

## A THEORY FOR MORE CREATIVE TEACHING WITH THE VAV METHOD

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**Abstract:** *We describe and show a fuller, more effective way to use the Summary and Conclusion in a way that makes them important in the creative process. To do this, we*

- a. suggest a formal set-theoretic description of creative actions,*
- b. describe the VaV method and give a kinematics-based analogy for it.*
- c. develop a new vocabulary of acronyms ( JLM, RLM, PaS, HOP)*
- d. Highlight and illustrate the use of PaS as part of the Conclusion*

**Key Words:** VaV ( Vystup and Vstup, which in English is „exit and enter“ or EaE), , Content, Structure, Links and Connections, prior knowledge, PaS (Pointing and Sketching), JLM(Just Learned Materials), RLM,Recently Learned Materials, HOP, Hand-Over Phase

### 1 (A Creative) Introduction

Creativity in the teaching/learning context has its own special characteristics. When these are identified and utilized, a better, more reliable, approach to creative teaching is made possible.

#### 1.1 Creative Acts and Formal Ethics

In this section we define a creative physics teaching project in terms of some values  $V$ , a current state of the world,  $W$ , some goals  $G$  and, a decision system  $D$ .

Consider the 4-tuple,  $(V,W,G,D)$ , where,

$V$  is a set of values.  $V$  defines what is regarded as valued and what is regarded as good in physics education.

$W$  is the set that describes the state of the relevant world. E.g., in the physics teaching,  $W$  refers to the state of the students (their prior knowledge, and their potentials for future growth), to the required curriculum, and to the given best practices used for teaching.

$G$  is a goal or objective statement. This might be to increase test score performance, etc.

$D$  is a set of methods, models, techniques and norms used to make decisions in order to achieve the goals, $G$ , when starting in the relevant world context,  $W$  and the values  $V$  which are „believed“, or otherwise chosen as key .

**Terminogy:** We call  $V$  the *set of values*;  $W$ , the *world set*;  $G$  the *goal(s)*, and  $D$ , the *decision system*.

Consider an action or project or lesson plan,  $A$ , that

- a. achieves the goal  $G$ ,
- b. can be reached by the decision system,  $D$ , and
- c. preserves and satisfies the requirements of the set of values, $V$ ,

when it is performed under the conditions that are indicated or stated in the world set  $W$ ,

Such an action,  $A$ , is said to be creative if the set of values  $V$  contains „newness“ as a value. I.e., creativity is not only about creating value, but also about creating value in a new way.

Note The above characterization of creative acts refers to creative teaching. E.g., creative teaching is a special form of creativity, and so all four components of  $(V,W,G,D)$  are involved. This is true of any purposeful act. E.g., the use of the 4-tuple,  $(V,W,G,D)$  is useful to characterize ethical acts also. Just different definitions of  $(V,W,G,D)$  are involved. See References 1, 2, for a discussion of ethics systems based upon a similar approach and set-theoretic notation.

Creativity in physics teaching physics, the most important part is the set of goals,  $G$  which in turn are dependent on the values  $V$ . E.g., does the local school board want to educate students into free thinking individuals who know and practice creative thinking? Or is it satisfied to train technicians who have memorized many techniques and can operate many instruments without having any inner needs to explain them in physical terms?

## 1.2 Content Manipulation In Creative Teaching

Once, the values,  $V$  and the goals,  $G$  have been chosen (or given), the creativity is constrained. Creative teaching is not just a one-time event. A sequence of creative acts is possible when some training in creativity is given and when a system of creativity assessment is followed. A creative teacher knows how to be creative often - as often as he/she has the time and energy to creatively plan and design the content to be taught by using the  $V$  and  $G$ . But creating content is not a necessary condition for creative teaching to take place:-

- a. the same content can be presented creatively in different ways,
- b. the same content can be creatively presented in different orders or sequences,
- c. new content can be used in addition to the content that is required by a standard textbook, and a specified curriculum
- d. some content can be repeated or reviewed at key points of a specific sequence,  $(S_1, S_2, \dots)$ . This has to do with the nonholonomic nature of learning and thought. Often the repetition will lead to new thoughts, new comments, new ideas. Thus, theoretically, it belongs to the set of potentially creative manipulations of content. Potentially, it seems to the author, that content repetition is a powerful generator of creative ideas when this repetition is regarded as seeing the „same things“ in new ways. This will be made clearer in the context of the VaV method and of „pointing and sketching“, or PaS, both of which are discussed below..

There are various methods that can help practitioners to place themselves into the creative state of mind. The VaV method (4) is one of these.

