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Abstract

This project presents a study on the effect caused by the implementation of math teaching strategies based on the Felder-Silverman model of different learning styles in the bilingual kindergarten students from the public school, Stephanie Cravens Early Childhood Academy. This school belongs to Sheldon Independent School District located in Houston Texas, USA. Because of the students' age, the study was focused in the content of the instructional plan that it would have activities, which would reach all different learning styles without worrying about the particular learning style each child may have. It uses an experimental design with a post-test and a control group with which to compare the group that received the experimental treatment, both of random selection. The t - student was used to determine that significant difference existed between the means of the two samples, with that it was determined that the progress of the experimental group surpassed that exhibited by the students in regular classes. In the qualitative part, the students' confidence was noticed by the proposal, trend supported by the answers on the survey.

KeyWord: Teaching strategy, Learning style, Felder-Silverman Model, ICT, constructivist theory.

Resumen

Se presenta un estudio sobre el efecto causado por la implantación de estrategias de enseñanza, basadas en el modelo de Felder- Silverman sobre los estilos de aprendizaje, en los alumnos del kindergarten bilingüe de la escuela pública, Stephanie Cravens Early Childhood Academy, perteneciente al distrito escolar independiente de Sheldon ubicado en Houston, Texas, USA. Por la edad de los alumnos, el estudio se enfocó a que la instrucción integrara actividades que cubrieran los diversos estilos de aprendizaje, sin tener que preocuparse por los estilos de cada alumno en particular. Los contenidos matemáticos fueron: clasificar y ordenar, figuras geométricas básicas, patrones y movimiento, comparación de conjuntos correspondencia uno a uno y los números del 0 al 5. Se empleo un diseño experimental con postest y grupo de control como base para comparar con el grupo experimental, ambos de selección aleatoria. Se utilizó la ***t*** de Student para determinar que existió diferencia significativa entre las medias de las dos muestras, con lo que se determinó que el aprovechamiento del grupo experimental superó al de los alumnos expuestos a clases regulares. La satisfacción por la propuesta se sustenta por la tendencia arrojada por la encuesta.

Palabras Clave: Estrategia didáctica, Estilo de aprendizaje, Modelo Felder-Silverman, TIC, Teoría constructivista.

Background

An instructional design based on the Felder-Silverman model for different learning styles, was made to address the kindergarten math program (Texas Education Agency, 2004). This program is taught in bilingual classrooms at Stephanie Cravens Early Childhood Academy, which belongs to Sheldon Independent School District, located northeast of Houston, TX, USA.

Cravens Academy set up the goal to diligently achieve the objectives determined by the Texas Education Agency (TEA), known as TEKS (Texas Essential Knowledge and Skills), that includes the parameters of the mandatory curriculum for the Texas schools (TEA, 1998). There are thirty-four objectives of the program to fulfill, containing arithmetic, algebraic thinking, geometry, and probability and statistics. They are explicit in the textbooks and workbooks that the district has adopted (Math Advantage, Harcourt Brace & Company). These didactical materials, after using them for several school years, it was noticeable that the textbooks hardly touch the objectives, do not motivate the use of all the levels of critical thinking, and their format does not cover the different learning styles that exist in a group, in particular in the Bilingual Kindergarten student population.

The proposal was based on the models of learning styles considered in the constructivist theory, by means of those that facilitated the understanding and the learning of mathematics. This alternative was integrated by a manual of didactic strategies elaborated specifically for this study, whose objective was, when executing the suitable activities, that the student would build his knowledge in a learning environment, compatible with his learning style.

The mathematical content of the manual is: numbers, operations and quantitative reasoning, relations and algebraic thinking, geometry and spatial reasoning, measurement, and probability and statistics. The research was experimental, quantitative, and qualitative, in that it evaluated the effect produced by the didactic strategy, over the learning of the mathematic themes of the kindergarten level, which is imparted in the Stephanie Cravens Early Childhood Academy. The treatment was applied to an experimental group and the results were compared with a control group that did not receive the treatment (Isaac, 1971).

Once the experiment was concluded, a measurement was carry out about the dependent variable by means of a post-test, where it was concluded on the basis of comparison of measurements (***t*** - Student), that with the didactic proposal the students, from the experimental group surpassed the progress obtained on the exam evaluated in the area of mathematics by the students of the control group, which indicated that the didactic strategy proposal, positively influenced the learning of the mathematic content set by the TEA for the kindergarten level.

