Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.7, No.24, 2016

The Role of Visual Learning in Improving Students' High-Order Thinking Skills

Jamal Raiyn
Computer Science Department, Al Qasemi Academic College for Education, Baqa El Gharbia, Israel

Abstract
Various concepts have been introduced to improve students' analytical thinking skills based on problem based learning (PBL). This paper introduces a new concept to increase student's analytical thinking skills based on a visual learning strategy. Such a strategy has three fundamental components: a teacher, a student, and a learning process. The role of the teacher includes monitoring the learning process by considering the most productive way to improve higher-order thinking (HOT) skills.Many studies show that students learn from courses that provide information in a visual format. We introduce a meaningful learning strategy for the classroom that promotes the presentation of information in visual formats such as images, diagrams, flowcharts and interactive simulations. Furthermore, we compared visual and traditional learners based on their HOT skills, which were evaluated using the SWOT model. Performance analysis shows that visual leaning tools increased the students' HOT skills.
Keywords: visual learning, PBL, HOT skills

1. Introduction

Various studies report that 75 of all information processed by the brain is derived from visual formats. Furthermore, visual information is mapped better in students' minds (Williams, 2009)). *Visual learning* is defined as the assimilation of information from visual formats. Learners understand information better in the classroom when they see it. Visual information is presented in different formats, such as images, flowcharts, diagrams, video, simulations, graphs, cartoons, coloring books, slide shows/Powerpoint decks, posters, movies, games, and flash cards (Rodger et.al. 2009). Teacher can use the above mentioned formats to display large amounts of information in ways that are easy to understand and help reveal relationships and patterns. Based on various studies, students remember information better when it is represented both visually and verbally. These strategies help students of all ages to better manage learning objectives and achieve academic success.

Visual learning also helps students to develop visual thinking, which is a learning style whereby the learner comes better to understand and retain information better by associating ideas, words and concepts with images. Visual information is presented through various interactive visual tools, such as information and communication technologies (e.g., web services), and 2- and 3-D visual environments. This study focuses on interactive 2-D games, such as Turtle, at different levels for ages between10 and12. The contribution of this research lies in its assessment of visual thinking skills.

This paper introduces a new teaching method based on visual algorithms, which can be presented in graphic form. The visual representation of algorithms is useful both for teachers and pupils in their teaching and learning. Problem-based learning (PBL) leads to the development of higher-order thinking (HOT) skills and collaborative skills in students. There are two distinct types of HOT skills needed for problem solving: analytical and creative. Analytical, or logical, thinking skills use critical thinking and help the reasoner select the best alternative; they consist of ordering, comparing, contrasting, evaluating and selecting. Creative thinking skills are also needed for problem solving; these consist of problem finding, efficiency, flexibility, originality, and elaboration. (Hmelo-Silver, 2004; Bednarz, 2011; Cottrell, 2011; Cottrell, 2013). The goal of the proposed approach is to study the role of a visual learning environment based on information and communication technology, in improving students' HOT Skills. In previous research, we worked on the performance of a HOT thinking assessment through adaptive problem –based learning (PBL) (Raiyn, 2015). In this study, we introduce a PBL based visual environment.

2. Related Research

This section summarizes studies that use visual learning. The development of visual thinking skills requires information that is designed for, and supported by visual tools. We define a *representation* as the substitute for an argument in a function, understood in the mathematical sense. It is simply a mapping relation. Inputs and current states are mapped to subsequent states and outputs such as overt behavior. A function stands for a represented object, and there is always an implied relation to behavior.

Information collected is stored in the human brain (in the hippocampus), which perceives its environment and stores the information (knowledge base) in place cells. Based on the representation of the stored information in the hippocampus, the brain creates *cognitive maps*, and humans act on the environment by using these maps. Hence, there are various cognitive maps in the brain, and cognitive map management aims to find shortest path between the source and the target destination based on decision- making theory. Visual information supports human thought processes and maintains log-tern memory.

Rodger et al. (2009) integrated *Alice* 3-D in Middle school and designed lessons in math, science, language arts, social studies and technology. *Alice is an innovative 3-D* visual programming environment. It enables users to create an interactive game, animations, and videos, and is a teaching tool available for creating object-oriented programming.

