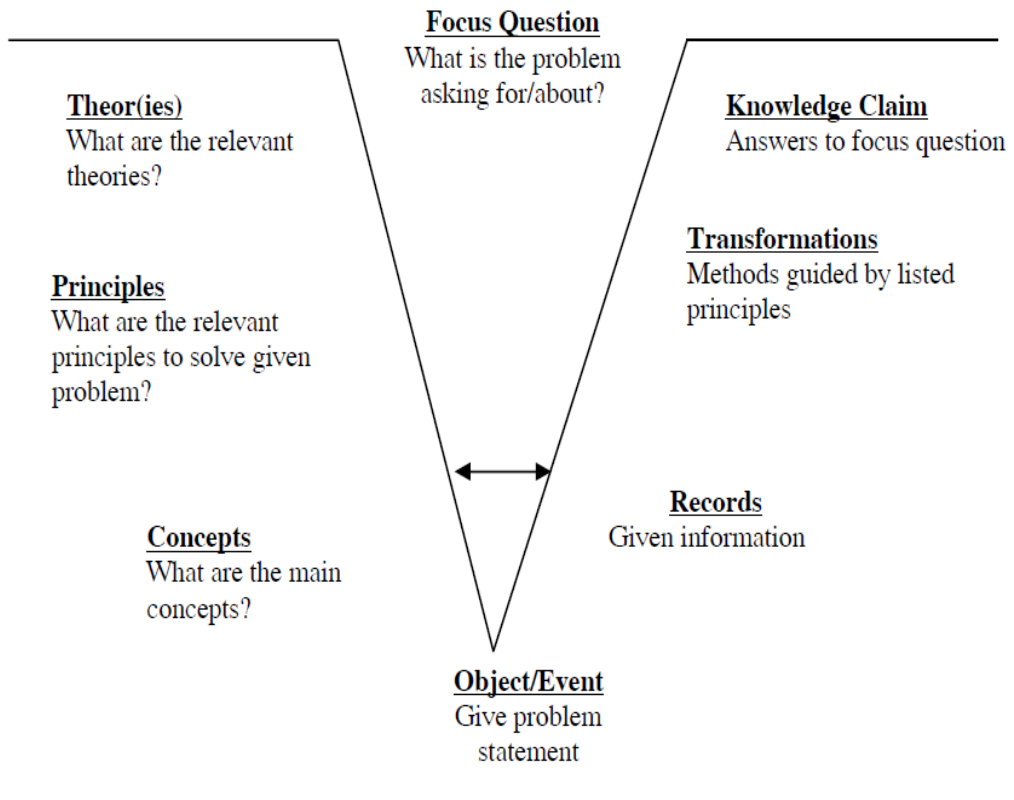


Figure 1 Afamasaga-Fuata'i (2004) modified from Novak & Gowin, 1984).

Every week in the lessons pre-service teachers studied subject information about the experiments. Before coming to the lab they used the research to complete first part of the V-diagram first part (i.e the conceptual part). To complete that side, they chose a personalized focus question. After making a concept list that includes vocabulary relevant to the questions, the conceptual part is finished. In the objects/events section, participants designed a procedure to examine the focus question. Afterwards, concepts and objects/events, theories and principles were concluded. Thus, they all had an extensive knowledge about the topic before the laboratory. In the laboratory, participants conducted the experiments with their group mates. They planned the experiments by themselves. I acted as a guide throughout the semester and at the lessons. After completing the experiment, my students recorded the data at the section and prepared charts, graphs, and tables in the proper field. Participants completed the Vee diagram by reporting their conclusions and answers to their focus questions in the knowledge claim section. I graded the V-diagrams for their motivation to other weeks and different experiments.

Analysis

After the statistical analysis the frequency distribution of students' responses to the beliefs' scale was explored and interpreted. Scores were analyzed using SPSS 21. Also the answers were categorized based on key ideas that had been extracted from the questionnaire.

While analyzing qualitative and quantitative data a mixed-method design was used. The mixed method design; is a term that is applied when research strategies are used at normally described as a part of that design. For instance, in quantitative inquiry, it may be the incorporation of an observational component (a non-numerical fieldwork) or supplementary open-ended questions at the end of a Likert scale; in qualitative inquiry it may involve the incorporation of strategies from ethnography to add a cultural dimension or the addition of quantitative measures. (Tashakkori, A. and Teddlie, C., 2010).

Categories were determined for coding raw data obtained from the replies of open-ended questions. To do this each response was read and the concepts within it were added to a summary sheet in order to a list of concepts from the responses. Categories for coding the concepts were then generated from this list. The analytical process then involved examining each response and using the categories to code the concepts present. Note that once a given category had made an appearance in a response, further occurrences of the same category in the response were not coded. In other words, the responses were coded for the *categories* present, and each category could only occur once (even though its presence may have been supported by several elements). Since one response usually contained several categories, the number coded was far greater than the sample size.