## 2 VaV Method Reviewed

The VaV method (Reference 3) provides a structure and a vocabulary for that structure to help in creative teaching. It enables the teacher and/or other users to design and plan the sequence of distinct steps that can be taken to creatively go from current prior knowledge  $PK_1$ , to a new understanding or to a new worldview,  $U$ , where  $U$  is the goal of the teaching. The VaV method is based on a physical analogy where topics/themes are



**C, Conclusion:**

**Teacher says**

„Now that you have studied the main body, M, you can now study or solve, or further investigate , the following topics or problems without needing any more new concepts or facts.“.

Clearly, more can be meaningfully said to the students in the C phases than in the I phases. Whereas in I the teacher draws on prior knowledge, in C there is more prior knowledge, and this difference although slight in quantity can be huge in qualitative apprehension, and readiness or preparedness to become excited about something new that is emerging on their horizon.

The conclusion C is a very free and open space where lots of teacher-specific or student-specific creativity can take place. . It can make crucial differences in the type of students that come from a school system, from a particular school, or from a particular teacher. It, or rather the types of conclusion,C, used in a school, or system, or country, can make or brake a student's interest in a theme or subject. In this paper we focus on phase C, but first we review the the VaV method because it is the method which can motivate better time and energy to spend on phase C.

### **3 Analogy for the VaV Method**

The VaV method can be illustrated and motivated by a simple analogy described below.

#### **3.1 The Stepping Stone (SS)Teaching Analogy Behind the VaV Method**

Consider a set of rocks or stepping stones across a pond of water, or a small quiet stream. A frog can skip or hop from stone to stone to cross the main body of water in several different ways - - depending on how the stones are arranged. Some will be easier than others to cross, because some hops might be longer than others. The stones are the possible themes that can be covered in the classes. The path taken, involves certain sequence of stones, or themes to be studied. It is the same with the mind, and the adding of concepts, or contents This is the stepping stone (SS) analogy.

So the design of curriculum is a matter of choosing a pleasant set of themes or topics. These are to be „traveled in a mental fashion“. So the teacher selects a sequence of themes, content topics, ., to ease the student's burden, and to make learning more fun.

#### **3.2 Pointing and Sketching (PaS)Activities**

However, when the teacher selects (designs) a way across the main body of knowledge („water“ in this analogy) some, (and probably, many topics) will be left out due to practical considerations such as class time, laboratory space, etc . Even so, he or she can still point out to the students the adjacent stones or rocks. Of course the „pointing“ is a metaphor. In the context of physics, the „pointing out and sketching“ (PaS) is done by saying something like,

**Pointing/Sketching (PaS) Activities**

**Teacher says**

„We shall not look into this topic or problem this time, but it is now within your reach. You can go back to one of these in your summer vacations, in your free time, or even later in your career, when you run across it again. Or you might get interested enough to do

research in that area yourself. In the mean time, we shall just do a little sketch of this by noticing that,  $x, y, \dots, z$ ."

In this fashion the teacher makes the transition between  $S_i$ , and the next step  $S_{(i+1)}$  interesting and informative. This is more effectively done in the conclusion phase, C, rather than in the introductory phase, I., because the student has the „just learned material“, JLM, from the last step available for a new understanding and a better grasp of what the teacher is pointing to. In the sketching phase the teacher and students can use the JLM content to make their descriptions more appropriate.

**Note** Of course, the most effective themes (stones in this analogy) are those that can be reached directly in one lesson (or less) from the current place of residence (the current resting stone in this analogy). The current place is the place from where the „vystup“ or exit is to take place. The „adjacent stones/themes are the possible places of „vstup“, or entry. Perhaps the curriculum mandates that some stones (themes) must be left out from the teaching, but in the I and C phases the teacher can point and sketch.

Inclusion of the pointing and sketching (PaS), into the summary and conclusion phases, indicates that something new is emerging from the analysis. Instead of summary, or conclusion we suggest a more inclusive, more effective phase, that we call the Hand-Over Phase, or HOP, discussed next.

#### **4 The Particular Possibilities of the Hand-Over Phase (HOP)**

Many things and activities can go into the conclusion phase, C. In fact we suggest to rename the C phase as the HOP, or Hand- Over Phase, because it is creative to do much more than summarize and conclude in the „ending“ of a lesson step, S. This is not really an ending, however, according to the VaV method, but a new beginning:, in the holistic sequence, ( $S_1, S_2, \dots$ ), which indicates a :hop: from step  $S_i$  to step  $S_{(i+1)}$ . Luckily, HOP is also an appropriate acronym.

We suggest that the following parts always go into the HOP of any creative VaV activity.

