Contribution to the Student Achievement of Using Different Teaching Methods in the Fourth Science and Technology Course in Primary Education

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Abstract: Effects of target accomplishment are examined as a testing process in this study. There are three experimental and one control groups. In the control group constructivism, in the experimental groups, in addition to constructivism, cooperative and problem based learning have been employed. Each group has been given a pre test and post test ‘achievement test’. Kruskal-Wallis deviation analysis has been used to observe the average grade difference in the results of the pre and final tests of the groups. The Wilcoxon matched sample test (Mann-Whitney U) has been used to observe the difference between the average results. There was no meaningful difference between the results of the final tests, whereas there was a meaningful difference between the pre and post tests in all groups. Some recommendations were made in light of these findings.

Keywords: Constructivism • problem based learning • cooperative learning • jigsaw technique • constructivist learning

INTRODUCTION

Primary education is the basic stage for education. Knowledge and skills acquired during this stage will be used throughout life. The stronger desired behaviors during this stage, the better it will be for students in their later education. In addition, it is important how this knowledge and skills have been acquired. Teachers, therefore, need to employ various approaches, methods and techniques to make classes effective. However, selected approaches, methods and techniques must be appropriate for desired behaviors.

Constructivism, problem based learning, cooperative learning and jigsaw techniques have been the subject of this study.

Constructivist Approach: The constructivist approach to teaching and learning is based on a combination of a subset of research within cognitive psychology and a subset of research within social psychology. The underlying principle is that an individual learner must actively "build" knowledge and skills and that information exists within these built constructs rather than in the external environment. Despite its recent popularity, Ya’ar has pointed out that the foundations of constructivism could be traced back to the 18th century, in the practices of Giambattista Vico, an Italian teacher whose views unfortunately hadn’t received the attention it deserved at his time [1]. Kindsvatter, Willen and Ishler, on the other hand, have stressed that, based on his work on cognitive development and the construction of knowledge, Piaget should be considered among the chief theorists, who have contributed to the current understanding of constructivism [2].

Baker and Piburn (1997)’s working definition of constructivism is as follows [3]:

- Constructivism is a theoretical position based on the argument that knowledge is constructed by individuals and cultures.
- Experience is mediated by schemata that are structured by the psychological and background characteristics of the individual and by the norms and values of the culture.
- The conceptual framework resulting from the application of a schema to experience cannot be said to be correct or incorrect. It is simply an alternative framework.
- The process of knowledge construction consists of movement from one schema to another, through a period of conflict induced by anomaly.

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Adoption of a new schema will, of necessity, require a reorganization of existing knowledge into a new conceptual framework.

In principle, there is no end to this process of knowledge construction. No absolute knowledge is possible. All knowledge is context bound and will change with the context.

Learning-Teaching process and Constructivism:
Learning points to a rather permanent change in the behavior of an individual. In other words, when an expected change in behavior is observed, this is perceived as an indication of learning. According to De Cecco (1998), learning theories define and explain the conditions under which learning takes place and to what extent. There is a general expectation that a learning theory should explain how learning takes place both within and outside the boundaries of schools. However, no learning theory is capable of fully unfolding all learning situations [4].

Constructivism is not an instructional theory, rather, it is concerned with learning and the construction of knowledge. Initially constructivism aimed at exploring how learning takes place, however in time it turned into an approach manifesting the construction of knowledge.

The main proposition of constructivism is that learning means constructing, creating, inventing and developing our own knowledge. Others can give us information, we can find information in books and we can get information from the media, but as important as information is – and it is very important – receiving it, getting it and hearing it does not necessarily equal learning [5].

Constructivists believe that knowledge results from individual constructions of reality. Constructivism emphasizes active learners, the linking of new knowledge to knowledge learners already possess and the application of understanding to authentic situations. Experience, interaction between teachers and students and students’ interacting with each other are instructional tools for constructivists [6].

What is constructivism and what do constructivists believe[7]:

- Constructivists believe that knowledge is constructed, not transmitted.
- Knowledge construction results from activity, so knowledge is embedded in activity.
- Knowledge is anchored in and indexed by the context in which the learning activity occurs.
- Meaning is in the mind of the knower.
- Therefore, there are multiple perspectives on the world.
- Meaning making is prompted by a problem, question, confusion, disagreement, or dissonance (a need or desire to know) and so involves personal ownership of that problem.
- Knowledge-building requires articulation, expression, or representation of what is learned (meaning that is constructed).
- Meaning may also be shared with others, so meaning making can also result from conversation.
- So, meaning making and thinking are distributed throughout our tools, culture and community.
- Not all meaning is created equally.