Table 1: Examples of pre-service teachers' answers to the questions for open - ended questionnaire categories formed and code samples

Question	Question / Included subject	Category / Code	Frequency
1	Planning importance	1/1	18
	Practice importance	1/2	20
	Learning importance	1/3	12
	Evaluating importance	1/4	4
2	Research	2/1	15
	Data collection	2/2	15
	Taking responsibility	2/3	14
	Documentation of all process	2/4	10
3	V schema format	3/1	7
	Focus question effectiveness	3/2	32
	Methodological part preparation	3/3	15
4	Preparing time	4/1	20
	Requires most attention	4/2	24
	Boring	4/3	10
5	Wide perspective vision to process	5/1	19

	Organized and planned documentation Seeking all the process at one diagram	5/2 5/3	15 20
6	Exactly yes Undecided No	6/1 6/2 6/3	42 6 6
7	Comprehension facility New thinking skills Communication skills Research experience	7/1 7/2 7/3 7/4	27 8 3 16
8	Understanding the experiment and subject effective Meaningful learning experience Understand all process fluently	8/1 8/2 8/3	17 23 14
9	Takes a lot of time Not proper for simple experiments Limitation of one page	9/1 9/2 9/3	33 10 11
10	Understanding Subject and experiment after the process Contribution to meaningful learning and research skills An alternative way for science education laboratories abstractions	10/1 10/2 10/3	11 31 12

The data collected from the application is a document consist of 162 pages. The data content analyzed as codes and frequencies. 33 different codes determined and the codes generally compatible with the quantitative data obtained from scale. Consequently ; the categories and codes abstracted as three general group names; as **Vee supporters**, **undecided group** and **non believers group** for the results.

Results

First, using of SPSS 21, the reliability of the beliefs scale was shown as to be 0.750. Total scores obtained from the beliefs scale were determined, and it was concluded that the highest total points were 94, which is the most positive indicator. The minimum point on the scale was 44. So, the indicator of the most negative attitude was 44 for this study. All of the “undecided” replies were rated, and we obtained the neutral situation point of 60. In other words, a score over 60 represents a positive attitude and under 60 represents a negative attitude. Therefore, 42 pre-service teachers (77.7%) who had more than 60 points showed a positive attitude, while 12 pre-service teachers (22.3%) showed a negative attitude toward using Vee diagrams in science education laboratories. After examining attitudes, I assessed the perceptions of pre-service science teachers about the use of Vee diagram in the laboratory by questionnaire. A total of 18 students had received laboratory lessons from the researcher in the previous semester, so they were familiar with Vee diagrams. The other 36 students had never used Vee diagrams before this study.

According to t test results comparing groups by gender in regard to the attitude scores after the application, there was no statistically significant difference between the two groups (p > .05). So preparing Vee diagrams for science education laboratory doesn't effected by the gender

Gender	N	M	SD	DF	t	p
Girl	42	78,76	13,066	52	4,999	0,469
Boy	12	57,33	13,20			

According to t test results to comparing groups by Vee diagramming experience, there was a statistically significant difference between the two groups ($p > .05$). As mentioned by this result experience of Vee drawing gives confidence to students for new applications.

Vee map experience	N	M	SD	DF	T	p
Experienced	36	83,02	6,85	52	10,199	,000
Not experienced	18	55,94	12,73			

Teacher candidates' answers can be qualitatively analyzed as follows. The responses vary among three different categories. First, the questionnaire answers were categorized. Those who had high scores on the attitude scale were considered to be VEE supporters (34 students, 63%). Their attitude scores were higher than the arithmetical mean of the total scores (73,96-74) and between 74 and 94. The students who got scores between 60 and 74 were categorized as the undecided group (8 students, 14.81-15%). And the last group did not believe in the use of Vee diagrams, rating below the score of 60 (12 students, 22%).

	VEE supporters	Undecided group	Non believers
Points	74 – 94	60 – 74	44 – 60
Frequency	34	8	12
Percentage / %	63	15	22

The replies of pre-service teachers who answered the open-ended questions were similar with some of the attitude scale sentences. Some views determined from pre-service teachers answers are given below;

Beliefs chosen by **Vee supporters group** were as follows;

- Vee diagrams really help to abstract the knowledge before and after the laboratory period.
- Vee diagrams help us to test our subject matter knowledge and gain meaningful knowledge till the conceptualization of the tool.
- I think this new tool drives pre-service students to research new knowledge, and serves as an experiment report to help construct new information.
- V-diagrams provide a new and improved way for laboratory applications, and have positive effects on the students' achievement as an alternative to classical lab reports.
- V-diagrams are a useful tool as a new exam format for science education laboratories, such as the quizzes that we had after the laboratories each week.
- I believe that I gained a new ability to retain knowledge of the theoretical details as during the laboratory work and after the process.
- Vee diagrams helped us to link new concepts while learning during the experiment process.
- V-diagrams or maps really taught me the basic concepts for science education. I realized that, over course of the semester, I had developed many misconceptions about the theoretical knowledge involved in the experiments.
- Vee maps are new formatted schemas for new experiment applications. In the classical format, we only abstract the experiments applications list and write down the basic results.