Ben-Ari (2012) introduced programmable interactive media with *Scratch* to support the development of computational thinking skills. Wilson at al. (2009) introduced *games-based learning*, such as scratch, and game-based construction to engage children at the primary level with computer programming concepts. *With Scratch*, users can program interactive stories, games, and animations. It helps young people learn to think creatively. Stolee and Fristoe (2011) used *Kodu Game Lab* to introduce children to programming in early ages. *Kodu is 3-D* visual programming platform. Kodu can be used to teach creativity, problem solving, as well as programming. Ioannidou A. (2011) used games to support the development of computational thinking skills and to promote increased opportunities for computer science education in the regular curriculum. Hero et al. (2015) used the visual programming platform, *MIT App,* to increase interest and skills in computational practices. A visual programming platform, *MIT App*, enables users to create and to design Android apps and games. It can be used in various fields. The App Inventor platform teaches students how to program mobile apps, and the material is suitable for middle school, high school, and college courses. Peluso and Sprechini (2012) used *Alice* to examine the attitudes of high school students toward computer science; the students expressed their satisfaction with the use of *Alice* visual programming.

We conclude that the use of educational visual programming environments such as, *Alice*, *Scratch*, *Kodu*, and *Greenfoo*t, supports the development of computational thinking includes logical thinking and algorithmic thinking, and these involve other kind of thought processes, such as reasoning, pattern matching, and recursive thinking.

Furthermore, these environments introduce primary school children to visual programming concepts. The most common ones being taught are loops (iteration) and conditional statements that support problem solving, logical reasoning and systematic thinking

3. Methods

The SWOT model was used in this study to evaluate HOT skills in the heterogeneous classroom by SWOT stands for strengths, weaknesses, opportunities and threats (see Figure 1). Based on the evaluation of HOT skills using the SWOT model, we can determine the strengths, and the weaknesses of individual students.

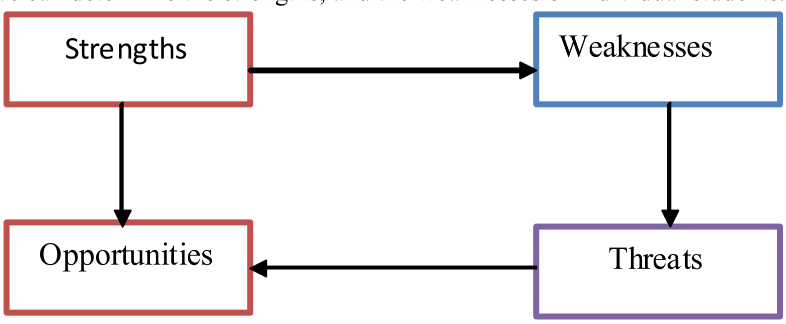

Figure 1: SWOT model

SWOT was used to evaluate a student's HOT skills and to support interactions between among students to improve HOT skills in the group. Figure 1 illustrates the combinations of SWOT categories used to design sub-group for problem solving in the classroom.

- Strengths and Weakness (SW): This combination identifies strengths that can reduce weaknesses.
- Weakness and Opportunities (WO): This is combination offers alternative ways to prevent weaknesses.
- Weaknesses and Threats (WT): The role of teacher is to prevent threats in light of weaknesses.
- Strength and Opportunities (SO): This combination is used to find ways to reduce weakness and threats.

The SWOT analysis was drawn from the internal environment of the classroom to determine the strategy for building sub-groups. According to student's HOT skills evaluation, we created sub-groups of three students. Each sub-group consists of three students. In this case we give the students an opportunity to increase his academic score. In sub-groups the collaboration between groups member is needed and is evaluated.

There were three strategies for creating the sub-groups:

- The assessment of HOT skills.
- Students' assessments
- Creating of sub-groups with leaders.

A platform for sharing information was established for the teacher to implement visual learning. This platform provided visual tools and synchronous and asynchronous communication among students, as illustrated in Figure 2. Students were asked to give a presentation on an issue in computer science, after which their HOT skills were evaluated through a face-to-face meeting and an oral test on the project submitted.

