Constructivism and the ancient art of Origami

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Abstract

This paper provides a framework for thinking about origami construction and constructivism. In an attempt to understand the conceptual and theoretical framework supporting the field of inclusive teaching strategies in relationship to origami, I have prepared a model for origami which represents six types of constructive learning: (1) Hands-on learning, (2) explicit instruction, (3) higher order thinking, (4) multimodal instruction, (5) social learning, and (6) self-management strategies.

Introduction

By folding and unfolding a piece of paper, students are involved in constructing and deconstructing concepts that eventually lead to a three dimensional product. Teachers must allow students to experience learning in a constructivist method. Origami is an ancient art which compasses hands-on learning, step-by-step instructions, schema building, prior knowledge activating, spatial reasoning and logical concepts mapping (Ellis, 1938; Marton, Hounsell, & Entwistle, 1984; & Gay, 2000). Through origami construction, students have the opportunity to discover both individual differences and universal commonalities between western and eastern cultures (Leo, 2001; Harriot & Martin, 2004). Students are able to explore different perspectives, examine stereotypes, develop global awareness and celebrate diversity in their own classrooms. Origami combines multiple intelligences. It exemplifies the spirit of educational aspects needed in schools: creativity, authenticity, and coping skills (Sze, 2004). Origami stimulates more parts of the brain through using more than an antiquated teacher-lecture format. It is an educational approach involving joint intellectual effort by students and teachers.

As students practice origami, they begin to understand and experience some of the complexities and interconnections of life laws and perseverance. Hands-on learning such as origami has proven to be effective when used in different learning styles and with students from diverse populations (Bucher, 1999). Teachers can apply the knowledge of constructivism and the ancient art of origami to involve a student in a total learning experience, enhancing student's abilities to think critically, to create class dialogues, and to pose questions so as to encourage higher levels of thinking.

Operational Definitions of Origami & Constructivism

A dictionary definition of Origami is that is the Japanese art and science of folding paper into shapes representing objects. An earlier use of the term referred to it as Japanese paper folded in half, thirds or smaller sizes (Heibonsha, 1932). Folded paper later came to be used for certificates which accompanied valued objects such as swords or gifts presented to others. Constructivism is a philosophy of learning founded on the premise that, by reflecting on our experiences, we construct our own understanding of the world we live in. Each of us

generates our own "rules" and "mental models," which we use to make sense of our experiences. According to Brunner (1966), learning, therefore, is simply the process of adjusting our mental models to accommodate new experiences.

A Model for Origami and Constructivism

A study conducted by Sze (2004) found that origami construction can be aligned with various learning theorists and conceptual frameworks (See Chart 1). Learners make sense of their experiences by constructing their own understanding through their own “mental models”. Origami construction is a process of adjusting mental and physical models to accommodate new experiences. New experiences include: providing a least restrictive environment, purposeful learning, explicit instruction, multiple intelligences, outcome based performance, student-centered learning, scaffolding, schema learning, concept mapping, multimode instruction, self- management, reflective learning, positive reinforcement, problem solving, and cognitive appropriate level instruction. I have prepared a model for origami which represents six types of constructive learning: (1) Hands-on learning, (2) explicit instruction, (3) higher order thinking, (4) multimodal instruction, (5) social learning, and (6) self-management strategies.

1. Hands-On Learning

Student-Centered Learning

Prestia (2003) stated that many students with special needs have neurological, biological and sensory difficulties that affect how they learn and respond to classroom environments Strategies like origami which accommodate sensory differences are essential for success and achievement in the classroom. By using sensory strategies for all students in the school, students with specific sensory needs are not singled out. Origami exercises enable the student to visualize the creative process in terms of outcome and process in a short time frame, with a tactile demonstration that is easily accomplished. For example, a finished plane model can be unfolded to show the lines. Origami exercises utilize the five senses, incorporate multiple intelligence areas, institute cooperative learning, and enrich all disciplinary areas of learning including social studies, language arts, mathematics, and science.

