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The Effects of a Constructivist Teaching Approach on Student Academic Achievement, Self-concept, and Learning Strategies

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The effects of a constructivist approach on academic achievement, self-concept and learning strategies, and student preference were investigated. The 76 six graders were divided into two groups. The experimental group was taught using the constructivist approach while the control group was taught using the traditional approach. A total of 40 hours over nine weeks was used to implement the experiment. The instruments used were as follows; mathematics tests administered by the teacher, self-concept inventory, learning strategies inventory, and a classroom environment survey. The results are 1) constructivist teaching is more effective than traditional teaching in terms of academic achievement; 2) constructivist teaching is not effective in relation to self-concept and learning strategy, but had some effect upon motivation, anxiety towards learning and self-monitoring; 3) a constructivist environment was preferred to a traditional classroom.

Key Words: Constructivist teaching, Academic achievement, Self-concept, Learning strategies, Teaching preference.

Statement of the Problem

Knowledge is not attained but constructed (von Glasersfeld, 1989). This statement came from a new challenge to the concept of traditional knowledge. Today, we are facing the challenge from an educational paradigm shift in public education in Korea. Parents and the general public have criticized the public schools and classroom environments, arguing that they are not ready to meet learner's needs and the demands of the industrial society in this 21st century information society. Some complain about current educational practices, raising questions about the inability of Korean students to perform creative thinking as well as problem solving tasks when compared to other advanced countries. There is a growing number of people and educational theorists claiming that educational consumer needs rather than supplier needs are far more important.

The proposals concerning educational assessment have been put forward to address the issues surrounding student academic achievement, self-concept and learning strategies. This proposal suggests overhauling assessment practices to make them more relevant for students of the 21st century. Educational reform must start with how student learn and how teachers teach, not with what students learn and what teachers teach. So the construction of understanding is a core element in the highly complex process of teaching and learning underpinned by constructivist teaching. Traditional teaching is still valued by some in the general public in terms of student academic achievement. Parents are more concerned about test scores rather than student self-concepts and learning strategies. Some teachers and parents devalued the proposed constructivist teaching, arguing that educational circumstances in Korea are not ready to implement it under the competitive college entrance examination system. The pros and cons regarding the constructivist paradigm appear to be an endless debate. Therefore, we need to confirm the effectiveness of these two educational practices in terms of academic achievement, student self-concepts and learning

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strategies in ways which are more relevant to the needs of the contemporary and future information society.

The Purpose of the Study

Educators must invite students to experience the world's richness, encourage them to ask questions and seek their own answers, and challenge them to explore the world's complexities, not solely focus on academic achievement scores.

To effectively explore the way our educational system works, we must retrain the classroom teacher as a constructivist, since our teachers, who have trained in the traditional teaching approach, in which the teacher dominates the classroom with the over use of the textbook (Kim, 2002). The typical Korean classroom situation is as follows: Firstly, teachers often disseminate knowledge and expect students to identify the facts of the knowledge presented. Secondly, most teachers rely heavily on textbooks. Often, the information the teacher disseminates to students is directly aligned with the view of the textbook. Thirdly, most classrooms encourage competition among students, structurally discourage cooperation and require students to work in relative isolation on tasks that require low level thinking, rather than high-order thinking. Fourthly, students' independent thought is devalued in most classrooms. When asking students questions, most teachers seek not to enable students to think through intricate issues, but to discover whether student knows the "right" answer. Fifthly, schooling is premised on the notion that there exists a fixed world that students should understand. The construction of new knowledge is not as highly valued as the ability to demonstrate mastery of conventionally accepted knowledge.

Recently the educational reform relevant to the constructivist approach has been challenged by a number of people and in some professions, who have devalued the effectiveness of the constructivist ideas. Thus this researcher designed the study to validate its value in relation to student academic achievement, self concept and learning strategies on the part of students. To achieve this purpose, four research questions were formulated: Firstly, are there any differences in academic achievement between a teacher oriented classroom and constructivist classroom? Secondly, are there any differences in student self concept between the two classrooms? Thirdly, are there any differences in learning strategies between the two classrooms? Fourthly, what is the focus of student feedback in relation to constructivist teaching?

