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TO WHAT EXTENT SCIENCE TEACHERS ARE CONSTRUCTIVIST IN THEIR CLASSROOMS?

Abstract. *The primary science curricula have strong constructivist elements since 2000 in Turkey. As the creator of the learning environments it is the teacher who determines its quality. The purpose of this research is to determine if science teachers' behaviour and thoughts are consistent with what the primary science curriculum in essence offers. The research was conducted with two researchers based on a qualitative design consisting of observation and interview with primary science teachers of Turkey. At the end, it was found that, although science teachers have constructivist ideas they do not behave in constructivist manner in the classroom.*

Key words: *constructivism, primary science teacher, science teaching.*

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Introduction

In the last three decades, science educators and researcher have strongly advocated the perspectives of constructivism on learning and teaching (Wu & Tsai, 2005). Constructivism is a theory about "knowing" and "learning" that assumes knowledge can not exist outside the minds of thinking persons (Bodner, 1986; Fosnot, 1996; Limon, 2001; Ozden, 1999). According to constructivist theory, everyone constructs his/her own meaning and learning in the way they experience the world. It suggests that knowledge is not transmitted from one knower to another but is actively built up by the learner (Driver et al., 1994). The construction and reconstruction of meanings by learners requires that they actively seek to integrate new knowledge with knowledge already in their cognitive structure (Novak, 2002). Conceptual development and deeper understanding is at the focus rather than behaviours and abilities in the constructivist education (Fosnot, 1996). Then, the lecturing or accurate telling of scientific facts without any consideration of cognitive aspects of learning as science teaching is the transmission of knowledge (Dana et al., 1997).

Because constructivism is a theory of learning, the characteristics of effective constructivist teaching are not clear (Matthews, 2003). However, it is known that the constructivist theory of teaching must be based upon the constructivist theory of learning (Selley, 1999). The constructivist framework challenges teachers to create environments in which they and their students are encouraged to think and explore the scientific knowledge (Brooks & Brooks, 2001; Fosnot, 1996). Students, in

such a kind of classroom environment, change from passive receptors to active learners being responsible for their own construction of meaning. The challenge for teachers is how to help students effectively construct meaning. For this, the teacher takes account of what students know, maximizes social interaction between learners and provides variety of sensory experiences resulting in learning (Tobin, 1993). Moreover, as a mediator, the teacher needs to ensure that students are given opportunities for quality learning experiences that providing a solid base understanding. Considering the content domain, age level and prior learning of the students, school context and the teaching style, the constructivist pedagogy is the creation of learning environments, activities and methods grounded in a constructivist theory of learning (Richardson, 2003).

The learning environment is created by both what a teacher says and the way that he or she behaves (Watts & Bentley, 1987). It is believed that, it is the teacher who determines the learning environment designed in a constructivist manner or not. In this case, the teacher aspect of constructivist theory is important. Regarding teachers, the elements of constructivist theory in the classroom is summarized as follows (Richardson, 2003, Brooks& Brooks, 2001):

- attention to the individual and respect for students' background or prior knowledge;
- encouraging and facilitating group dialogue;
- planned and often unplanned introduction of formal domain knowledge into the conversation;
- provision of opportunities for students to determine, challenge, change or add to existing beliefs and understandings through engagement in tasks;
- development of students' metaawareness of their own understandings and learning processes;
- use of cognitive terminology such as "classify", "analyze", "predict", and "create";
- evaluating the students in process and give priority to their participation.

The primary science curriculum in Turkey has strong constructivist elements since 2000. It offers to make students engage in hands and minds on activities on their own prior knowledge and experiences. Besides, it gives a role to science teacher as a facilitator stating that "The science teacher is not a transmitter of knowledge to students but is a learner who is actively engaged in the classroom activities as if he or she is learning with students and preparing self-learning environments." (M.E.B., 2000). From a constructivist perspective, curriculum means a set of learning activities and interactions that promote particular learning outcomes with what learners bring to the learning situation (Driver, 1995). A constructivist teacher works as an interface between curriculum and student to bring the two together in a way that is meaningful for the learner (Tobin, 1993). Then, it can be stated that the teachers' development of constructivist behaviours and intentions in the classroom are critical for the working of a constructivist based curriculum. In other words, if the teachers' behaviours and thoughts are in consistent with the curriculum then there is living curriculum. The concern of this research is whether the constructivist curriculum is being used or not. Therefore, the purpose of this study is to determine to what extent the science teachers are constructivist in the classroom. The research problems are defined as the following;

1) Do science teachers behave in a constructivist manner in the classroom?
2) Do behaviours of science teachers vary with their experience in the classroom?
3) What do science teachers think about learning environment in the classroom?