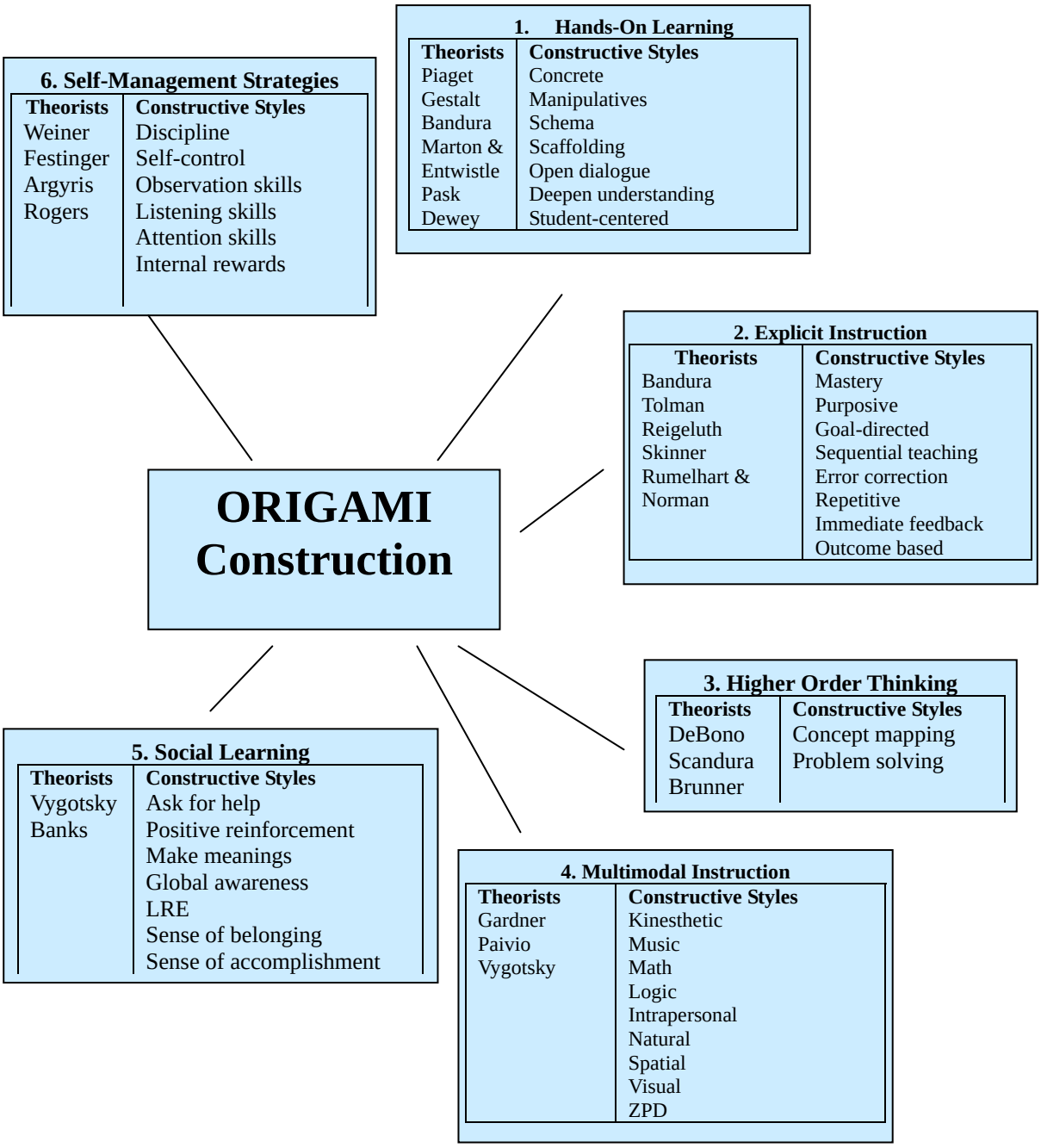

Chart 1. Constructive Styles / Theorists/ Theoretical Frameworks –Origami Construction