The Basis of Constructivist Teaching

The Epistemological Base of Constructivist Teaching

The epistemological base of constructivist teaching comes from an epistemological difference between the traditional epistemology of knowledge and the constructivist epistemology of knowledge. Traditional epistemology views knowledge as an objective phenomenon while the constructivist views knowledge as a subjective understanding of the person. In the early 18th century, an Italian philosopher Giambattista Vico defined knowledge as a cognitive structure of a person so that to know something is to know how to create (von Glasersfeld, 1989). The concept of Vico's view was not readily accepted by contemporary western philosophers until the German philosopher Immanuel Kant who had tried to transform the western epistemological tradition of the late 18th century in his book ***The Critic of Pure Reason***(1781, Rev.1999).

Kant believed that the nature and limits of human knowledge is not possible to find such evidence out of a few cases as long as we continue to think of the mind and its objects as separate entities. He held instead that the mind is actively involved in the objects it experience. That is, it organizes experience into definite patterns. Therefore, we can be sure that all things capable of being experienced are arranged in these patterns, even though we may not yet have experienced them. He seems to attempt to coordinate two disparate views of knowledge: The view that logical analysis of action and objects leads to the growth of knowledge and the view that one's individual experience generates new knowledge. Kant went on to argue that both views have their own merit such that analysis, by definition, occurs after the facts, and individual experience occurs before or during the event. Both are a function of one's own idiosyncratic mental filtering system. These views affect how one makes sense of new information.

Pragmatic philosopher John Dewey, in his ***Democracy and Education*** (1916), defined education as a process to restructure the individual experience by reflective thinking through expanding one's present experience. Individual experience is the core of knowledge, not knowledge offered by others. Thus, continuous development of the child must be stimulated through his interaction to his environment to create meaningful knowledge.

Thomas Kuhn, in his book, ***The Structure of Scientific Revolution*** (1962) warns against scientific misconceptions and claims a scientific paradigm shift. His paradigm shift in science is similar to the adaptive process offered by Jean Piaget, one of the most influential epistemological constructivists.

The Psychological Base of Constructivist Teaching

Jean Piaget (1976), in his book ***To Understand is to Invent: the Future of Education*** (1973) states that the growth of knowledge is the result of individual constructions made by the learner's understanding. Piaget contends that the current state of knowledge is temporal, changing as time passes as knowledge in the past has changed, it is not a static instance; it is a process. It is a process of continual construction and reorganization. Piaget viewed constructivism as a way of explaining how people come to know about their world. He collected an extensive body of research of children's behaviors and witnessed children's behaviors which then use to create well-supported inferences about the function of the mind.

Lev Vygotsky (1978) in his ***Mind in Society*** outlined how thought and language are independent and develop separately, but with similar processes. He also offers pointers for instructional technologists. Vygotsky analyzed a number of studies to help develop his theories of thought and language. He took the strengths of those studies to form his theories, and then tested his theories in his own studies. His theories were influenced by Piaget in which he wrote about the development of thought and speech. Throughout his book he made statements about instruction that have been compiled to connect how instructional technologist can benefit from Vygotsky's analysis and studies. He wrote that a child develops thought and speech separately before two years of age and then s/he merges and joins these functions at two years to initiate a new form. Thought becomes verbal, and speech becomes rational. Speech serves the intellect as thoughts are spoken. Social environment is important to a children's development because it can accelerate or decelerate development.

Although Vygotsky did not emphasize the zone of proximal development (ZPD) in this book; the ZPD is relevant to instructional technologists. Since instruction should precede development, the requisite functions are immature when instruction begins. The discrepancy between children's actual mental age and the level they reach in solving problems with assistance is the ZPD. There is no single ZPD for individuals because the zone varies with culture, society, and experience. Vygotsky claimed that the larger the zone, the better students will learn in school. For a ZPD to be created there must be a joint activity that creates a context for student and expert interaction. The expert may then use multiple instructional strategies. Social interaction is important because the expert can model the appropriate solution, assist in finding the solution, and monitor the student's progress. Vygotsky believed that partners should jointly solve problems to bring about cognitive development. Computer programs can be designed by the expert to help the students reach their potential in their ZPD in many ways.