##### **4.1 Restating**

Restating is important both for teaching and for problem solving, as well as for research. In fact, in math, a restatement of a famous theorem can be thrilling, amazing, and lead to bursts of new growth. For this the NASC ( necessary and sufficient) proofs are famous. However, for physics, teaching just

###### **4.1.1 The Standard Summary**

First, we can restate what was learned . The quest for conciseness, and for „essentials only“, is one good attempt at restating. This is the standard summary.

###### **4.1.2 The Shadows Analogy for Restatements**

Other points of view that can be used in the restatement. We can restate the just learned materials“, or JLM, in other words. For example we can take another approach to the topic/theme or another cross-section, according to another „cut“ at the main body, M. E.g.,

a physical object can make many different types of shadows, depending on the illumination point or points, and on the orientation of the viewing screen upon which the shadow is viewed. In addition to that, the „shadow“ is in space, not only on the screen. It is amazing what differences different witnesses to an action can honestly perceive, just as are the differences in shadows perceived when the screen orientations are varied from one extreme to the opposite ones.

#### 4.1.3 The NASC Method of Restatement

In mathematics and logic, a restatement of a famous theorem can be thrilling, amazing, and lead to bursts of new growth. For this the NASC ( necessary and sufficient) proofs are famous for showing that intuition needs to be not only developed (evolved) but that it often needs to be precised by rigorous demonstrations. NASC proofs are beautiful examples to be strived for. When the connections are lacking, then only one sided versions are all that can be achieved. Then a clear counter-example is desirable to showc the implication does not work in the other direction. However, for physics teaching at the secondary level just being presented a topic from a different point of view can awaken curiosity - - or even wonder - - if not actual disbelief ( in the sense of the statements such as, „Am I dreaming?“, „Is this real?“, „I can't believe my own eyes,“, or „Just pinch me.“ , etc.). As an example consider the sequence of concepts that underlie what we mean by „atom“ while stepping/evolving from Democritus, through Dalton, Thompson, Rutherford, Einstein, Bohr, Chadwick, CERN,etc.

#### 4.2 Pointing and Sketching (PaS), an Assembly Line of Connections

Secondly, there is the important possibility of „pointing to and sketching“ (PaS) to places (themes/topics) that the class will not „visit formally in the main body,M.

Note The acronym,PaS is used not only for the phrase „pointing and sketching“, but also for „point and sketch“. The context makes the meaning clear.

Some important topics that have not been chosen for as main bodies, M of a step Si, of the VaV sequence being used still are important. While PaS we can consider ourselves as tourist guides who point out a monument or place of interest to the tourists. Then they give tourists a small historical sketch to anchor their memories, to awaken local knowlege, and to create an affection for the place being visited. PaS is a means to create futures awareness. It also is a means to create an awareness of linkage, connections and relations. These three have essentially the same meaning in an abstract space and are regarded as most important for creativity. PaS will teach students to make passing connections. Before a person can relate deeply to another person, or to a subject or theme, there must be at least the initial phase of PaS. By PaS we create great potential for future student interest.

**Backward Principle 1** A creative VaV sequence is founded upon a set of values, V, and a set of goals, G. From V and G we can work backwards to the HOP content and to the links that the HOP will PaS.

### 5 Choosing Links Creatively

Choosing links and making connections is one of the most creative parts of creative teaching. How do teachers choose the themes or items ( „stones“ in the SS analogy), to

highlight and discuss, or to PaS? Well, the main content of the main body, M is assumed to be given by the required curriculum. So there is not much to do there. For the Introductory and HOP phases where there is lots of creative space, we suggest Web search and WebQuest (Reference 4) methods. Search engines such as Google are good for key word. But an even more important thing is to get good web sites of science newsletters, and other scientific information organizations. These are good for the hot topics that can excite students and that can make the main body content, M, relevant to their lives at present and to their future expectations. We recommend that at the secondary school level or below, the teachers should survey the scientific newsletters, pick the appropriate link and work it into their class materials.

The author has found the sites in Reference 5 very useful for interesting links.

### a **The method of Hot Topics**

This method is about big-news. Whether the news is big in the popular press or mainly in scientific circles is not so important. What is important is that the PaS can be described in terms of prior knowledge, such as in terms of the JLM, or RLM.