As students use their fine motor skills to fold and crease paper to actively create fun shapes and structures, they build skills involving spatial reasoning; follow precise directions in sequence; learn about fractions and geometry, and much more. The educational theorist John Dewey (1902) believed that “learning is active”; he felt that students learn best through hands-on activities. Dewey supported the idea that all students have the capability to learn if provided with the proper means such as hands-on activities and cooperative learning. Origami is an example of a hands-on activity. The physical classroom, based on Vygotsky’s theory, would provide clustered desks or tables and work space for peer instruction and collaboration. Thus the classroom becomes a community of learning; truly constructivism and scaffolding in action.

Scaffolding
Scaffolding allows the teacher to provide students with the opportunities to extend their current skills and knowledge. The teacher must engage students' interest, simplify tasks so they are manageable, and motivate students to pursue instructional goals. In paper folding, although the teacher gives the lead, the process is built upon the entire community of learners trying to model the desired outcome, as each student refers to the next student. By breaking down the project into a sequence of steps, the teacher is able to scaffold learning. Additionally Reciprocal Teaching allows for the creation of a dialogue between students and teachers, and as Sze (2002) states this strategy involves the teacher and students exploring problems (e.g. a mathematics problem) and then sharing their different problem-solving strategies through an open collaborative dialogue. To proceed to the next step in problem-solving, the previous one must be completed and it is important for students to understand the foundation steps before moving on to a more theoretical understanding.

Schema Learning
During instruction, the teacher may introduce a cooperative learning model, background information on a topic, and discuss the benefits of origami creation. Through various paper folding exercises, students have the opportunity to create new ideas by building on previous knowledge and learning becomes an active process in which students construct new ideas or concepts based upon their current or past knowledge (Brunner, 1966). Contrary to the constructivism approach, origami instruction provides principles to students rather than just encouraging them to discover principles by themselves. Origami builds on schema in both the right and left hemispheres of the brain by using imagination, 3D-comprehension, attention, non-verbal thinking and memory. As each of the geometric shapes is created schematic foundations are laid and can be used. To be successful, the student must watch closely and listen carefully to specific instructions and then carry them out with neatness and accuracy. This type of repetitive reinforcement ensures that the information enters the long term memory. In order to strengthen schemata, teachers continuously review and rehearse the information being taught. Consequently, creation of artifacts using origami engages the whole brain, as it requires the participation of both hands without the domination of one hand over the other. Clearly, the use of origami opens up the framework and dynamics of a typical, formal lesson, and provides students with a deeper understanding, through a more enriched and meaningful lesson.

2. Explicit Instruction

Purposeful Learning
According to Tolman (1932), learning should always purposive and goal-oriented. Origami learning is an active, constructive process. Students must work actively and purposely to learn new ideas, skills, or information. They do not simply take in new ideas. They are creating something new with the information and ideas supplied. The class dialogue directs them toward issues in the curriculum that are not necessarily addressed through the use of expository texts. Teacher poses questions to encourage higher level thinking and show how these ideas are often intertwined with emotions. Through purposeful learning, students are able to apply, compare, and adapt what they have learned and experienced to new situations.

Explicit Instruction
Swanson (1999) asserts that direct instruction produces very positive outcomes for students with disabilities. Origami is presented with direct instruction. When the students study paper folding in order to create an object out of paper, they are asked by the teacher to follow a specific set of instructions. The steps are verbally expressed by the teacher in a very specific

sequence. The teacher ensures that all students have completed one step before they proceed to the next. An important aspect is that the teacher demonstrates each step of the procedure in front of the class yet each student is independently creating their own item from a piece of paper. Direct Instruction allows the teacher to plan instruction to create an effective learning environment, and modify instruction to accommodate different learning styles (Gagne, 1987).