The Theoretical Assumption of Constructivist Teaching

What is the theoretical assumption of constructivist teaching? There are three fundamental differences between constructivist teaching and other teachings. Firstly, learning is an active constructive process rather than the process of knowledge acquisition. Secondly, teaching is supporting the learner's constructive processing of understanding rather than delivering the information to the learner. Thirdly, teaching is a learning-teaching concept rather than a teaching-learning concept. It means putting the learner first and teaching is second so that the learner is the center of learning. Who argues for these assumptions? The constructivists such as Jonassen(1990) and others enlist the following theoretical assumptions(Kim, 1993):

Firstly, knowledge is constructed out of sensual and perceptive experiences of the learner in which learning is internalize through the learner's constructive process in nature. Secondly, knowledge is the personal understanding of the outside world through personal experience rather than the experiences of others. Thirdly, this internally represented knowledge becomes the basis of other structures of knowledge and a new cognitive structure of the person. Fourthly, learning is an active process of developing meaning based on individual personal experiences. In other words, learning is a developing process by the learner's understanding of the real world. Fifthly, it comes from the premise that personal understandings result in various perspectives. The perspectives constructed within the individual cognitive conceptual structure attempt to share all possible various perspectives. Sixthly, learning creates knowledge in the context of a situational reality. Knowledge is the understanding of meaning through situational contexts, not objective reality.

The Principles and Strategies of Constructivist Teaching

Constructivist teaching stands in contrast to traditional teaching practice in the Korean classroom. Traditionally, learning has been thought to be nothing but a repetitive activity, a process that involves students imitating newly provided information in tests. The constructivist teaching practice, on the other hands, helps learners to internalize and transform new information. Transformation of information occurs through the creation of new understanding that results from the emergence of new cognitive structures. Teachers may invite transformations but may neither mandate nor prevent them. Deep understanding is, unlike the repetition of prescribed behavior, the act of transforming ideas into broader, more comprehensive images which escape concise description.

The principles of constructivist teaching are: 1) posing problems of emerging relevance to students; 2) structuring learning around primary concepts: the quest for essence; 3) seeking and valuing student's points of view; 4) adapting the curriculum to address students' suppositions; and 5) assessing student learning in the context of teaching(Brook & Brooks, 1993)

Traditional instruction leads students to believe they are not interested in particular subject areas. The constructivist paradigm holds disinterest less as a function of a particular subject area than as a function of the ways in which students have been taught. Let's look at the following table, which summarizes the differences in school environment between traditional classrooms and constructivist classrooms:

Some characteristics of constructivists teaching are: 1) constructivist teachers invite student questions and ideas. 2) Constructivist teachers accept and encourage students' invented ideas. 3) Constructivist teachers encourage student’s leadership, cooperation, seeking information, and the presentation of the ideas, 4) constructivist teachers modify their instructional strategies in the process of teaching based upon students; thought, experience and or interests. 5) Constructivist teachers use printed materials as well as experts to get more information. 6) Constructivist teachers encourage free discussions by way of new ideas inviting student questions and answers. 7) Constructivist teachers encourage or invite students' predictions of the causes and effects in relation to particular cases and events. 8) Constructivist teachers help students to test their own ideas. 9) Constructivist teachers invite students' ideas, before the student is presented with the ideas and instructional materials. 10) Constructivist teachers encourage students to challenge the concepts and ideas of others. 11) Constructivist teachers use cooperative teaching strategies through student interactions and respect, sharing ideas and learning tasks. 12) Constructivist teachers encourage students to respect and use other people’s ideas

A Look at the School Environment

Traditional Classrooms	Constructivist Classroom
Curriculum is presented part to whole, with emphasis on basic skills.	Curriculum is presented whole to part with emphasis on big concepts
Strict adherence to fixed curriculum is highly valued	Pursuit of student questioning is highly valued
Curricular activities rely heavily on textbooks and workbooks	Curricular activities rely heavily on primary sources of data and manipulative materials
Students are viewed as “blank slates” onto which information is etched by the teacher	Students are viewed as thinkers with emerging theories about the world
Teachers generally behave in a didactic manner, disseminating information to students	Teachers generally behave in an interactive manner, mediating the environment for students
Teacher seeks the correct answer to validate student learning	Teachers seek the student’s point of view in order to understand student’s present conceptions for use in subsequent lessons
Assessment of student learning is viewed as separate from teaching and occurs almost entirely through testing	Assessment of student learning is interwoven with teaching and occurs through teacher observations of students at work and through student exhibitions and portfolios
Students primarily work alone	Students primarily work in group

Source: Cited from Brooks and Brooks, 1993, p.17

through reflection and analysis. 13) Constructivist teachers welcome the restructuring of his/her ideas through reflecting on new evidence and experiences (Yager, 1991)

The instructional strategy of constructivist teaching is inviting ideas, exploring, proposing explanations and solution, and taking action (Yager, 1991)

Methods

76 elementary six graders were divided into two groups: the experimental group, 38(male 21, female 17), and the control group, 38(male 22, female 16). The learning task was mathematics of sixth grade level (counting, areas of circle and fans, area and volumes of trunks, ratio graphics and proportions) for sixth graders. The treatment period was 40 hours over 9 weeks.