The process of constructing meaning is called constructivism. A basic principle of the constructivist learning theory is that learners actively interpret knowledge, information and the world around them and that cognition serves an adaptive function. This adaptation involves an individual’s making personal sense of the information by mediation and negotiation in a social setting [8].

To understand constructivism, you have to know where knowledge comes from. If you haven’t studied the history and philosophy of science, you probably don’t know much about that [3]. A corollary of constructivism is the development of situated learning, meta-cognition, higher order thinking, the social basis of learning, a move away from didactic approaches to teaching, an emphasis on the process of learning; not simply on the product, the breaking of subject boundaries and the development of project-based, real world (authentic) learning and authentic assessment, student-centered learning and the significance of intrinsic motivation [9]

Constructivist Learning: Marlowe and Page (1998), learning in constructivist terms is [5]:

- Both the process and the result of questioning, interpreting and analyzing information.
- Using this information and thinking process to develop, build and alter our meaning and understanding of concepts and ideas; and
- Integrating current experiences with our past experiences and what we already know about a given subject.
Although information is important, passively accumulating disconnected information is not learning. Passively receiving readymade knowledge from someone or something else is not learning. To learn, a student has to be mentally and often physically active. A student learns (that is, build knowledge structures) when she discovers her own answers, solutions, concepts and relationships and creates her own interpretation [5].

The teaching approach that incorporates these features has come to be called constructivist teaching [2]:

- Less whole-class, teacher-directed instruction, e.g. lecturing
- Less student passivity: sitting, listening, receiving and absorbing information
- Less attempt by teachers to “cover” large amounts of material in every subject area thinly
- Less rote memorization of facts and details
- Less tracking or leveling students into “ability groups”
- More experiential, inductive, hands-on learning
- More emphasis on higher-order learning
- More responsibility transferred to students for their work
- More enacting and modeling of the principles of democracy in school
- More cooperative, collaborative activity; developing the classroom as an interdependent community.

Behavioral theory provides ways to manage classroom behaviors and to teach basic intellectual and motor skills. Instructional strategies based on this theory are particularly helpful with younger students, students with learning or behavioral disorders and students of low ability. Cognitive theory promotes student acquisition of dispositions and skills associated with complex tasks or tasks that have multiple solution paths or right answers. Information processing theory also enables us to understand and assess students’ cognitive processing so that we can encourage more effective processes and ultimately transfer control of the learning process to the student. Constructivist theory recommends ways we can take advantage of the social nature of the classroom to provide meaningful experiences for students that are likely to transfer to the world outside of the classroom [10].

In constructivist learning environments, the learner is expected to be proactive and have effective communication skills. In addition, the learner is supposed to be equipped with higher order thinking skills such as critical and reflective thinking, as well as being capable of transferring all these skills to real life situations. Constructivist learning is a decision making process which is shaped by the skills, drives, beliefs, attitudes and experiences of the student. Students construct knowledge through exploring, interpreting and interacting with their environment. Thus, they learn the content and the process concurrently [11].

**Constructivist Approach in Curriculum:** It can clearly be viewed that the Turkish primary years school curriculum of science and technology is based on the principles of constructivism. In order to achieve the stated outcomes, this new curriculum highlights the importance of making use of the teaching practices and learning experiences which reflect the constructivist philosophy. Moreover, the guidelines of the curriculum emphasize the adoption of the instructional strategies which give way to the active involvement of the student in the learning process.

In this study, techniques based on the principles of problem solving and cooperative learning have been employed in a complementary way.

**Purpose of the study:** The 2005-2006 academic year witnessed a change in the science curricula. This new curricula is based on the principles of constructivism. Overall, the new curriculum highlights teaching and learning practices that help create environments conducive to constructivist philosophies. In line with the current changes in the science curriculum, this study aims at exploring the effects of the above mentioned applications on student achievement.

**Problem statement:** What effects do adopting different instructional approaches in the 4th year primary years science and technology program have on student achievement?

- Is there any meaningful difference between the achievement scores of the control group, exposed to instructional practices reflecting constructivism and the experimental group, exposed to instructional practices reflecting the principles of constructivism and problem based learning?
- Is there meaningful difference between the achievement scores of the control group and the experimental group which was exposed to instructional practices based on the principles of cooperative learning and constructivism?
- Is there meaningful difference between the achievement scores of the control group and the
experimental group which was exposed to instructional practices based on the principles of cooperative learning and problem-based learning.