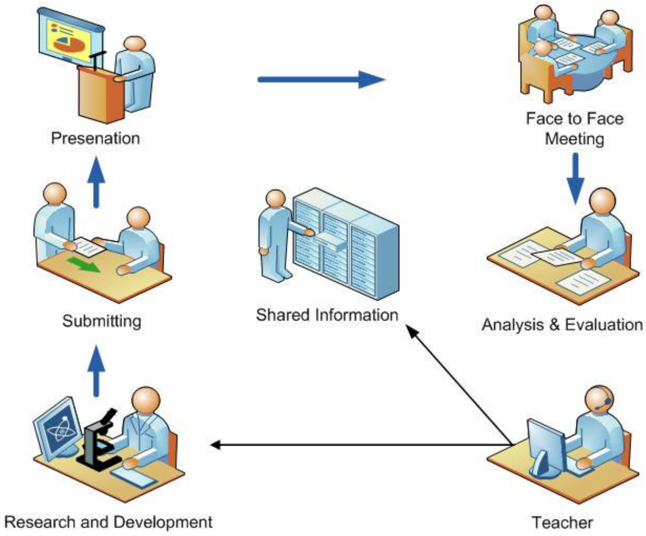

Figure 2: Visual learning based PBL

3.1 Lesson plan for visual learning

As illustrated in Figure 3, the teacher selected a lesson in visual learning and the . corresponding learning tools for presenting the visual material. After introducing the selected lesson, the teacher managed a discussion, solicited question, and fielded student comments, until all goals were addressed. The teacher distributed the visual assignment. The teacher then analyzed and summarized the students visual HOT learning skills

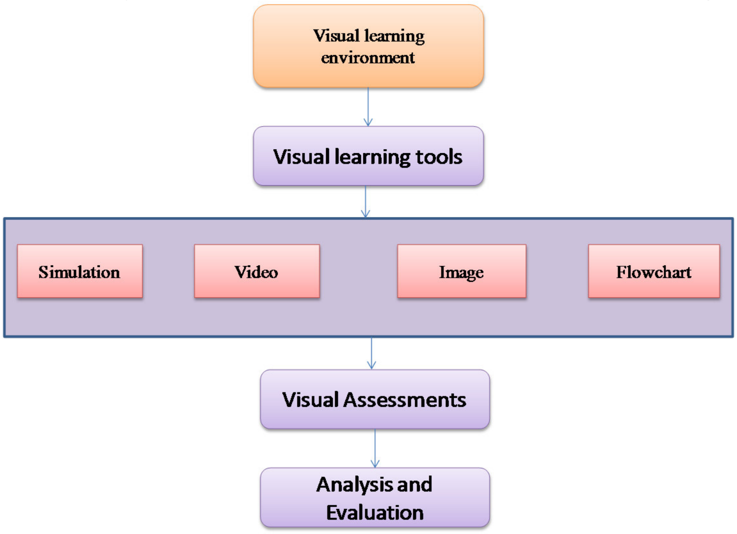

Figure 3: Visual learning strategy

Figure 4 illustrates the strategies for creating the sub- groups of students in the classroom. We used two strategies; the first was based on results of the individual HOT skills analyses, the second was based on students' self-assessment.