The constructivist teaching approach based on Yager(1991) undertook the following steps: 1) inviting ideas; 2) exploring; 3) proposing; 4) explanation and solution; 5) taking action. Traditional teaching approach undertook the following steps: 1) introduction; 2) development; 3) review.

The instruments to validate the effectiveness were: a) academic achievement test made by classroom teacher; b) self-concept inventory which includes 15 items of general self-concept, 20 items of academic self-concept, and 20 items of non-academic self-concept. Cronbach alpha for the scales range from .74 to 81 and test-retest correlation coefficient for the scales range from .85 to .93; c) learning strategies inventory made by Claire et al includes 77 items(8 items of learning attitude and interest, 8 items of motivation, diligence, self-discipline, willingness to work hard, 8 items of use of time management principles for academic tasks, 8 items of anxiety and worry about school performance, 8 items of concentration and attention to academic tasks, 8 items of information processing, acquiring knowledge, and reasoning, 5 items of selecting main ideas and recognizing important information, 8 items of use of support techniques and materials , 8 items of self-testing, reviewing and preparing for the classes, 8 items of test strategies and preparing for tests), with each item being scaled by 5 on the Likert scale. Coefficient Alphas for the scales range from a low of .68 to a high of .86 and test-retest correlation coefficients for the scales range from a low of .72 to a high of .85, demonstrating a high degree of stability for the scale score; d) the classroom environment survey on constructivist teaching made by Kim(1997), 41 items which includes 7 items of relevance of the learning tasks, 4 items of big concepts presented by the teacher, 11 items of seek and value learner's view by the teacher, 11 items of learner supposition, 8 items of assessment in the context of teaching. Coefficient Alphas for the scales range from .74 to .82 and test-retest correlation coefficients for the scales range from .72 to .83.

The research design was a nonequivalent control group of pretest/post-test design as follows:

Pretest	Treatment	Posttest
O1	X1	O2
O3	X2	O4

O1 O3: Pretest of Academic Achievement, Self-concept, Learning Strategies
O2 O4: Post-test of Academic Achievement, Self-concept, Learning Strategies
X1: Constructivist Teaching
X2: Traditional Teaching

The Results of the Study

The Academic Achievement of the Students

The academic achievements of the experimental group compared with those of the control group appear in the table 1.

<Table 1> indicates that the experimental group scored an average 64.60 at pretest and 75.65 at post-test for a 11.05 gain while the control group scored an average 69.73 at pretest and 64.65 at post-test for a 5.08 decline. In order to determine the effectiveness of constructivist teaching on academic achievement, pretest and post-test scores were

Table 1. *Mean and Standard deviation of pre-posttest score*

Group	N	Pretest		Posttest		Difference	Rem M
		M	SD	M	SD		
Exe. gr.	38	64.60	19.41	75.65	16.34	11.05	77.35
Con. gr.	38	69.73	20.86	64.65	18.58	-5.07	62.95
Total	76	67.17	20.18	70.15	18.24	2.98	70.15

Table 2. *The covariance of academic achievement*

Variance	Square	Degree of freedom	Median square	F
Covariance	11598.64	1	11598.64	89.11***
Main effect	3873.94	1	3873.94	29.76***
Residual	9501.51	73	130.15	
Total	24974.10	75		

*** p<.001

statistically analyzed by teaching methods as the independent variable, academic achievement of the students as dependent variable. Covariance analyses were performed and the results are shown in <Table 2>.

<Table 2> shows that there is a significant difference found between the constructivist teaching group and the traditional teaching group at p<.001 with F=89.11 in academic achievement. Therefore, the constructivist teaching group outperformed the traditional teaching group in academic achievement.

The Self-concepts of the Students

Self-concept of the experimental group compared to those of the control group appeared in <Table 3>

<Table 3> indicates that the pretest mean score of self-concept of experimental group is 89.60 while the score of control group is 92.39 which results in a difference between the two groups of 2.79. The subscale of self-concept appeared to show that the experimental group scored general self-concept (24.31), academic self-concept (30.86), and nonacademic self-concept (36.05) while the control group scored general self-concept (24.94), academic self-concept (31.39), and nonacademic self-concept (36.05). It indicates that the control group's scores in all sub-scales are over those of experimental group.