Outcome Based Performance
Students become magically attentive and well behaved when an activity occurs where students can create something with the confines of art. According to Rogers (1969), significant learning takes place when the subject matter is relevant to the personal interests of the student. Origami exercises will benefit students with and/or without disabilities especially for those who have trouble follow directions. Origami steps enable students to strive for an end result, specifically a form of paper art, representing structures, symbols, feelings, or concepts. Phibbs (1991) describes how origami can be used to improve listening skills and student performance. Schematic learning through repeatable actions fosters one of the most basic learning skills: the ability to actively listen to classroom instruction.

3. Higher Order Thinking
Concept Mapping
According to elaboration theory, instruction should be organized in increasing order of complexity for optimal learning. Reigeluth (1987) states that instruction will be more effective if it follows an elaboration strategy. For example, epitomes containing motivators, analogies, summaries, and syntheses are used. Instruction for folding in Origami always begins by forming a "base," and students learn how to form specific "bases". In following elaboration theory, whenever possible, the simplest solution path is taught first and then more complex paths or rule sets are taught (Scandura, 1973).

Problem Solving
According to lateral thinking theory, the point of thinking is that many problems require a different perspective to be solved successfully. In order to get a different perspective on a problem, one may try to break the elements up and recombine them in a different way (DeBono, 1991). At the same time Gestalt theory applies to all aspects of human learning based upon the laws of organization, proximity, closure, similarity and simplicity (Ellis, 1938). Origami instruction means that teachers will reflect for example on mathematics concepts and skills through considering creation, pedagogy modeling, equity, diversity, and history-cultural considerations. Teachers become acquainted with the pedagogy and geometry concepts involved in using Origami in the classroom. Students through paper folding, learn to examine, transform, apply, represent, prove and communicate while helping develop a sense of spatial relationships (Phibb, 1991). Students also require abilities in describing, comparing, representing, and relating objects in the environment. The development of such abilities relies heavily on the kinds of experiences children have with tangible objects and on the ways which they respond to these experiences. Understanding the concepts involved and the way the students learn allows the teacher to facilitate activities which are rich in exploration, application, representations, communication and mathematical reasoning. Origami provides a highly engaging and motivating environment within which children extend their geometric experiences and powers of spatial visualization. It gives a venue for their creative nature and invites play, problem solving, and problem posing.

4. Multimodal Instruction

Multiple Intelligences

The theory of multiple intelligences (Gardner, 1993) proposes a major transformation in the way our schools are run. It suggests that teachers be trained to present their lessons in a wide variety of ways using music, cooperative learning, art activities, role play, multimedia, field trips, inner reflection, and much more. Origami combines different intelligences. It is a verbal activity (listening and reading directions), a visual activity (model), as well as a kinesthetic activity (hands-on). According to dual coding theory (Paivio, 1971), recall and recognition is enhanced by presenting information through both visual and verbal forms. This will be useful for students with attention deficit disorders and visual and hearing impairments. These types of activities stimulate more parts of the brain than just transmission format. The exercise also requires hand-to-eye coordination. For difficult folds, a teacher may have to prepare several precise explanations. The steps provoke the students to think about the next step, to be intuitive, and to try to picture the final results. The students usually work in groups of two or more, searching for understanding, solutions, meanings, or creating a product.

Precision Instruction

Throughout verbal and visual instruction, teachers may use origami vocabulary to describe each fold or base. In origami, pronouns like "it", "this", "there", or words like "over here" are not precise enough to be part of origami vocabulary. When describing a fold, the precise name is used, the place where the fold begins and ends is described, or other "landmarks" are used to locate it exactly. This provides time for students to follow and ensures mastery before moving on to the next fold.