- Is there meaningful difference between the post test scores of the control and experimental groups?

This study is limited to:

- the 4th grade students at the “İhsan Doğramacı Vakfı Özel Bilkent Primary School”;
- the “Light and Sound” unit of the 4th grade science and technology program;
- the 2007–2008 academic year;
- the sources which could be accessed through computer applications in Ankara and;
- the current curriculum of 4th grade primary years program of science and technology.

MATERIALS AND METHODS

A methodology requiring multiple experimental groups has been employed in this study. The three experimental groups and the control group were randomly assigned. Each group received a pre test prior to the interventions. While the control group received applications based on the principles of constructivism solely, the interventions reflected a combination of practices. Respectively, the experimental groups received treatment based on the principles of constructivism & problem based learning; constructivism & cooperative learning and finally, constructivism, problem based learning & cooperative learning.

Following the applications, a post test was submitted to each group.

Research design

<table>
<thead>
<tr>
<th>Experimental group</th>
<th>Pre-test</th>
<th>Treatment 1</th>
<th>Post-test</th>
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<tbody>
<tr>
<td>T1</td>
<td>EG1: Constructivism + PBL</td>
<td>T2</td>
<td>EG2: Constructivism + CoL</td>
</tr>
<tr>
<td>Control group</td>
<td>T3</td>
<td>EG3: Constructivism + PBL + CoL</td>
<td>T4</td>
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Abbreviations

EG: Experimental Group  
CoL: Cooperative Learning  
PBL: Problem Based Learning

Data Collection: National and international resources accessed through the internet and local libraries were used in this study. Particular attention was paid to the selection of the most relevant resources. Following the literature review, the pre test (achievement test) was developed. Experts were consulted and the initial test was piloted. The KR-20 reliability coefficient of the test was calculated as 0.87.

Data Analysis: The Kruskal-Wallis one way analysis of variance was used to reveal the differences between the pre and post test scores of the experimental and control groups. In order to observe the differences among the medium scores of the pre and post tests for each group, the Wilcoxon signed – rank test was employed.

FINDINGS AND INTERPRETATIONS

The Kruskal-Wallis one way analysis of variance revealed no meaningful difference between the pre-test scores of the experimental and control groups, which indicated an equivalence among the groups (Ki-square=5.86, p=0.119>a=0.05).

The Kruskal-Wallis one way analysis of variance was used to analyse the scores of the post-test administered following the interventions. No meaningful difference was found between the post test scores of the experimental and control groups (K-

The Mann-Whitney U test was used in order to detect whether or not there was a difference between the pre and post test scores of the groups. This analysis required the mean scores of the 3 experimental groups to be compared to the scores of the control group and no significant difference was observed neither among the pre-test scores nor the post-test scores (Respectively; p=0.577>a=0.05, p=0.262>a=0.05).

Finally the Wilcoxon signed – rank test was used to depict whether or not there was a meaningful difference between the pre and post test scores of each group. The analyses revealed meaningful differences for all groups.

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<tr>
<th>95% confidence interval</th>
<th>Degree of freedom</th>
<th>Significance (2-Tailed)</th>
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<td>Lower</td>
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<tr>
<td>1 pre test-post test</td>
<td>-0.2092</td>
<td>-0.0918</td>
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<td>2 pre test-post test</td>
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<td>3 pre test-post test</td>
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<td>4 pre test-post test</td>
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<td>-0.0625</td>
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The findings of the study indicate a positive response to the problem statement “What effects do adopting different instructional approaches in the 4th year primary years science program have on student achievement?” Adopting different instructional techniques not only enhance interest but also increase achievement. Moreover, group work has a positive effect on social interaction. Interacting and learning from each other was considered as a valuable experience. The literature also points to similar findings.

A study carried out by Yurdakul and Demirel has revealed that the constructivist learning process has positive effects on students’ attitudes towards the class and results in a greater ownership of the learning process. Constructivist learning environments enhanced recall, helped information processing and resulted in the development of higher order thinking skills such as critical thinking, problem solving and creativity. Moreover, establishing links to real-life situations increases the retention of learning.

Through the “Educational Leaders in Mathematics Project”, Simon ve Schifter guided experienced math teachers as how incorporate constructivist principles into their teaching practices. In order to determine the effectiveness of the intervention, the students’ attitudes and beliefs towards learning maths and their in class achievement were used. A comparison among the attitudes of the 171 students who did not take part in the study and the 179 students who did, revealed a meaningful difference in the attitudes of the students who joined the program. Especially responses to the items “studying maths is fun”, “I’d prefer math homework to others” and “math helps me think better” indicated a meaningful difference.