Methodology of Research

The research was conducted with the primary science teachers from different locations of Buca in Izmir (Turkey). All schools in Buca were divided into three groups as centre, middle and slums of city, then schools were randomly selected. 30 primary science teachers were interviewed and 19 of them were observed. Data were collected qualitatively by using observation techniques and semi-structured interview. The observation was carried out by using observation checklist in an evident based style during 15 minutes interval for two months. The observation checklist was

consisted of 24 items regarding the elements of constructivist teaching. Some examples from the observation checklist are: *"Find out prior knowledge of students about the subject", "Gives enough time for students' response", "Creates learning environments to link newly learned subjects to other domains", "Asks open ended questions for comprehension"* and etc. During the lesson, tally sticks were ticked and they were turned into scores at the end of each lesson. Scores were resulted from the ratings: always, sometimes and never scored as 1, 2 and 3 respectively. Observation statements were in positive manner; therefore, the range of scores is spread from 24 to 72. Table 1 shows the score range of each category.

Table 1. Distribution of Scores for the Categories.

Traditional	Transitive	Constructivist
24-39	40-55	56-72

The scores in the range of 56-72 correspond to the constructivist model of teaching whereas the scores in the range of 40-55 correspond to transitive model of teacher and the scores in the range of 24-39 correspond to the traditional model of teaching.

Due to their observation scores, teachers were classified into traditional, transitive and constructivist categories. The level of agreement between the researchers on the evaluation of the observation scores was calculated as 0.92.

In this study, the semi-structured interview based on open-ended questions is used to have comparable results. The interview was conducted with 30 teachers. The content and face validities of interview were supplied by the experts from university and primary science teachers. After the completion of data collection, each researcher transcribed each interview. The transcription consistency, as a level of agreement between the two researchers, was found as 0.89. The data reduction, data display and data verify were used for analysing interview data (Miles & Huberman, 1984). The categories were traditional, transitive and constructivist teaching. The 'traditional' category has teacher characteristics based on a teacher centred approach where the only source and the determiner is the teacher him or her self. Learning is viewed as the memorisation of transmitted basic scientific facts and giving correct answers. The 'transitive" category has some implications in a reformist manner towards constructivist model although not being fully constructivist. Students are viewed at the centre but, teacher takes decisions on behalf of students. Learning is not only viewed in cognitive domain but also has little applications regarding emotional and social learning of the students. The "constructivist" category gives importance to student's constructing of ideas by the students. Teacher sees him self or herself as a guide. The researchers concluded categories by defining descriptors with a level of agreement of 0, 84. Similar categories and methods were used by different researches (Tsai, 2002; Koballo et al., 2000; Haney & McArthur, 2002; Selly 1999). Descriptors of each category and their percentages were briefly given in the following parts.

Results of Research

The analysis and findings of study regarding the research problems are given in the following order:

1) Do the science teachers behave in a constructivist manner in the classroom?

The observation checklist was used for answering this research question. The possible minimum and maximum values were given in Table 1. The scores of 19 science teachers are shown in Table 2.

Table 2. Observation Scores of the Teachers.

Total score	51	49	46	40	37	34	32	30	28	26	24	22
Number of teachers	1	1	1	1	1	1	2	1	2	1	6	1

As can bee seen from Table 2, the maximum score is 51 and the minimum score is 22 among 19 science teachers. There is not any score above 51. The number of teachers and their percentage is given in Table 3.

Table 3. Scores of Teachers Regarding Behaviours.