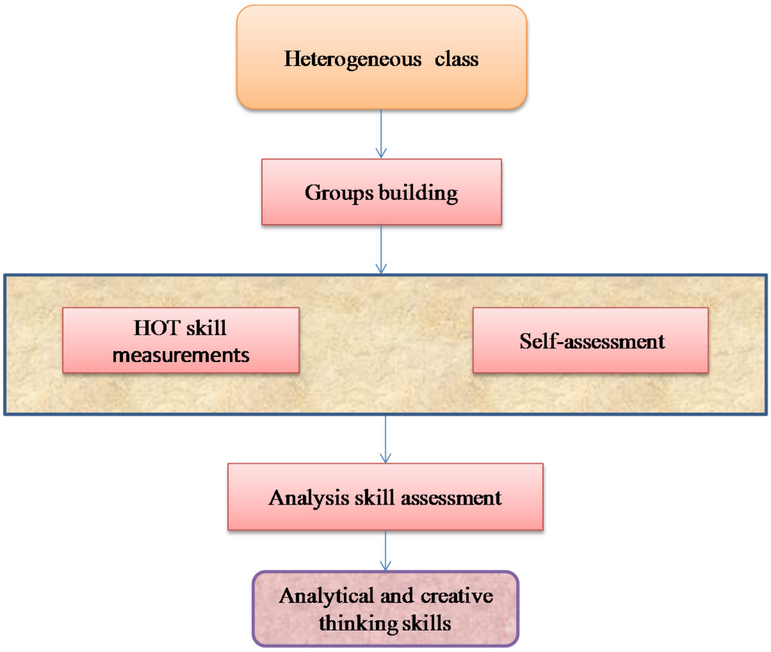

Figure 4: strategy for creating group

4. Evaluation of the Visual Code Strategy

The evaluation and performance analysis of student's HOT skills was based on a mapping process, as illustrated in Figure 5. HOT skills were classified a low (L), medium (M) or high (H). To improve student's HOT skills, we created sub-groups, each consisting of students with H-L HOT skills.

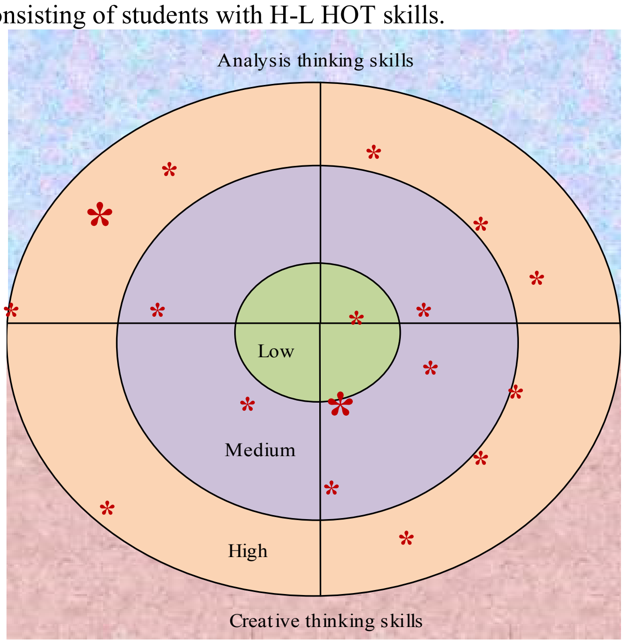

Figure 5: Mapping of students HOT skills

The measurement of HOT skills collaboration was done according to leadership strategy. Students with high HOT skills led the sub-groups. We scored the group leaders collaboration skills with positive a sign (+) if they could influence at least one of their group members, otherwise, they were evaluated with a negative sign (-). To motivate the sub-group members to collaborate, we positioned a student with low HOT skills as the leader, and other sub- group members collaborated with him, or her to improve the leader's HOT skills as illustrated in Table 1.

Table 1: Leadership strategy

Students		HOT skills	Position	Collaboration		
Group A	S1	H	Leader	+	+	-
	S2	L	Member	+	+	-
	S3	L	Member	+	-	-
Group B	S1	H	Member	+	-	+
	S2	H\M	Member	+	-	+
	S3	L	Leader	+	-	-

Figure 6a illustrates the students' HOT skills for PBL via the traditional learning process. Figure 6b illustrates the students' visual HOT skills. It can be seen that the use of visual tools for PBL increased students' HOT skills comparison with the traditional learning process. Figure 6c compares traditional HOT skills to visual HOT skills. Figure 6d compares HOT skills in the traditional learning process to the HOT skills in the visual learning process. Visual learning improved the HOT skills of students. Figure 6c and Figure 6d illustrates the strong collaboration among group members. This return to SWOT tools was used to diagnose students' HOT skills in the initial assessment of individual students.