Cognitive Leveling

Teacher uses a large piece of paper to demonstrate when modeling the origami creative process. A teacher decides on the size and type of paper needed so as to be large enough to be seen from the back row. From a distance, the contrast between the white side and light colors or foil cannot always be distinguished. Vygotsky (1978) asserts that cognitive change occurs within the zone of proximal development, and instruction should be designed to reach a developmental level that is just above the student’s current developmental level. A teacher has to be knowledgeable about folding the model enough to know it well and also which moves or folds are difficult. Besides being familiar with the vocabulary, a teacher needs to understand the skills of novice, intermediate, and advanced students and try to match the model being taught to the students' level of competence. At the same time the task needs to be difficult enough to maintain interest but not so difficult as to raise frustration. The teacher can adapt the level of design to the ability of the students. Give extra time, it may take three times as long to teach the model as it does to fold it, so time has to be watched (Sze, 2004). Sequential instruction is useful for meeting the requirements of effectively teaching special needs students. At any level, there is a starting point and an ending point, with a number of steps between them. Through this step-wise approach, desired outcomes seem more surmountable.

5. Social Learning

Least Restrictive Environment

A good teacher creates a pleasant atmosphere by sharing amusing stories while waiting for the students to finish a move in origami. By doing so, a least restrictive environment for children with or without disabilities is enabled. Children with disabilities often lack the daily interaction, social, behavioral, study, self-management, academic, and life skills needed to operate in the regular environment. Origami allows students to be creative and builds their confidence as they share their successes with others and a sense of being included is

developed. By folding and unfolding a piece of paper, learners are involved in constructing and deconstructing concepts which eventually leads to a three dimensional product. There is a sense of authentic accomplishment when students have "built" something with their own hands.

Immediate Feedback

Behavior that is positively reinforced is more likely to reoccur (Skinner, 1954). Skinner's theory is based on the idea that learning is a function of change in overt behavior and requires immediate feedback. As the teacher walks around the classroom, demonstrating the folding steps and checking that the students are completing the task, the teacher is repeatedly administering feedback. Immediate feedback which contains accurate information is essential as delaying feedback for "intellectually challenged students' results in more errors and a greater number of trials being needed to reach solutions (Epstein, Brosvic, Costner, Dihoff, & Lazarus, 2003). In origami exercises, students are also encouraged to compare their model with their neighbor. More skilled folders can help by demonstrating through their own model.

6. Self-Management Strategies

Modeling

The teacher encourages the students to observe his or her demonstration of a move before they attempt it. Sometimes it may be helpful to teach each move twice. The social learning theory of Bandura (1977) emphasizes the importance of observing and modeling the behaviours, attitudes and emotional reactions of others as a learning process. The highest level of observational learning is achieved by first organizing and rehearsing the modeled behavior symbolically (folding) and then enacting it overtly. Coding modeled behavior into words, labels or images results in better retention in comparison to simply observing.

Internal Reward

*S*pecial needs children rarely experience success with academic projects (Sze, 2004). Origami is a fun activity with a clear reward at completion. By breaking down the participatory exercise into bite-sized chunks, origami enables each student to gain a feeling of accomplishment. The students are motivated by creating an end product, and are therefore more likely to turn to other students for assistance. Students are not to afraid to ask for help from their peers or the teacher in a positive emotionally safe learning environment. It is only natural that the student's enthusiasm spills over to those around them. It becomes a natural instinct to want help a neighbor who may be struggling with something the "skilled" student has already mastered.

Summary

The relationship between origami and constructivism has a direct impact on diversity and special education. Origami represents Japanese ancient art which promotes culturally awareness and sparks intellectual, cultural and social exchange. Like multiple intelligences, constructivism focuses on learner's different gifts and learning skills. Origami construction is a process of adjusting mental and physical models to accommodate new experience. It levels the playing field for at-risk students, students with disabilities and students from culturally and linguistically diverse backgrounds. This is especially important in schools where resources and opportunities for exposure to diverse students are limited.

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