Behaviours	Traditional	Transitive	Constructivist
Range of Score	24-39	40-55	56-72
%	78.9	21.1	0

As can be seen from Table 3, there is not any teacher in constructivist range but, the majority is in traditional range and there is some in transitive range.

2) Do the behaviours of science teachers vary with their experience in the classroom?

When the teachers' classroom behaviours and their experience in teaching examined (Table 4), it can be seen that teachers who are at their 1 to 5 year experience are behaving traditionally in the classroom. Teachers who spent 16 and more years at teaching showed more transitive teaching features in classrooms.

Table 4. The Year of Experience versus Total Observation Scores of Teachers.

Experience (Years)	Traditional %	Transitional %
1-5	100	0
6-10	71.5	28.5
11-15	84	16
16 and more	67	33

For the analysis of this problem Kruskal-Wallis H-test, a rank test that may be applied samples that are unequal in size where the distribution does not obey the normal parametric distribution (Ferguson & Takane, 1999), was used. The ranks for each sample are summed and their means are checked for if there is any significant difference. The sample consists of four groups of experience. Table 5 shows the ranks and tests statistics for the total scores and test statistics those belong to four groups of experience.

Table 5. The Ranks for the Total Scores of Teachers.

Experience(years)	Number of Teacher	Mean Rank	* $p<0.05$
1-5	3	8.0	$\chi^2 = 1.473$
6-10	7	11.5	
11-15	6	8.5	df = 3
16 and more	3	11.5	

It can be seen from Table 5 that the behaviours of science teachers do not vary significantly with their experience.

3) What do science teachers think about learning environment in the classroom?

For this problem, data was gathered by using the semi-structured interview including three major questions reflecting the constructivist learning environments. The answers were categorised according to their content having regard to the constructivist learning environment. The main characteristics of each category are outlined shortly under the headings. In addition to typical quotations for each question, the distributions of the categories were given at the end.

First question was about the teachers' understanding of students' prior knowledge. The typical interview results for each category are given in Table 6.

Table 6. Selection from the Views of the Teachers about Prior Knowledge.

Category	Traditional	Transitional	Constructivist
Descriptor	-ignoring prior knowledge, -interpreting in a different manner	-giving importance on prior knowledge unconsciously, -surface usage of prior knowledge	-gives importance on prior knowledge - know why to use prior knowledge
Sample from Interview	"..important but most of my students work outside after school. Therefore they do come to the school prepared and I do not want to spent time by checking their prior knowledge…"	"..prior knowledge helps the learning of the new subject as it means the involvement of the student to the subject before…"	"… I know from where to start and how much information they have in their minds…"
%	**10.1**	**49.6**	**40.4**

It can be seen that, only minority of the teachers (10 %) have traditional thoughts those do not give importance to the students' prior knowledge. The transitive thinking teachers are majority (50 %) who believe in the functionality of prior knowledge although they have limited knowledge and usage about it. The constructivist teachers (40 %) use prior knowledge as an instructional tool.

The second question was about student assessment. The views of teachers were derived from the three sub-questions about how they assess students, kind of instruments they use for assessment and kind of abilities or features of students they assess. The typical answers are given in Table 7.

Table 7. Selection from the Views of the Teachers about Assessment.

Category	Traditional	Transitional	Constructivist
Descriptor	-using paper-pencil tests -giving importance to product of learning not to process -caring on cognitive development. -assessing students at knowledge level.	-using alternative assessment criterions and paper-pencil tests -both learning product and assessment is important -caring on cognitive development also social or emotional development may be considered. -assessing above knowledge level.	-using paper-pencil tests inactively, but open ended questions, individual portfolios or development forms. - both learning product and assessment is important. -knowing, being successful, social and emotional developments are important. -assessing in all cognitive levels.
Sample from Interview	"I give importance to their questions …, the exam results, verbal grading and also home-works are important..., I am interested in how much they know..."	"…being active, answering the questions, being prepared for the lessons are important for me, I think about their future life therefore, I try to assess them as much as what they could do..."	".. I do not concern the marks or exam results they have … I give tests and often essay type comprehensive questions… I try to assess how much they know, they are interested in lesson and their hand skills…"
%	**20.6**	**30.8**	**48.6**

Table 7 shows that almost half of the teachers (49 %) have constructivist thoughts about students' assessment and majority of the rest have heavily transitional thoughts. Only about 21% of teachers have traditional thoughts.

