UBD *(UNDERSTANDING BY DESIGN)* MODELINE GÖRE HAZIRLANMIŞ FARKLILAŞTIRILMIŞ FEN VE TEKNOLOJI DERSI ÖĞRETIM PLANI: TÜRKIYE ÖRNEĞI

Nihal YURTSEVEN[i]
Selçuk DOĞAN
Sertel ALTUN

Özet

UbD modeli ve farklılaştırılmış öğretimin eğitim ortamlarında kullanılması son yıllarda adından sıkça söz ettirmeye başlamıştır. İkisinin öğretimi planlama ve süreci farklılaştırma konusundaki birlikteliği birçok eğitimciye ilham kaynağı olmuştur. Bu araştırmanın amacı Ubd modeline göre hazırlanmış farklılaştırılmış fen öğretiminin etkisini incelemektir. Araştırmanın modeli karma model olup, nitel ve nicel verilerin harmanlanmasıyla oluşmuştur. Araştırmanın çalışma grubunu 14 altıncı sınıf öğrencisi, bir fen bilgisi öğretmeni ve bir gözlemci oluşturmaktadır. Araştırmada veri toplama aracı olarak bir akademik başarı testi, öğretmen görüşmesi, öğrenci görüşmesi, öğrencilerin yansıtma notları ve gözlemcinin notları kullanılmıştır. Araştırmanın sonucunda Ubd modeline göre hazırlanmış farklılaştırılmış fen öğretiminin, öğrencilerin akademik başarılarında anlamlı farklılık olduğunu ortaya çıkmıştır. Ayrıca, araştırmanın nitel verileri de bu sonucu desteklemiş ve uygulamanın avantajları ve dezavantajları konusunda ipuçları sunmuştur. Öğretmen, öğrencilerin derse aktif katılımının önemli olduğunu vurgulamış ve Türkiye'de yapılan genel sınavların Ubd ve farklılaştırılmış öğretim üzerinde olumsuz sonuçları olduğunun altını çizmiştir. Öğrenciler, eğlenceli öğrenme ortamının, öğrenmeyi kolaylaştırdığını ifade etmişlerdir. Araştırmadan elde edilen sonuçlar, etkili bir öğretmen eğitimi yardımıyla, öğretmenlerin Ubd'yi kullanarak ve farklılaştırılmış öğretimi dahil ederek bir tasarım oluşturabileceğini göstermektedir. Bu şekilde gerçekleştirilecek bir tasarım, hem tüm öğrencileri daha iyi öğrenme fırsatlarına yakınlaştıracak, hem de akademik açıdan daha donanımlı ve topluma katkıda bulunan bireyler olmalarını sağlayacaktır.

Planning Differentiated Science Instruction Using Understanding by Design: The Case of Turkey

Abstract

The combination of Understanding by design (UbD) and Differentiated Instruction (DI) in the educational settings has been gradually evolving. Their essential partnership has inspired many educators to plan instruction to differentiate the process of teaching and learning in an effective way. The purpose of this study was to investigate the effect of UbD-based differentiated science instruction. The research had an embedded mixed method design that combined quantitative and qualitative data. The study group consisted of 14 sixth grade students, a science teacher, and an observer. Data collection instruments were an academic achievement test, the teacher interview, the students' interview, students' self-reflection notes and observer's notes. The findings of the study indicated that there was a significant difference on the academic achievements of the students after UbD-based differentiated instruction. In addition, the qualitative data both supported this finding and yielded advantages and disadvantages of this implementation. The teacher emphasized the importance of active participation of students. However, he underlined that national exams in Turkey have negative effects on using UbD and DI. The students thought that the enjoyable nature of the instruction helped them learn better. With effective teacher training,

[i] Öğr. Gör., Yıldız Teknik Üniversitesi Yabancı Diller Yüksek Okulu, İstanbul, ysnihal@hotmail.com

it can be suggested that, teachers can plan the instruction using UbD and implement DI strategies to provide all children with better opportunities to learn, resulting in more academically equipped and contributing members of society.