The post-test mean score of self-concept of the experimental group is 92.94 while the score of the control group is 96.28, meaning the difference between the two groups is 3.34 whereas the control group is still higher in scores compared to the experimental group. The sub-scale of self-concept appeared to show that the experimental group scored general self-concept (25.28), academic self-concept (31.57), and nonacademic self-concept (36.86) while the

Table 3. *The self-concept of the two groups*

Self-concept			General self-concept	Academic self-concept	Nonacademic self-concept	Total
Score			30	40	40	110
Experimental group	Pretest	M	24.31	30.86	35.35	89.60
		SD	3.46	4.09	2.64	11.29
	Post-test	M	25.28	31.57	36.07	92.94
		SD	2.56	3.78	2.61	7.28
	Remedial M		25.46	31.79	36.39	93.78
Control group	Pretest	M	24.94	31.39	36.05	92.39
		SD	3.11	4.07	2.73	8.70
	Post-test	M	26.57	32.84	36.86	96.28
		SD	2.90	4.62	2.38	8.57
	Remedial M		26.40	32.62	36.66	95.45

Table 4. *The covariance of self-concept*

Source	Square	df	M Square	F
Covariance	2840.96	1	2840.96	103.56***
Main effect	52.38	1	52.38	1.91
Residual	2002.57	73	27.43	
Total	4895.93	75		

*** p<.001

Table 5. *The covariance of self-concept subscale*

(Covariance: pretest self-concept)

Self-concept	Source	Square	df	M square	F
General self-concept	Covariance	249.16	1	249.16	56.38***
	M effect	16.91	1	16.91	3.83
	Residual	332.59	73	4.41	
	Total	588.67	75		
Academic self-concept	Covariance	878.31	1	878.31	138.94***
	M effect	12.84	1	12.84	2.03
	Residual	461.47	73	6.32	
	Total	1532.63	75		
Nonacademic self-concept	Covariance	186.62	1	186.62	50.38***
	M effect	1.34	1	1.34	0.36
	Residual	266.69	72	3.70	
	Total	454.66	74		

***p< .001

control group scored general self-concept (26.57), academic self-concept (32.84), and nonacademic self-concept (36.86). It indicates that the control group's scores in all subscales are higher than those of the experimental group. In order to determine the implications of this statistical analysis, a covariance analysis were performed with pretest scores as covariance and the results appear in <Table 4>.

<Table 4> indicates that although the covariance of pretest scores of self-concept appeared to show a significant difference found at p<.001 with F=103.56, there is no significant difference found between the two groups after covariance analysis of pretest scores. To find any differences within the self-concept scales, covariance analysis was performed with the results shown in <Table 5>.

<Table 5> indicates that although covariance of pretest of general, academic, and nonacademic self-concepts appeared to show significant differences (found at p<.001 with F=56.38. 138.94, and 50.38 respectively), there is no significant difference between the two groups found after covariance analysis of pretest scores was performed.

Consequently, constructivist teaching did not appear to be influential in regard to the learners' self-concept change in this study.

Learning Strategies of the Students

The learning strategies of the experimental group compared to those of the control group and appear in <Table 6>

<Table 6> indicates that the experimental group scored 451.60 at the pretest of learning strategies while the control group scored 469.73. However, the experimental group scored 468.13 at the post-test while the control group scored 450.65. This means that the experimental group improved at post-test while the control group deteriorated at post-test. It appeared that the remedial mean score of the experimental group shows