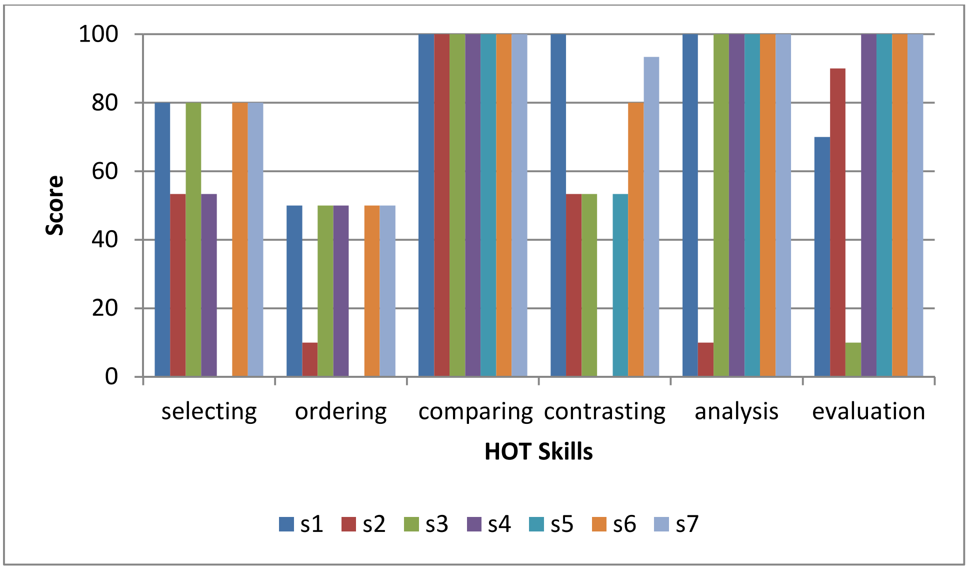

Figure 6a: Traditional learning environment

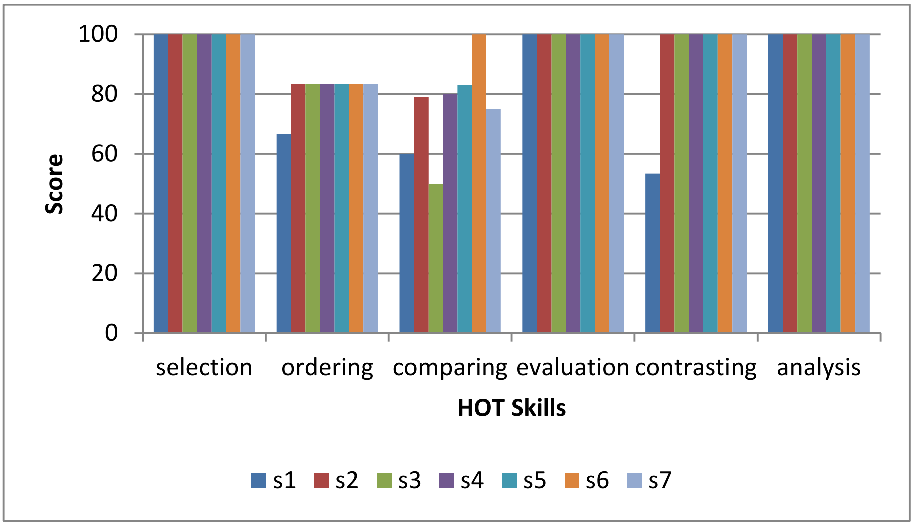

Figure 6b: HOT skills in visual learning

Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.7, No.24, 2016

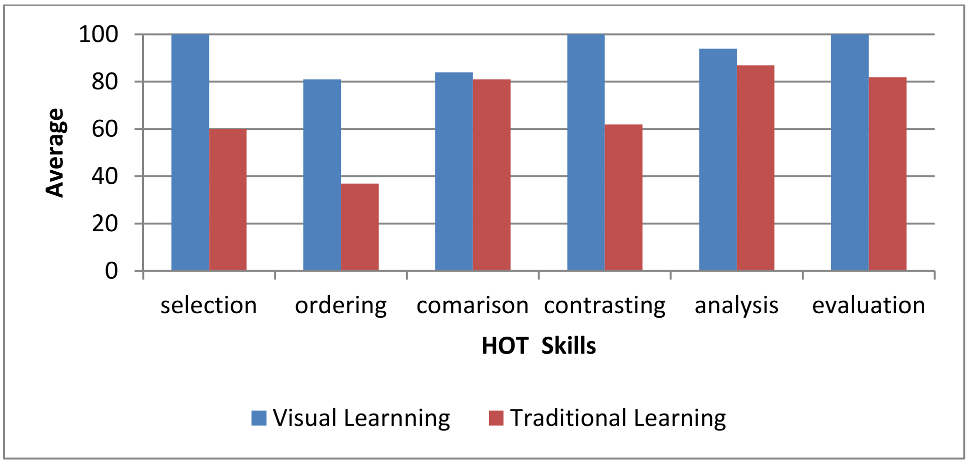

Figure 6c: Traditional compared to visual learning strategy

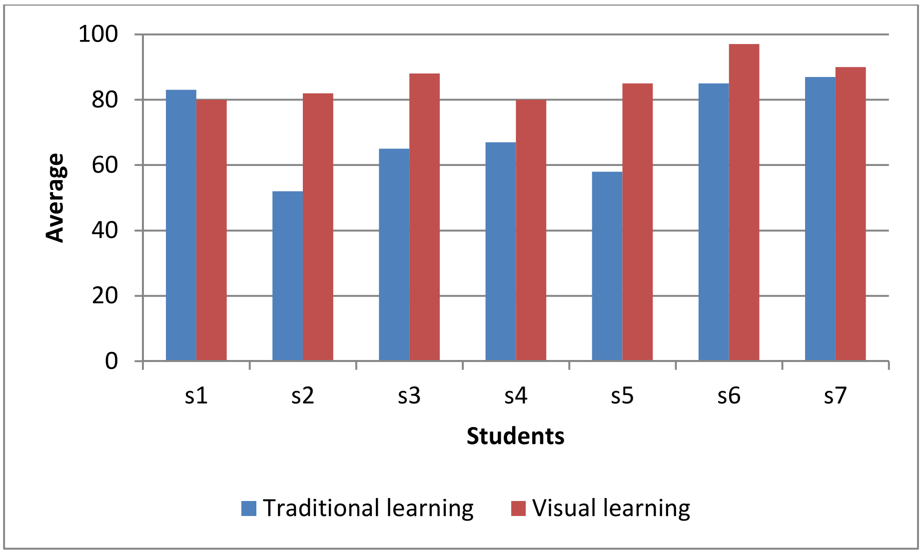

Figure 6d: traditional compared to visual learning strategy

Conclusion and future work

This paper introduces a new visual learning strategy and its impact on the development of student's high-order-thinking skills, corresponding to analytical thinking. The SWOT model was used to discuss and to evaluate student's performance and their ability to make decisions by creating sub-groups of students. Visual learning offers better results than traditional learning systems. In primary and middle schools, the effects of visual learning on the development of student's HOT skills are significant.

In future work we will consider visual reasoning. In a visual learning environment, the learners use their eyes to collect visual information. Some studies in human cognition show that in human brain, visual information is stored accordance with its location in the environment, and it is presumed that the location of the spatial cognitive map is in the hippocampus. Furthermore we will use the visual learning tools in primary school to study the Attitudes of pupils toward Learning Programming through Visual Interactive Environments.

References