Learning Style

The theories that explain how one learns, and which of the multiple factors influence teaching and learning, are diverse. Teaching should be guided toward the way of learning of the student, which according to his way or style (Morrison, 2001); it will be influenced by environmental elements, social, physical, and psychological motivations. McNergney and Herbert (1995) describe the learning styles in function of five domains or characteristics of the students:

(a) intelligence and cognitive development,

(b) physical development,

(c) exceptional skills and disabilities,

(d) social and moral development, and

(e) attitudes and motivations.

Keefe (1991, cited by Hood, 1995) describes learning style from two perspectives, the first as a characteristic of how the student learns and how he likes to learn, and the second from the instructional strategy that relates the cognition, the context, and the contents of the learning. All people are born with certain preferences toward a style of learning, but these distinctions are influenced by culture, experience, and development. The different learning styles that are suggested are mainly given in relation with the cognitive, affective, and physiological factors.

The cognitive styles are the habits of processing information of an individual and represent a person's typical model of perceiving, thinking, remembering, and problem solving. The affective components of the learning styles include the personality and the emotional characteristics related to the areas of persistence, responsibility, motivation, and peer interaction (Reiff, 1992, cited by Hood, 1995). The physiological components of the learning styles are biological ways of answer that are found due to differences to sex, nutrition, personal health, and reactions to the physical environment (Keefe, 1991, cited by Hood, 1995).

So, with the purpose of detecting in the students the skills that are used for learning, since August 2001, it was observed with thoroughness the way of learning of five and six year old children, particularly in the area of mathematics. In the two years prior to this investigation, learning activities were introduced related with the different learning styles. These activities, observations, and experiments, in conjunction with the model of the different learning styles, were combined to integrate them to the curriculum of mathematics in the form of a manual, suitable for the learning styles from the model of Felder-Silverman (1988).

Felder-Silverman Model

The Felder-Silverman model considers that the learning, in a structured educational environment, is sustained in two stages: the reception and the processing of information.

In the reception stage, the external and internal information was put at the disposition of the students, who selected the material that they processed according to the content of the session. Important element of this stage was the perception, concept that refers to the organization, interpretation, analysis and integration of the stimuli, and involves both the activity of the sensory organs and the person's brain (Feldman, 1999). For the instructional design, it was considered that the information could be sensory or intuitive, while the means of perception can be visual or auditory.

Students where the sensory type is prevalent learn from facts and established data. They like to solve problems by well-defined methods. They are patient with details, memorize well, and do practical or manual things. They do not like complications, surprises, and courses that don't have an apparent connection with the real world.

In cases where the intuitive characteristic prevails, the students prefer to discover possibilities and relationships. They are better at picking up new concepts, abstractions, and mathematical formulas than those where the sensory type prevails. They tend to work quicker and to be innovators. They don't like courses that have a lot of rote memorizations and routine calculations.

For students with high visual sense, learning is easier through photographs, diagrams, movies, and demonstrations. If the characteristic that stands out in the student is the verbal type, he learns by spoken or written explanations.

In the processing stage, the way to use information can be by active or reflexive style. Those in the active style process information through an activity: they discuss, apply, or explain it to others. Those in the reflective type first think about the received information.

In the understanding stage, students where the sequential type is prevalent gain understanding by means of a logical pursuit, linear steps, in search of solutions that follow logical, sequential steps. In cases where global understanding prevails, students use the material aleatorily, without seeing connections and instantly pick up the concept; they also have the characteristic of solving problems in innovative ways, but it is difficult for them to explain the way that they arrived to their solution.

It usually happens that a student uses a different learning style for each content (Garner, 1993), and here it is important that the same theme be presented in a plethora of ways that includes the learning styles of the students in the class, as happened in this research. It is advisable that the students have access to knowledge in the way that makes it easier for them to learn, but also that they receive it by the approaches of other styles. That way, in the end they have had the challenge of learning by other means and they develop their cognitive and social abilities and increase their academic potential.

According to the Felder-Silverman perspective that each style of learning is in correspondence with the style of teaching, the teacher, based on his experience and knowledge, will design the courses so that they integrate the concrete and abstract aspects, and the visual and verbal styles. He will also design courses that promote the participation of the students in the active and passive styles, and finally that provide the process of teaching in the sequential and global representation. In the design, outdoors activities were included that students developed cooperatively. Another important point was that in the sessions a discussion was brought about between the actors of learning, even when the solutions that they planned were incorrect (Bouvier, 1997), since the construction of knowledge is a dialectical process.