Key Words: *Understanding by design, differentiated instruction, science teaching, UbD, backward design, Turkey.*

Introduction

Effective classrooms have five basic elements; whom teachers teach (student), where teachers teach or where students learn (learning environment), how teachers teach (instruction), what teachers teach (content), and how teachers assess (assessment) (Tomlinson & McTighe, 2006). Considering all the elements separately, each one has its unique characteristics. As for the first element, students are like fingerprints; their background, interests, attitudes toward the school, socioeconomic status and learning styles are different (Beler & Avcı, 2011). In fact, today's classrooms possess significant diversity of student abilities, motivation, language and ethnicity (Darling-Hammond, 2003; Lawrence-Brown, 2004). Therefore, classrooms should be responsive to learners' varieties (Gale, 2001; Pianta & LaParo, 2000; Tomlinson & Kalbfleisch, 1998). Being successful requires teachers to think deeply about learning strategies and methods. It is problematic that same instructional strategies and learning environments, which are the second and third elements of effective classrooms, do not fit all of the students. Teachers should provide instructional strategies for various learner profiles so that students will become ready for future academic opportunities (Abbati, 2012) and they are responsible to do so irrespective of students' abilities, needs and backgrounds (Jehlen, 2006).

The fourth element of effective classrooms is about content. The selection of the content should be based on what is most important for students (Young, 2005) and on enduring understanding to provide long-lasting effects for learners (Wiggins & McTighe, 2005). Understanding is of utmost importance, because, as cited in McTighe and Seif (2003), the main aim of education is to develop and deepen student understanding. Achieving this aim requires students to apply knowledge and skills to authentic contexts. Wiggins and McTighe (2005) proposed that content should be organized in such a way that it should not be "textbook coverage" but it should have clear priorities and purposes. As Wiske (2005) stated teachers should think about the four questions: "What topics are worth understanding? What about these topics must student understand? How can student understanding of these topics be fostered? And how can we tell what students understand about these topics?" The answers to these questions lead teachers to identify relevant subject matter that focuses on central ideas and also understanding.

It is a fact that learners' characteristics vary significantly and content should be prioritized. However, there is a growing need to improve performance of schools. In this regard, the fifth element of effective classrooms, assessment, must be taken into account to determine the success of schools, in turn, students.

The five elements of effective classrooms force teachers and educators to reexamine their teaching and instructional planning. A framework is needed for teachers to work closely on content, instruction and assessment. To address all students, differentiated instruction (DI) is suggested because it is one of the ways to ensure various learning opportunities for diverse learners (Tomlinson, 1999; 2000;

2001; Tomlinson & McTighe, 2006). According to Tomlinson (2003), DI has more emphasis on student, learning environment and instruction. Furthermore, to ensure an understanding-based instruction, a planning structure and rationale are needed. Understanding by design (UbD) is a framework enabling teachers to provide students with instruction in which critical thinking and in-depth understanding are in favor (Wiggins & McTighe, 2005).

In Turkish educational settings, curriculum development and instructional planning focus on student-centered approach. The Turkish national curriculum is based on students' interests and needs. Thus, using differentiated strategies for planning learning experience is preferred for Turkish students (Beler & Avcı, 2011). On the other hand, the results of PISA, PIRLS and TIMSS indicate that Turkey is not one of the highest-achieving countries because of Turkish students' lower degree of understanding (Afancan & Nuhoğlu, 2008; Anıl, 2009; Bayraktar, 2010; Berberoğlu, 2007; Berberoğlu & Kalender, 2005; Ceylan, 2009; Savran, 2004). DI and UbD can be used in order for students to provide coherent curriculum, enduring understanding and differentiated strategies for various styles of learning. In this` context, the main purpose of this study is to investigate the effect of UbD-based differentiated science instruction on academic achievements of the students and to investigate the teacher and students' views.