Table 6. *The learning strategies of two groups*

Subscales	Score	Experimental group					Control group				
		Pretest		Post-test		Remedial	Pretest		Post-test		Remedial
		M	SD	M	SD	M	M	SD	M	SD	M
Attitude	100	46.42	31.39	46.47	27.92	47.27	49.36	27.90	45.55	25.96	44.75
Motivation	100	24.26	20.78	23.68	15.92	24.04	26.39	17.49	16.05	13.90	15.69
Time-mgnt	100	64.86	16.74	66.44	20.98	65.53	62.50	19.92	58.02	24.06	58.93
Anxiety	100	40.68	26.08	49.97	28.52	53.69	50.26	27.28	48.52	28.37	44.80
Concentrat	100	55.52	28.49	53.36	27.71	53.99	57.44	28.12	59.31	26.31	58.68
Info.proces	100	39.13	26.65	40.44	26.81	43.03	46.68	31.73	42.65	29.82	40.07
Main idea	100	58.28	31.79	56.44	31.44	55.56	55.60	33.09	60.78	26.47	61.67
Supt mat.	100	36.78	29.45	38.57	26.23	38.81	37.57	28.70	32.00	26.36	31.76
Self-test	100	35.00	28.48	43.60	31.37	44.71	37.97	33.23	36.42	30.77	35.31
Test	100	50.63	27.26	49.10	30.33	47.54	45.92	25.83	51.31	25.64	52.87
Total	1000	451.60	186.30	468.13	182.13	475.89	469.73	156.10	450.65	158.56	442.88

475.89 while those of the control group shows 442.88 which indicates the experimental group has scored 33.01 more than the control group. We may assume that constructivist teaching influenced the learning strategies of students more positively than the traditional teaching.

The mean score changes of the learning strategies between two groups by the post-test scores minus pretest scores resulted in the following data<Table 7>.

<Table 7> tells us that the learning strategies score of the experimental group improved 17.03 while that of the control group deteriorated -19.06 points. Thus, the mean score differences of the two groups is 36.09 points. The score differences of the two groups appeared to show that the experimental group increased in terms of attitude (3.86), motivation (10.29), time management (6.04), anxiety to learn (11.04), information processing (5.33), support techniques and materials (7.35), self test or review (10.15) higher than the control group while the control group increased the score of concentration (-4.42), main idea (-7.35), preparation for test (-6.91) higher than the experimental group.

It tell us that the students of the constructivist teaching group employed more learning strategies in attitudes to learning and interest, motivation to learn, the use of time management principles for academic tasks, anxiety and worry about school performance, information processing and reasoning, the use of support techniques and materials, self testing, reviewing and preparing for class while the control group makes more use of the learning strategies in

Table 7. *The comparison of learning strategies score between pre & post-test*

Subscales	Exp. group	cont group	Mean score differences Between pre-/post-test
	M	M	
Attitude	0.05	-3.81	3.86
Motivation	-0.05	-10.34	10.29
Time mgnt.	1.57	-4.47	6.04
Anxiety	9.28	-1.73	11.01
Concentrate	-2.15	1.86	-4.42
Info.proces	1.31	-4.02	5.33
Main idea	-1.84	5.18	-7.02
Supt mat.	1.78	-5.57	7.35
Self-test	8.60	-1.55	10.15
Test	-1.52	5.39	-6.91
Total	17.03	-19.06	36.09

Table 8. *Covariance of learning strategies*

Source	Square	df	M square	F
Covariance	1590098.19	1	1590098.19	210.01***
Main effect	20644.35	1	20644.35	2.73
Residual	552733.60	73	7571.69	
Total	2163476.15	75		

*p< .05 **p< .01 ***p< .001

Table 9. *Covariance of learning strategies sub-skills at pretest*

Subscales	Source	Square	df	M square	F
Attitude	Covariance	19243.18	1	19243.18	40.77***
	M effect	120.89	1	120.89	0.26
	Residual	34454.90	73	471.98	
	Total	53818.98	75		
Motivation	Covariance	2935.75	1	2935.75	16.00***
	M effect	1322.34	1	1322.34	7.21**
	Residual	13390.58	73	183.43	
	Total	17648.68	75		
Time-mgnt	Covariance	15339.49	1	15339.49	48.89***
	M effect	824.13	1	824.13	2.63
	Residual	22906.10	73	313.78	
	Total	39069.73	75		
Anxiety	Covariance	30466.95	1	30466.95	79.40***
	M effect	1455.55	1	1455.55	3.79*
	Residual	28011.73	73	383.72	
	Total	59934.25	75		
Concentrate	Covariance	25785.30	1	25785.30	66.00***
	M effect	416.89	1	416.89	1.07
	Residual	28518.90	73	390.66	
	Total	54721.10	75		
Info.proces	Covariance	29767.61	1	29767.61	73.23***
	M effect	164.20	1	164.20	0.40
	Residual	29672.96	73	406.47	
	Total	59604.78	75		
Main idea	Covariance	33524.70	1	33524.70	85.43***
	M effect	708.43	1	708.43	1.81
	Residual	28646.78	73	392.42	
	Total	62879.93	75		
Supt mat.	Covariance	22968.52	1	22968.52	59.69***
	M effect	946.44	1	946.44	2.46
	Residual	28090.65	73	384.80	
	Total	52005.63	75		
Self-test	Covariance	38493.98	1	38493.98	87.04***
	M effect	1673.12	1	1673.12	3.78*
	Residual	32283.87	73	442.24	
	Total	72450.98	75		
Test	Covariance	22482.54	1	22482.54	46.29***
	M effect	535.86	1	535.86	1.10
	Residual	35456.22	73	485.70	
	Total	58474.63	75		