Structure of the manual

The activities integrated in the manual were sustained in the Felder-Silverman model and are strengthened with the different materials manufactured specifically for the project and others already developed. The plan of instruction was elaborated according to the strategies suggested by Felder and Brent (1996), taking into account the diverse learning styles of the students.

The new material was tied to prior knowledge acquired by the student in concrete situations carried out in his environment in order to perceive the need of new knowledge in the different styles, taking into account sensitive, intuitive, sequential, and global styles.

The balance between concrete and abstract information (sensitive and intuitive styles) was looked for. In order to reach this outcome, different types of visual and manipulative materials were included, along with verbal explanation. Intuitive learning primarily needs opportunities to explore, opportunities to observe objects and try or experiment for oneself, and discover possibilities and relationships.

The way that the experimentation stage operated was by the presentation of the theme by the instructor, through verbal instruction, helped by many visual aides and the materials included in the instructional design.

In the classroom there were from four to six areas or spaces called Learning Centers. In the Learning Centers, different activities were planned for each theme, with the objective of giving the student the opportunity to participate in different ways of learning, including his own. In other words, in each Learning Center there was a different activity, that will lead to learn the same mathematical skills and the rules for using the materials were explained in detail. In some Learning Centers the materials were changed according to the activity that had been accomplished. In Table 1 the Learning Centers that were used in the sessions on August 11th and 12th, 2005 are described. These sessions were mainly for material's exploration.

Table 1. *Basic learning centers*

Learning Center	Activity
1.	Students work with clay or play doh, molds and different tools to shape or model the play doh.
2.	Students work with plastic and wooden geometric shapes making designs and different types of constructions as they wish.
3.	Students explore the usage of tri-dimentional shapes like: cubes, cylinders, spheres, etc.
4.	Students explore how to work with blocks and legos.
5.	Students learn to work with the Chinese puzzle called tangram made with construction paper and also in the computer with software that allows them to do their own puzzles.
6.	Students work with a variety of material to make crafts: construction paper, scissors, glue, crayons, different types of paper, pipe cleaners, sort of wiggle eyes, etc.

Dewey and Piaget proposed that games were integrated to the learning because they provide the student with active and positive experiences, important elements for the cognitive development, reason that propitiated the recreational aspect in the proposal. Since the activities were of different levels, the teacher's roll in the experimentation stage was being a partner in the student learning, whose job was to give assistance or the minimum scaffolding require to face the challenges that they were subjected to (Sprenger, 2003).

Discussion of Results

Hypothesis

In order to validate the hypothesis of the investigation, the distribution ***t*** of Student was used with the computational program XLSTAT with a significance level of 95%, that allowed the difference between the regular method of teaching and the proposed to show (Isaac, 1971) given that the difference between the means was significant (Table 2). So, for the calculated value ***t*** = 6.4784, the probability was 0.0001 result that rejects the null hypothesis of equality of the means and the hypothesis of the investigation is accepted, meaning that the alternative proposal produces better results of learning than the option of traditional learning.

Table 2. Statistics

XLSTAT 7.5.3 – Two-Samples t-Test					
Sample 1: Experimental Group					
Sample 2: Control Group					
No missing values					
Significance level: 0.05					
Descriptive Statistics:					
Sample	Frequency	Mean	Variance	Standard Deviation	Standard error
Experimental	20	32.650	1.397	1.182	0.264
Control	20	27.550	10.997	3.316	0.742
Sample	Minimum	First Quartile	Median	Third Quartile	Maximum
Experimental	30.000	32.000	33.000	34.000	34.000
Control	22.000	25.500	26.500	29.500	33.000
Student's t test for independent samples / right-tailed test:					
The test is computed under the assumption that the two theoretical variances are equal					
Confidence interval at 95.00% of the difference of the means:				3.506 a 6.694	
t (observed value)				6.478381492	
t (critical value)				1.686	
DF				38	
One-tailed p-value				< 0.0001	
Alpha				0.05	
Conclusion: At the level of significance Alpha=0.050 the decision is to reject the null hypothesis of equality of the means. In other words, the alternative hypothesis that Mean1 > Mean2 is significant.					

Experimental Phase

Assigning a variety of learning tasks in order to have a complete spectrum of the learning styles gives as a result a balanced environment, rich in stimuli that propitiates active learning. The students of the experimental group learned the function of the learning centers and that, what allowed them to conclude the activity through the free use of the materials, which propitiated the construction of their knowledge.

The computer and the selected software were an excellent source of motivation for learning because the students showed their enthusiasm and interest in the work with this technology. The software selected consisted of using simple patterns, solving puzzles, and tangrams.