Aslan, I. and Bozkurt, R. (2010). Strategic Sustainable Development and Creating Strategies from TOWS Matrix at KipaĢ Group, 2nd International Symposium on Sustainable Development, June 8-9 2010, Sarajevo.

Ben-Ari, M. and Resnick M. (2015). New frameworks for studying and assessing the development of computational thinking, Computer Science Education, http://web.media.mit.edu/~kbrennan/files/Brennan_Resnick_AERA2012_CT.pdf

Herro, D. and McCune-Gardner, C. and Boyer, M.D. (2015). Perceptions of Coding with MIT App Inventor: Pathways for their Future. JOURNAL FOR COMPUTING TEACHERS.

Ioannidou A. (2011). Computational Thinking Patterns, Annual Meeting of the American Educational Research

Association (AERA).

Peluso, E.M., and Sprechini, G. (2012). The impact of *Alice* on the Attitudes of High School students Toward Computing, *Journal for Computing Teachers*, 7, 2012.

Raiyn, J. and Tilchin, O. (2015). Evaluation of Adaptive PBL's Impact on HOT Development of Computer Science Students, *Journal of Education and Practice*, *6*, 30, 51-58.

Rodger et.al. (2009).Engaging Middle School Teachers and Students with Alice in a Diverse Set of Subjects.SIGCSE09, March 3-7, 2009.

Stolee, T.K., and Fristoe, T. (2011). Expressing computer science concepts through Kodu Game Lab, SIGCSE'11, March 9-12, 2011, Dalla, Texas, USA.

Wilson, A., Hainey, T. and Connolly, T. (2009). Evaluation of Computer Games Developed by Primary School Children to Gauge Understanding of Programming Concepts.

Williams, R, (2009). Visual Learning Theory. http://www.aweoregon.org/research_theory.html.