*p< .05 ** p< .01 *** p< .001

concentration and attention to academic tasks, selecting main ideas and recognizing important information, and preparing for tests.

To test if there is any significant difference between the two groups, covariance analysis was performed using the pretest score as covariance as shown in <Table 8>.

As <Table 8> indicated that although there is significant difference in covariance in terms of pretest score differences, there is no significant difference found after analysis with pretest covariance. This means there is no significant difference found between constructivist teaching and traditional teaching.

To test any significant difference between subdivisions of learning strategies, Covariance analysis of the sub-skills of learning strategies was performed with covariance of pretest scores, the results of which are shown in <Table 9>

<Table 9> indicates that although all sub-skills have significant differences of covariance in the pretest stage, there are statistical differences found after controlled by pretest scores in motivation, diligence, self-discipline to work hard at $p<.01$ with $F=7.21$, anxiety and worry about school performance at $p<.05$ with $F=3.79$, self-testing, reviewing, preparing for class at $p<.05$ with $F=3.78$. Other sub-skills such as attitude and interest, use of time management principles for academic tasks, concentration and attention to academic tasks, information processing, acquiring knowledge, and reasoning, selecting main ideas and recognizing important information, use of support techniques and materials, and test strategies and preparing for tests showed no significant difference found between two groups.

Consequently, the result of this statistical analysis tells us that although the experimental group of the total score of post-test was higher than the control group's score, there is no significant difference found between two groups. However, only in motivation, anxiety, self-testing, is there a significant difference found except for other sub-skills.

Student preference to teaching paradigms

Student preferences regarding teaching paradigms of the experimental group compared to that of the control group appear in <Table 10>.

<Table 10> indicates that the pretest total mean score of the experimental group is 154.68 while that of the control group is 146.21 which represents a 8.47 difference between the two groups. The post-test total mean score of the experimental group is 160.81 while that of control the group is 137.13 which means a 23.68 difference between the two

Table 10. *Student preference to the teaching paradigm*

Dimensions			Relevance	Big concept	Student views	Suppositions	Assesment	Total
Score			35	20	55	55	40	205
Exp. group	Pre-test	M	23.60	12.36	43.28	43.71	28.26	154.68
		SD	3.00	1.88	6.67	5.19	4.40	17.46
	Post test	M	24.42	12.60	45.50	45.68	29.23	160.81
		SD	3.49	2.52	6.69	6.47	4.37	18.92
	Remedial M		24.21	12.51	45.25	45.13	29.15	158.96
Cont. group	Pre-test	M	21.92	11.86	42.26	39.86	27.52	146.21
		SD	3.65	1.81	5.95	5.85	4.39	16.78
	Post test	M	21.07	11.94	39.39	35.84	26.00	137.13
		SD	3.06	2.15	7.77	7.57	4.74	21.81
	Remedial M		21.28	12.04	39.63	36.39	26.08	138.98

Table 11. *Comparison of means on teaching preference between pretest and post-test score of the two groups*

Dimension		Relevance	Big Concept	Student view	Supposition	Assessment	Total
Exp. group	M	0.81	0.23	2.21	1.97	0.97	6.13
Cont. group	M	-0.84	0.07	-2.86	-4.02	-1.52	-9.07
Discrepancy of means		1.65	0.16	5.07	5.99	2.49	15.20

groups. The mediated means score of the experimental group in the post-test was 158.96 while that of the control group was 138.98 which represents a 19.98 difference between the two groups.

Comparison of means on teaching preference between pretest and post-test scores of the two groups is shown in <Table 11>.