The third question was about the learning climate teachers create in their science classrooms. For this, they were asked how and what they do and the way they behave in their science classroom for probing. The typical answers are shown in Table 8.

Table 8. Selection from the Views of the Teachers About Learning Climate.

Category	Traditional	Transitional	Constructivist
Descriptor	- teacher centred -usually the only technique is question-answer	-student centred -teacher gives decisions, makes demonstration experiments. -teacher tries to use different techniques.	- teacher is a guide and facilitator, allows for a democratic, warm situation -uses various instructional techniques.
Sample from Interview	"I tell the subjects, sometimes I give them time to tell the lesson" …. "I use question-answer method"…. "I ask them questions"… "I dictate them about the lesson and make them keep notes of my words…"	".. I try to use the techniques that arouse the attention of the students such as brain storming, questions and answer..,…" "…the best learning takes place during doing" ".. our classrooms are so crowded I can not do anything and I have to use the traditional techniques…"	".. I made experiments for the permanent learning, if we had enough materials every student do the experiments..., … I create a discussion about the subject and then try to guide the students.., I do not directly give the answers…"
%	**30.5**	**45.1**	**24.4**

Table 8 shows that, when the categories are viewed, teacher classroom behaviours are different regarding the techniques used, the role of both student and the teacher. The amount of teachers who see themselves as a facilitator allowing for a constructivist classroom atmosphere in the classroom is around twenty-four percent with the least share. Traditional teachers usually behave in a teacher centred manner with thirty percentages that is a considerable amount of share among teachers. Forty five percent of teachers' think of a student centred learning environment where they give decisions on behalf of students and mostly doing demonstration experiments. Moreover, they try to use different techniques such as brain storming, question-answer etc.

The science teachers' views given in Tables 6, 7 and 8 respectively, are presented as independent of years they spent in teaching. However, Table 9 shows the views of science teachers arranged according to their years of experience. The interview data was firstly grouped according to the years teachers spent in teaching by means of five-year periods. Afterwards, each group were again analysed according to key descriptors given for each category at the top of the Tables 6, 7 and 8 respectively. The percentages of the descriptors for each category were calculated and presented in Table 9.

Table 9. The Year of Experience versus Interview Categories of Teachers.

Experience (years)	Traditional %	Transitional %	Constructivist %
1-5	35.2	28.7	36.1
6-10	16.6	54.8	28.6
11-15	18.4	41.1	40.5
16 and more	17.2	45.8	33.3

The newly teachers, within the range of 1-5 year experience, seem to be the third (36 %) in constructivist thoughts also; they seem to have the highest percentages in this category compared to their percentages in transitional and traditional categories. Teachers within range of 6-10 year of experience have the least percentage of constructivist thoughts (29 %) however, they also seem to have strong transitional thoughts than other groups. Teachers within range of 11-15 year experience have more constructivist thoughts (40.5 %) than other experience ranges but, general tendency for this group seems to be transitional (41 %). Interestingly, teachers' thoughts within range of 16 and more years of experience can be said to take place in the least traditional category.

Observation and interview results are given together in Table 10 for comparison.

Table 10. Comparison of Observation and Interview Results.

OBSERVATION			Experience (years)	INTERVIEW		
Traditional %	Transitional %	Constructivist %		Traditional %	Transitional %	Constructivist %
100	0	0	1-5	36.1	28.7	35.2
71.5	28.5	0	6-10	28.6	54.8	16.6
84	16	0	11-15	40.5	41.1	18.4
67	33	0	16 and more	33.3	45.8	17.2

According to observation results, all of the new teachers (1-5 years experiences) behave in traditional manner although, 36 percent of them think of their learning environment in constructivist manner. The science teachers (6-19 years experience) mostly behave traditionally but, nearly 29 percent of them have transitional behaviours. This results show that, most of these science teachers have transitional thought and they have constructivist thoughts (29 %) with an amount of more than traditional thoughts (17 %). The classroom observation of the science teachers with 11-15 year of experience has similar results with science teachers' of 6-10 year of experiences. However, the interview results show that the ratios of transitional and constructivist teacher are almost the same. The results for the science teachers having 16 and more year experiences has similar amount about classrooms observation and learning environment thought.