These computer programs were not worked in the entirety of their contents. For example, for the teaching of patterns and geometric figures, the theme of triangles and squares were only worked on the easy section of the free software Tangram, which consists of 15 images in sequential order of difficulty.

Parallel to the activities with the computer, the objectives shown in the TEKS regarding the use of technology for kindergarten, such as open and close programs, use of the mouse, and use of software programs to propitiate learning experiences, were accomplished. Besides this type of interactive program is accepted by most of the students, especially those of the visual-reflective style.

In answer to the objective established for this study, it is affirmed that the didactic proposal that considers the different learning styles, accomplished the objectives suggested by the TEA because the students acquired the skills and satisfactory knowledge, which surpassed the achievement reached by the students that did not receive the treatment. This situation corroborated with the results of the post-test and of the tests that were given at Cravens Academy, which showed that the students that participated in the experiment obtained better grades.

The teaching strategies that considered the different learning styles propitiated learning more excitedly than the regular teaching that doesn't consider the diversity of styles, as defined by the statistical analysis that was done with the results obtained on the test given to the control and experimental groups.

The student-teacher interaction affected the results in a positive way because the instruction was made easier in many ways according to the need of the student, in a friendly environment in which the student did not fear making mistakes, and in addition, most of the times, it was like a game.

The didactic proposal encouraged social development, it was perceived that the students participated in all of the activities with encouragement and developed a spirit of camaraderie and mutual help.

Among the characteristics of the didactic alternative for the experimental group it was noted:

- They were exposed to a variety of activities corresponding to the styles of learning.
- The activities included the use of prior and new knowledge, which helped put what they had learned into the long-term memory (Sprenger, 2003) or also to give more opportunities to those who had not attained mastery in the abilities or skills that they sought.
- The design of the teaching proposal was integrated to try to correspond with the learning styles.
- Videos were shown from the series called Baby Einstein because of their rich content of visual and verbal stimuli.
- The interactive programs that were used on the computer help develop diverse abilities, like the capacity of analysis and synthesis in relation to geometric figures, spatial orientation and visual discrimination, that which is relevant for the spatial reasoning and the learning of geometry.

Post-test

The test was adapted and complemented from the Harcourt Brace and Company Teacher's Evaluation Guide Grade K, with questions to measure the mastery of the abilities and skills that TEA asks for, corresponding to the first period according to the school district's program. Both the experimental and the control group were given the same test.

Survey of Attitudes

In order to consider the attitudes toward the strategies used in the experiment, a survey was applied to the experimental group with the purpose of analyzing the attitudes and the satisfaction of the students with respect to the activities of the course.

The survey consisted of 7 statements or affirmations in which the student should indicate one of three options: (a) I like it, affirmative or always; (b) sometimes yes, sometimes no, regular, indifferent; (c) I don't like it, negative or never (see Table 2). For the age of the student subjects to the proposal, the options were explained and illustrated with drawings for bigger easiness and understanding because at this time of the school year, they still do not know how to read.

It was also asked each student that they illustrate with a picture the activity in which they most liked to participate. The answers to the survey in general were positive, what shows an acceptable satisfaction on the part of the students with regard to the employed strategies. In Table 3 the results of the survey are shown.

Table 3. Statements and answers to the survey

Statement	(a)	(b)	(c)	Total
1. I like solving problems in math.	17	2	1	20
2. I like telling how I solved a problem.	15	3	2	20
3. I like working alone in math.	12	5	3	20
4. I like working with others.	15	4	1	20
5. I think math is easy.	12	6	2	20
6. Math is one of my best subjects.	12	6	2	20
7. Math activities are fun.	16	3	1	20

Conclusions

The function of the teacher from the perspective of the different learning styles is to design and organize didactic experiences that converge the channels of perception, organization, and retention in order to promote student learning and give him confidence that he can learn, not only from the explanation of the teacher, but also from the learning styles included in the instructional design. It will help him to learn in other styles, which will generate the abilities required for self-guided learning. Upon coinciding the teaching style with the learning style, the students' individual needs are better satisfied and there is more success on the educational objectives.

The learning centers are a good strategy for combining different ways of teaching and for reaching an environment rich in opportunities for significant learning, independently of the student's preference. It was observed that most of the students learned how to work in all of

the centers and acquired an intrinsic motivation for learning, instead of only accomplishing the given assignment.

To design a proposal where it is captured the interest and enthusiasm to experiment, to explore, to inquire, to do, to try, and therefore to learn.

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