Note Even if a hot topic is not a mass media topic, the big news item can create interest because of its currency. A bright young student can, for instance ask her/his parents, „Do you know ( or, Did you hear) that Slovak scientists from SAV ustav XX are doing research at CERN on a „God“ partical?“. Or „I think, that the idea of trees being connected through their roots like nerves in the human brain could be scientifically possible. Do you think that trees can link together like neurons to make a giant brain, like James Cameron’s movie, Avatar, suggests?“ Before these kinds of comments and questions are likely to happen there must be linkages pointed out in school. This is what PaS is about.

a.1 **Hot news items** ( e.g., BP oil spill, the Mars 520 day simulation with its simulated communication delays, etc)

a.2 **Hot science fiction , Fantasy fiction, etc.,films** ( e.g. Avatar, Star Trek, Empire strikes back, etc)

a.3 **Hot scientific themes or areas** where lots of new experimental and/or theoretical activities or discoveries are currently going on/ E.g., space sciences, astronomy, climate change science, ecology, molecular and synthetic biology, DNA engineering, synthetic life, etc)

b **Connections to other subjects** depending on physics, such as biology, chemistry, medicine,

c **Connections to other areas of physics** such as nano technology, climate change modeling, weather prediction, hurricane tornado studies, Sun models, space weather, etc.

d **Explanatory links.** These are links to theories, laws, and phenomena that can be understood and explained by the JLM in conjunction with older prior knowledge items. The link can be part of a subject connection, b, or a hot topic,a.

e **Sideview Links.** These links involve student construction and brainstorming. They in particular ask the students to form teams and debate the innovation possibilities for usage of the JLM. The usage can be „ANYTHING“ that pleases their interest, imagination, or reasoning minds. It can be applicable in any context, even imagined, even science fiction

ones. It can be serious also. For serious possibilities of using the JLM, the teacher should remind the students that many great inventors had to struggle many hours and over many experiments before the „serious use“ became a more than just a plausible „may be“. There are many examples. Perhaps the most famous one is about Thomas Edison's light bulbs.

When a woman said, „Mr Edison, you mean you have had hundreds of failures to invent a light bulb and still keep trying?“, Mr. Edison replied, „No, Madam. I have not had any failures. I have learned hundreds of ways how not to make a light bulb. That is why I still keep trying“.

Evidently Thomas Edison kept trying new approaches every time. He kept learning, and so he got better and better. His chances of success were improving as he learned. And as he learned, he also could reduce the number of reasonable possibilities to consider.

**f Prior Knowledge Restructuring** The JLM and RLM can have implications for other areas of the student's previous learning. It is good to periodically update their old understanding within the HOP activity. Mr. Edison restructured the woman's attitude from negative ( failures) to positive ( learning instances). In section 4.1.3, the PaS made about the concepts of the atomic structure of matter indicate that scientists have been updating their belief systems by, with, and through methodological and unbiased search for truth, through experiments, through an openness to change prior beliefs when new evidence arrives, and through the beauty of a quest for consistent accounts/explanations of observed phenomena.

## **6 HOP, (Hand-Over Phase)**

In this section we plan to illustrate how the HOP might be used in designing and implimenting a step sequence,  $(S_1, S_1, \dots)$ . Each step,  $S_i$ , has a HOP,  $H_i$ . The full sequence has, a HOP for itself. This section gives a HOP for the whole paper.

### **6.1 Pointing and Sketching (PaS)**

In the PaS activity, we can point and sketch to future possibilities, and to current realities:-

a. The SS analogy has been used to introduce the theory Markov chains, and Markov processes. Both of these are important techniques in the physics of random processes.

b. A future enhancement of the VaV method might include the fact that learning and thinking are complex processes with certain self-organizing and emergence properties. It seems reasonable that such properties can be used to make better design of the teaching steps,  $(S_1, S_2, \dots)$ , of the sequence of introductions,  $(I_1, I_2, \dots)$ , and the sequence of HOPs,  $(H_1, H_2, \dots)$ .

c The theory of creative acts might be a useful introduction to a general theory of creativity

d Creative act theory might be enhanced by placing an optimization procedure over it. For example, we might be able to use the set of values,  $V$  to create a function ( an objective function, or value function),  $O$ , that can be used to select a step sequence

(S1,S2,...,Sn) that provides the maximum value of the objective function, O, for a minimal value of n.

### 6.2 Other View Restatement

The SS analogy is useful for the teaching process, because a teaching sequence is a matter of a non-linear stepping from topic to topic. Sometimes the topics must be followed in a given sequence, but often there is freedom in designing the order of coverage. Also, some topics might be left out in favor of other topics. In this regard the SS analogy is good because the path taken is an important aspect of effective teaching.

The SS analogy has some applications to the VaV method. For example, the question of review time might be involved in placing some content closer together in order to teach more content, more effectively

### 6.3 Hot Topics

a At a time when the political desire to teach well is leading to declining educational investment, the indicated optimizations might be well worth the extra effort. The desire to formalize language, to describe and utilize structures, systems, and place into set-theoretic language is also a hot topic.

All these topics promise to increase creativity in teaching physics and to make it more formal, more, more repeatable, and more valuable or effective..

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