- I think that I will use the V-diagram when I apply experiments in my school because the tool really provides all the details for the students before, during and after the application. While abstracting all of the knowledge, it allows you to write down the procedure and results in just one page in some instances.

Beliefs of **Undecided group** were a mixture of positive and negative ideas;

- Over the course of the semester, I realized that classical lab reports are very easy, but I think it's enough for short experiments. long experiments, however, may require Vee maps.
- The V-diagramming method is a new schema for science education literature, so we can't be sure that it is a useful tool for our standard laboratories process.
- Observations cannot be listed in the V-diagram, but a lot of details can; this may confuses the students as I lived till semester for the experiments.
- I am really not sure that abstracted format of the Vee could list enough information for some experiments' subject knowledge such as biology-oriented experiments or maybe chemistry, for example.

The beliefs of the **Non-believers group** contained some negative ideas, as follows:

- I couldn't mention basic differences with this tool. Some of the parts are like the classical reports, but some parts are new. I'm not sure that it is useful.
- V-diagramming is a new method. It must abstract the process. But I think lab reports must be long documents for science education field laboratories.
- The classical report method has been used for a long time, so it is so hard to change. I think the classical report is good for experimental documents.
- I think Vee diagramming is difficult in the preparation stage, and time-consuming for me and my group. At the end, some results or knowledge couldn't be mentioned in any parts of the diagram.

Conclusion

This study was conducted to determine pre-service science teachers' attitudes and beliefs toward the usage of Vee diagrams in science education laboratories at the third class. Novice learners had General Chemistry, Physics and Biology labs in the first and second years. My study aimed to contribute to the literature on Gowin's Vee as an application for science education laboratories in science teacher education programs. The results show that most students have a positive attitude towards the Vee tool as an alternative to classical reports. Some students show negative attitude, but their Vee schemas and diagrams are not adequate for the application. Furthermore, the teacher candidates in this category were also unable to construct good reports. The students mention that it Vee diagrams are difficult to prepare and take a lot of time. Most teacher candidates had never used Vee diagrams before prior to this semester; in their other laboratory lessons, they had only used classical report formats. Their negative attitudes may have been influenced by this factor. Some students had experience in using Vee maps, because we had a laboratory lesson last year together using the Vee map schema for reports in some experiments. They were able to draw appropriate examples.

The most important results of my study have some implications for V-diagramming literature.

- For example, some students thought that this new tool leads to research everyone for the new knowledge and provides a useful experiment report to construct new information on new subjects.
- In contrast, some students' found the Vee format difficult for short experiments and basic subject applications.
- Most students who had a positive attitude mentioned that V-diagramming had more benefits than classic reports.
- V-diagramming helps students to abstract the procedure, research the information they need, and draw conclusions about the focus question.
- Consequently, knowledge claims provide to repeat all our information before the experimental process. In the transformations part, we can learn new ideas and concepts with both their relations. Some of these sentences match with the literature.

These important sentences or beliefs emphasize the importance of the current study. Instead of making an important contribution to the literature, my study supports the findings of the benefits of Vee diagramming, as shown below:

- Vee diagrams are informative, useful and facilitative for the students' conceptual understanding (Ramahlape, 2004);
- The Vee tool is helpful for conceptual learning and understanding (Nakiboğlu & Meriç, 2000);
- Vee diagrams led students to conduct research before the laboratory application (Roth & Browen, 1993; Atılboz & Yakışan, 2003); and
- V-diagrams could be used as pedagogical tools to organize and order teaching and learning activities using the results from the content (Afamasaga-Fuata'i & Cambridege, 2007).

Consequently, the findings of the research point to the following conclusions. The use of Vee diagrams, Vee maps or Gowin's Vee in science education laboratories will provide benefits to students by helping them to learn the content meaningfully; using this tool, students, novice teachers and teacher candidates can overcome the problems of rote learning. Vee diagrams organize theoretical knowledge and the experimental application process in a correlated way. Vee diagrams should be suggested to educators in science education laboratories lessons in universities and elementary education departments. In Turkey, we have science education laboratories lessons called 'Science application', 'Science teaching' and 'Science education' for the preschool level; in Classroom Teacher, Science Teacher and Preschool Teacher education departments. The usage of Vee diagrams must be expanded for these lessons, especially at the university level, to contribute to the science education literature.

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