Discussion

There are many studies based upon the assertions of constructivism to promote students' science learning (Wu and Tsai, 2005; Marss, Blake & Garvin, 2003; Alparslan et al., 2003; Venville, 2004; Palmer, 2003; Windsehitl & Andre, 1998). Therefore, as the creators of the constructivist learning environments, teachers' behaviours and thoughts are important for students' learning. In this research, we dealt with science teachers' classroom behaviours and thoughts for their consistency with constructivist model. Science teachers were both interviewed and observed in their natural classroom settings.

The data from the observation indicates that none of the science teachers is constructivist in the classroom. Most of the teachers behave in traditional manner in the classroom, only one out of five teachers seems to behave in transitional way. The behaviours of science teachers in the classroom, as shown in Table 5, do not vary significantly regarding their experience in teaching. However, when the percentages of teacher behaviours are examined (Table 4), it can be seen that all of the teachers within range of 1 to 5 years of experience have traditional behaviours in the classroom. When their experience in years increases, their behaviours tend to show more transitional elements. It seems difficult for the constructivist science curriculum to achieve its goals with the science teachers mostly behaving traditionally. Because the science teachers personally create and socially mediate their knowledge about teaching and behaving in their classrooms as making sense of what they already hold about teaching, learning and curricula (Dana et al., 1997).

When the science teachers' views about prior knowledge are examined in Table 6, it seems that more than half of the teachers do not realize the importance of prior knowledge. This may result from teachers' insufficient understanding of how students' learning occurs. Prior knowledge can be defined as a combination of the learner's pre-existing attitudes, experiences, and knowledge (Kujawa & Huske, 1995). The evidence that students' prior knowledge is an important aspect of their science learning is overwhelming, resulting in the consensus that science teachers will have to confront this aspect of learning in their instruction to bring about the elusive goal of meaningful learning in their classrooms (Zietsman & Hewson, 1986). However, these findings show that it seems difficult for the constructivist science curriculum to reach its goals, where nearly 60 percent of science teachers have traditional and transitional thoughts about prior knowledge. This finding is also consistent with teachers' classroom observations. Both behaviours and thoughts are important for determining whether a teacher constructivist or not. Although, the interview results show that there are science teachers having constructivist thoughts, there are not any science teacher behaving in the constructivist way according to observation results. Mellado's (1998) study also demonstrated that there was not a general consistency between science teachers' pedagogical views of teaching science and their classroom behaviour.

When teachers were asked about students' assessment, it was seen that almost half of them (49 %) has constructivist thoughts (Table 7). The other half of the science teachers has transitional and traditional views about assessment. Taking these results into consideration, it can be said that almost half of the teachers do not use constructivist assessment ways since the constructivist model of teaching suggests assessing students during process (Brooks &Brooks, 2001; Kilic, 2001)

and with their active participation (Akpinar & Ergin, 2004).

When teachers were asked about the learning climate they created in the classroom, 24 percent of the science teachers see themselves a guide within a constructivist classroom environment. However, this category may be expected to be higher since the learning environment created by the science teacher plays an important role in shaping students' perceptions of the way science is practised and how new knowledge is created (Tsai, 2000). Moreover, a considerable amount of science teachers with 30 percent is traditional. This may lead to an image of real science classrooms emphasising didactic methods. Majority of science teachers seem to have transitional views such as giving decisions on behalf of students and mostly doing demonstrating experiments by putting forward the crowded classrooms as reasons behind their such behaviours. The fact that many teachers hold traditional views of learning environment may stem from the problem of their own school science experiences. The science classes, laboratory exercises, relevant activities in teacher education programmes may have reinforced the 'traditional' views (Tsai, 2002).