Literature Review

What is Understanding by Design (UbD)?

UBD is a curriculum design and development model in which the focus is on understanding (McTighe & Wiggins, 2004; Wiggins & McTighe, 1998; 2005). It offers a curriculum-planning framework to provide coherency among curriculum, assessment and instruction (Brown, 2004). In order to accomplish this, UbD utilizes three stages of planning process, called backward design. The logic of backward planning resides in the notion of keeping the end in mind. Wiggins and McTighe (2005) advocated that beginning with the end (aim), identifying the evidence of achievement (assessment) and then determining appropriate action plans enable teachers to have their students perform well and gain in-depth understanding. This view was presented earlier by Tyler (1969) as a fact that instructional planning could be made to attain the objectives. Apart from Tyler's point of view, Wiggins and McTighe (2005) highlighted the importance of teacher participation (the concept of teacher-as-a-designer) and peer assessment in curriculum development process. Furthermore, they are object to the ideas of activity-focused teaching and coverage-oriented teaching for effective learning.

According to Wiggins and McTighe (1998; 2005), the backward planning starts with "identifying the desired results" in which the goals and priorities have great importance. In this first stage, established goals, big ideas, essential questions, skills and knowledge statements are identified. The big ideas and essential questions are relatively new components of curriculum, which, as cited by McTighe and Thomas (2003), provide a conceptual focus on priority and clarity of content which is being taught. The large quantity of content knowledge is being separated into manageable parts so that students are engaged in meaningful learning (Bransford, Brown, & Cocking, 1999). Important knowledge (concepts, formulae, facts) and skill (write, develop, prepare) objectives are also identified in the first stage.

In stage two: "determining acceptable evidence", UbD encourages teachers to consider curriculum as a collection of assessment needed to report and document students' learning. Wiggins and McTighe (1998; 2005) offered a new perspective for teachers to learn more about students' understanding. "Six facets of understanding" are like indicators whether or not students truly understand. Explaining, interpreting, applying, having perspective, empathy and self-knowledge are those six facets that students should have so that they have an enduring understanding about the content. Performance task and other assessment techniques (test, quizzes, informal checks, and observations) are designed in order for students to be engaged in both authentic and traditional classroom settings and to reveal understanding. With clearly identified results and assessment evidence, teachers can plan specific learning activities in stage three –"planning learning experiences and instruction".

In stage three: plan learning experience and instruction, it is a kind of daily lesson plan in which teachers plan the whole unit as a guideline. The main purpose of the stage three is to provide students with plenty of learning opportunities planned by the teacher in a well-organized fashion. To be consistent in all of the three stages in UbD, Wiggins and McTighe (1998; 2005) offered a conceptual guide, called as "template". This tool helps abstract ideas hold together in a tangible form.

What makes UbD unique is that teachers become active participants of curriculum development process. This also brings professional collaboration and dialogue into action. As McTighe and Wiggins (2004) stated as teachers plan their instruction, they become involved in such an engaging professional learning community that they share instructional ideas and make curricular decisions with their colleagues. In addition, UbD makes use of peer review sessions in which a set of "design standards" (rubric and criteria) are used to evaluate the quality of curriculum (Wiggins & McTighe, 1998; 2005). It is done both individually and as a whole group of teachers to identify the strength and weaknesses of the planned curriculum.

The UbD framework is guided by research in both cognitive psychology and academic achievement of students (McTighe & Seif, 2003). Moreover, Bruner's work in 1960s, Gardner and Perkins's projects in 1980s and Newmann's research helped UbD's components to develop (Kelting-Gibson, 2003). The very background of UbD is based on the research finding that teaching for in-depth understanding improves student academic achievement (Stigler & Hieber, 2004). This can also be supported by TIMSS research that the curriculum of higher achieving countries has more coherence and focus (Hirsch, 2003; Schmidt, 2004; Schmidt, Houang, & Cogan, 2002). To put it another way, the learning environment focusing on understanding facilitates learning, teaching and comprehension (Andre, 1979; Marzano, Pickering, & Pollock, 2001). In the lights of these findings, it can be stated that UbD is a curriculum design model used for students to make sense of the learning process (Wiggins & McTighe, 2005).