This indicates that the score of the experimental group progressed 0.81 points while that of the control group fell backward 0.84 points on relevance of learning task which represents a 1.65 difference between the two groups. The experimental group progressed 023 points while the control group progressed 0.07 points on big concepts which represents a 0.16 differences between the two groups. The experimental group progressed 2.21 points while the control group fell backward 2.86 points on seeking and valuing student view which represents a 5.07 points difference between the two groups. The experimental group had a 1.97 point gain while the control group had a 4.02 loss on student supposition on curriculum which represents a 5.99 points difference between the two groups. The experimental group had a 0.97 point gain while the control group had a 1.52 point loss on assessment in the context of teaching which represents a 2.49 points difference between the two groups.

Table 12. *Covariance of means on teaching between the two groups*

Source	Square	df	M square	F
Covariance	7658.90	1	7658.90	20.92***
Main effect	7139.11	1	7139.11	19.50***
Residual	26723.92	73	366.08	
Total	41521.94	75		

***p< .001

To test the significance difference between the two groups, covariance analysis was performed with covariance by pretest score as shown in<Table 12>.

<Table 12> indicates that there is covariance of pretest scores at p<.001 with F=20.92 and a significant difference found between the two groups at p<.001 with F=19.50. This indicates that the experimental group responded more positively than the control group to constructivist teaching paradigms.

Table 13. *Covariance of means on the teaching of sub-scales of the two groups*

Dimension	Source	Square	df	M square	F
Relevance of learning tasks	Covariance	107.93	1	107.93	10.52**
	M effect	153.35	1	153.35	14.95***
	Residual	748.95	73	10.25	
	Total	1010.25	75		
Big concept	Covariance	39.95	1	39.95	7.86**
	M effect	4.11	1	4.11	0.81
	Residual	371.12	73	5.08	
	Total	415.19	75		
Seek and respect student view	Covariance	785.84	1	785.84	17.80***
	M effect	595.23	1	595.23	13.48***
	Residual	3223.71	73	44.16	
	Total	4604.78	75		
Curriculum based on student supposition	Covariance	737.73	1	737.73	15.44***
	M effect	1290.58	1	1290.58	27.02***
	Residual	3487.41	73	47.77	
	Total	5515.73	75		
Assessment in the context of teaching	Covariance	97.03	1	97.03	4.83*
	M effect	177.51	1	177.51	8.83**
	Residual	1467.38	73	20.10	
	Total	1741.93	75		

* p< .05 ** p< .01 *** p< .001

To test the significant difference between the two groups, covariance analysis on five principles of constructivist teaching were performed with covariance by pretest scores as shown in <Table 13>.

<Table 13> indicates that all five principles have covariance at $p< .05$ (assessment), $p<.01$ (relevance of learning tasks and big concepts), $p<.001$ (seek and respect for student views, and curriculum based on student supposition) respectively. There is a significant difference found between the two groups at $p<.001$ in relevance of learning tasks, seek and respect student views, and student supposition and at $p<.01$ in assessment. No significant difference was found in relation to big concept.

Consequently, the result of the statistical analysis tell us that the experimental group prefers a constructivist teaching paradigm more than the control group, especially in relevance of learning tasks, seek and respect student views, curriculum based on student supposition, and assessment in the context of teaching rather than after teaching. Thus, students who are taught using a constructivist teaching paradigm responded more positively to constructivist teaching than the students who were taught through traditional teaching methods.

Summary and Conclusion

The purpose of this study was to determine the effectiveness of a constructivist teaching approach in mathematics of elementary school education in terms of academic achievement, self-concept and learning strategies, and student preference for a constructivist teaching approach.

76 sixth grade students were selected for this study and were divided into two groups (experimental group and control group). The experimental group was taught using the constructivist teaching approach and the control group was taught using the traditional teaching approach. Research design for this study was of a non-equivalent pre-and-post test control group design.

The total hours of the treatment were 40 hours over nine weeks. The block time schedule was applied for the constructivist approach while the regular time (40 minutes / hour) schedule was implemented for the traditional approach.

The instruments used for this study include 40 items of a written test developed by the classroom teacher, the self-concept inventory by Jung and Song (1986), the learning strategies inventory by Weinstein et al (1995), and the classroom environment survey by Kim (1997).

This study concluded that 1) constructivist teaching is more effective in terms of academic achievement of students; 2) constructivist teaching is not effective in terms of student self-concept enhancement and student learning strategy changes in general, but have some effect upon motivation to learn academic tasks, causing anxiety in the academic learning process and self-monitoring in terms of learning for tests; 3) the students have some preference for a constructivist teaching classroom environment.

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