When teachers' views are considered regarding their years of experience as in Table 9, it can be seen that the amount of teachers who have constructivist and traditional thoughts are almost equal (36 % and 35 % respectively). The views of teachers within range of three categories of experience (6-10, 11-15, 16 and more) are remarkably transitional. These may result from their insufficient experience in teaching and learning based on constructivist perspectives. The programs and the teaching models should be dealt with constructivist manner, if the teachers are expected to teach according to a constructivist curriculum (Richardson, 2003).

When the observation and interview results are compared together (Table 10), it is clear that there is not any teacher both behaving and thinking in the constructivist manner at the same time. Although there are teachers having constructivist thoughts in each experience group, none of them has constructivist learning environments in their classrooms regarding their observation results. It seems that teachers have not assimilated constructivist theory and therefore, their behaviours lag behind their thoughts. Actually, this result may be explained by the fact that, science teachers have transitive beliefs about learning environments in spite of having constructivist learning environment images in their minds (Cohen, 1990). Haney & McArthur (2002) have obtained similar results in their studies. They found that teachers who say, "I believe in hands-on student inquiry" were using classroom actions relying on lecture (ibid: 789). Moreover, 6 and more year experienced science teachers have stronger transitional thoughts despite having mostly traditional behaviours in the classroom. This may result from that, teachers first acquire knowledge and skills and after then they can use it to create learning environments that will support the needs of the students (Dana et al., 1997).

Conclusions and Recommendations

The main aim of this study was to identify whether primary science teachers' behaviours and thoughts are constructivist or not. This study shows that although teachers could express their learning environments as constructivist settings, their behaviors in classroom do not have constructivist features. Moreover, almost half of the science teachers do not have idea of prior knowledge and student assessment as the basic elements of constructivist teaching and learning. When the science teachers' views about learning environment were compared according to their experiences, it is found that most of the teachers have views between the constructivist and traditional ways. Classroom observations indicated that none of the teachers are constructivist but overwhelmingly traditional. At the same time, the behaviors of the science teachers do not vary significantly regarding their experiences. Besides, around one out of four teachers has the idea of a constructivist learning environment.

The better practices of curriculum may be achieved by reducing the gap between science teachers' behaviors and thoughts. To achieve this, researches are needed to clarify the differences between teachers' views and behaviors. Additionally, the reasons driving constructivist thinking

science teachers to behave traditionally in the classroom should be also investigated. In-service programs should consist of elements helping teachers understand the basic philosophy of constructivist primary science teaching programs and the new paradigms. In order to overcome the traditional behaviours of science teachers, their understanding of science courses should be investigated. This study should be re-conducted for longer periods of time with using more instruments.

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Резюме

УРОВЕНЬ КОНСТРУКТИВИЗМА НА УРОКАХ У УЧИТЕЛЕЙ ЕСТЕСТВОЗНАНИЯ

Гул Унал, Еркан Акпинар

С 2000 года в программах начальной школы Турции заметны элементы конструктивизма. Учитель сам создает среду обучения/учения и только он решает о качестве среды. Цель данного исследования – установить как соотвествуеют поведение на уроке и мысли учителей с требованиями и рекомендациями новых программ.

Опираясь на модель проверки качества, данное исследование проводили два исследователя. 19 учителей были под наблюдением, а также проводился опрос. Другая группа из 11 учителей была только опрошена. Исследование проводилось в двух городах Турции – Бука и Измир. Контольный лист наблюдения составили 24 пункта, которые тесно связаны с элементами конструктивного обучения. После каждого урока результаты обобщались. Уровень соотвествия между двумя наблюдателями составил 0,92. Каждый исследователь четко записал данные, полученные способом опроса. В этом случае также был произведен анализ соотвествия между исследователями, который составил 0,84. Используя два способа сбора информации – контольный лист наблюдения и беседу – полученная информация расспределена в три блока: традиционное, транзитивное и конструктивное обучение.

В конце исследования все таки было установленно, что большинство учителей можно отнести к категории традиционного обучения. Только несколько учителей можно отнести к категории транзитивного обучения и ни одного в блок конструктивного обучения. Значимые различия между поведением учителей естественников на уроке и их опыта не выявлены.

Ключевые слова: конструктивизм, естественнонаучное образование, учителя естествознания.

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