Reviewing the literature and research findings show that curriculum designed by UbD has a positive effect on student academic achievement (Noble, 2011), on pre-service teachers attitude about curriculum planning (Graff, 2011; Gulsvig, 2009; Kelting-Gibson, 2003), on teachers' preference of teaching methods (Brown, 2004; Grooms, 2010; Harris, 2010) and on enduring understanding (Meyer, 2006). On the other side, Young (2005) found out that the implementation of UbD framework causes teachers to experience more stress and anxiety in curriculum planning.

What is differentiated instruction (DI) ?

DI refers to designing the curriculum and instruction in a systematic way by taking students with diverse academic needs into account. DI is a kind of classroom organization through which each student's learning needs are honored and each student's learning capacity is maximized. DI suggests that teachers focus on two classroom dynamics, namely, the nature of the student and the fundamentals of the curriculum. With this approach in mind, teachers can increase their understanding about what to teach and how to teach in classes where the population is heterogeneously distributed (Tomlinson & Strickland, 2005).

There are three core student characteristics for teachers to bear in mind during the differentiation process: readiness, interest and learning profile. As Tomlinson and Strickland (2005) stated readiness is the extent to which a student knows, understands, and can do in parallel with what the teacher is planning to teach. The reason why readiness is considered in differentiation process is that the curriculum is designed appropriately challenging, yet supportive for a range of diverse students. The goal of differentiation in interest is to connect newly gained information with what students find interesting and appealing. The learner can easily be hooked to the new subject if it is linked to an already motivating component for the student. Learning profile involves learning style, intelligence preference, gender, and culture. By considering learning profile, it is intended that learners can learn in ways that are efficient and convenient for them.

Differentiation in the classroom can be obtained by elaborating on five elements. These elements are content, process, product, affect and learning environment (Tomlinson & Strickland, 2005). For differentiation to be carried out efficiently, the teacher should possess a solid conceptual understanding of the material, should be able to answer questions related to the material and should teach the content through more than one approach (O'Meara, 2010). Either in a single lesson or across a unit to be instructed, teachers can enrich the experiences of students by using a variety of tasks. These tasks can be exemplified as graphic organizers, reading materials with different difficulty levels, using direct instruction method in small groups and scaffolding learners where necessary. Presenting a diversity of tasks or instructional methods can be beneficial for students with different needs and can create balance between complexity of instruction and opportunity for success in classrooms (Brown, 2004).

The classroom can be differentiated by integrating several strategies. Tiered instruction, station instruction and learning centers are among the most common approaches. Tiered instruction is a way of creating tasks based on difficulty level. As Heacox (2009) stated, it is essential that teachers picture a ladder, tier the process by designing a basic task for the bottom rung, and develop more challenging and complicated activities throughout the process. While designing activities tiered by process or product, teachers should first consider what they want all students to learn as a foundation and what they expect some students to learn because of the complexity or sophistication of the task. In this way, they can put a basic goal for the whole class and an ultimate and challenging goal that is appealing for students with higher abilities. Station teaching generally occurs at times when teachers want to reinforce information that is new to the class. With this purpose in mind, the teacher sets up different stations with various levels or modalities to include different types of needs. With station teaching, various learning adaptations and strategies are

represented and different styles are encompassed during the instruction (D'Amico & Gallaway, 2010). Learning centers are kinds of zones where learning materials related to common goals are gathered. Students proceed at their own speed and try to learn, explore, create or develop a certain task. Learning centers is a kind of strategy through which students are responsible of their own learning. Each center has a predetermined goal. Apart from the station teaching, students do not have to study in each learning center to fulfill a learning task as there is not a certain bond between them. Learning centers can be created by considering the needs of the students (Gregory & Chapman, 2007).