Hasan Delen’s study entitled “The Effects of Cooperative Learning on Academic Achievement for 5th Grade Elementary School Students in the Social Studies Course” was conducted with 68 students attending the Alpoglan Primary School, situated in the Pertek district of Tunceli, during the second semester of the 1996-1997 academic year. A Pre-test post-test experimental design was adopted for the study. The Achievement Test developed as part of the study was administered as a pre-test and a post-test. The intervention lasted 7 weeks. The results indicated that cooperative learning methodology had a positive effect on the achievement of the experimental group.

Çiğerci, Meydan and Ektem’s study, which was conducted in the Social Science class with 6th grade students’, aimed at examining the effects of Problem-based Learning on student’s achievement and attitudes. The study was carried out during the 2004-2005 academic year, in Meram Sare Ozkasik Primary School with 40 students in two equivalent classes. Attitude inventories were administered as pre and post tests. The t test was used for analyses. The findings indicated a meaningful difference in favor of the experimental group.

**CONCLUSIONS AND RECOMMENDATIONS**

The findings indicate that the learning approaches employed, positively affected the learning gains. As all the target learning approaches required students to actively construct knowledge and be autonomous, meaningful differences were detected between the pre and post test scores. On the other hand, no meaningful differences were found between the different interventions, which indicates that all three approaches had a positive effect on student gains.

Although the students in the first experimental group had some difficulty forming and testing problem-based hypothesis at the beginning, they soon got used to it and made considerable effort to carry on. Eventually, the students were able to form hypotheses based on the problems introduced and learn the subject while testing their hypotheses.

Similarly, the students in the second experimental group confronted some difficulties at the beginning of the intervention because “the jigsaw technique”, which is a cooperative learning technique, created different expectations among students. Since all students had different capabilities concerning information exchange, they had difficulty in learning from each other. Furthermore, the competition among groups, created an expectation for reward. When the children realized that there was no reward, their motivation decreased. However, when it was stated that there was a reward for the winning group, the performance of students improved.

No problem was encountered in the third experimental group, where all the three techniques were combined. Students benefited from this approach more, since the approach enabled them to construct problems and test their hypotheses. Cooperative learning and the element of competition also contributed to their performance. Even if students had difficulty tolerating a specific learning approach or technique, they were able to overcome it and carry on learning using the other approaches or techniques available to them.
Since students were used to this approach, there was no significant difference in the mean scores between the pre and post test results in the control group, where the constructivist approach was used.

Based on the findings of this study, the followings are recommended:

1. **Recommendations towards the findings of the study**

- The significant difference between pre and post test scores indicate that adopting these approaches would have a positive impact on learning. Since there was significant difference between the results of pre and post tests of students taking part in this study, more often use of these approaches in teaching and learning environment may result in better learning.
- Selected approaches should take into consideration the age and developmental levels of students.
- Students should be properly motivated in the beginning of the process.
- Students should be made aware of the value of learning from each other.
- When the techniques are used for the groups of young students, the students should be given rewards at the end of the process.
- Reinforcement and rewards should be used especially with younger students.

2. **Recommendations towards school curricula**

- It should be emphasized that either these approaches replace the current techniques in the primary school curricula or current curricula should integrate the principles of the techniques of these approaches.
- Either learning objectives that require these approaches to be employed should be incorporated into the current programs, or the current objectives should be pursued using these approaches.
- Student teachers in teaching institutions should be advised to read and evaluate these studies so that they can utilize the gains of the curricula where the different learning approaches are used.
- Student teachers should be encouraged to analyse and explore how to incorporate these approaches into their daily practices.
- Professionals responsible for the preparation of teaching curriculum should be informed about these studies so that they can use the findings and recommendations of these studies to improve the teaching curriculum preparation process.
- Experts responsible for preparing curricula should be informed of the findings of research so they can make informed decisions.

3. **Recommendations towards further studies**

- It can be looked at whether diversion and combining techniques in the cooperation learning approaches has any effect on the higher level (upper grade) students.
- The effectiveness of the jigsaw technique can be tested on older students.
- Project based approach can be used instead of problem based approach and then these two approaches can be compared.
- It can be investigated whether the problem based teaching approach or project based learning approach is more effective at different ages.
- The effects of problem based and project based learning approaches can be tested and compared with different age groups.
- A study can be designed to investigate the effect of young students' reward anticipation since young students have reward anticipations in learning.
- Studies exploring the reward anticipation of younger students can be carried out.

**REFERENCES**