There are several studies (Avcı, Yüksel, Soyer, & Balıkçıoğlu, 2009; Grant & Lerer, 2011; Maynard & Coyne, 2010; Richards & Omdal, 2007; Springer, Pugalee & Algozzine, 2007; Stager, 2007) showing that implementing DI in the learning process brings positive outcomes no matter what the domain is. In addition, there are specific findings that DI improves academic achievement of students for mathematics, science and physical education (Campbell, Campbell, & Dickerson, 1999; Gamoran & Hannigan, 2000; Koeze, 2006; Tomlinson, 2007, Tomlinson, Callahan, & Lelli, 1997), provides instructional effectiveness (Pardini, 2005), and improves student participation and interaction in the class (Gamoran & Weinstein, 1995; Houtveen & Van de Grift, 2001).

The Combination of UbD and DI

The combination of UbD and DI is currently a major subject for educational research that receives a high level of attention worldwide. The reason for this interest is their "logical and practical appeal" (Tomlinson & McTighe, 2006). UbD addresses the need for standards, how meaning and understanding emerge in classroom settings and build coherent curriculum to accomplish all of these. In addition, it focuses on dealing with the questions of what to teach and how to assess. In comparison, DI offers a scope for considering diversity of learners during the curriculum planning process and deals with the questions whom, where and how to teach. For this reason, UbD and DI are both supportive and supplementary of one another (Tomlinson & McTighe, 2006).

Each instructional method brings a fresh perspective to the classroom; however, it is of crucial importance that it should address all the aspects of the lesson. The combination of the UbD and DI makes the instructional process more concrete and sound, which in turn enhances the determination of learning goals and the transformation of knowledge into ability. In addition, this combination can create a more dynamic process in the assessment period and it can provide more positive learning outcomes. Although DI is a common way of individualizing instruction and it has grasped the attention of many researchers so far, the combination of UbD and DI for curriculum construction is a new phenomenon. There is limited data about the implementation of UbD-based differentiated instruction. Thus, this research aims to bridge this gap in the literature about examining the partnership of UbD and DI during the planning and instruction process. In addition, Turkey's national curricula and instructional practices emphasize mainly on the teaching factual knowledge and acquisition of skills. Nonetheless, the results of international studies and assessment suggest that the focus of instruction and curriculum planning should be on enduring understanding. Therefore, by using the UbD framework researchers intend to see how an understanding-based instruction works in Turkish educational settings. The

results of the study also shed light on the implementation of different curriculum development models in Turkey.

Within this scope, current research was conducted to investigate the effect of UbD-based differentiated science instruction on academic achievement of the students studied. The study has an aim to base the implementation of UbD and DI partnership on an academic framework, which will foster the academic interest about the essential partnership of the two components. The hypothesis and research questions were:

- There is a significant difference between academic achievements of pre- and post-tests results.
- What are the teacher's views about UbD-based differentiated science instruction?
- What are the students' views about UbD-based differentiated science instruction?

Method

Research Design

The study was carried out in 2012-2013 academic year, between February and June with the purpose of investigating the effect of UbD-based differentiated science instruction on academic achievements of students. The embedded mixed-method design was employed in order to collect and analyze data that included both quantitative and qualitative components. As Creswell (2012, p.544) points out the purpose of the embedded design is "to collect quantitative and qualitative data at the same time, but to have one form of data play a supportive role to the other form of data". In the current study, an experiment the quantitative data of which were collected through an academic test was carried out and the qualitative data were used with an aim to strengthen the quantitative data.

The Study Group and Setting

The embedded research design was conducted at a private school by employing a purposive sampling technique (Cozby, 2001; Creswell, 2012). The study group consisted of 14 sixth grade students, who were 12 years old. A science teacher, with 10 years of teaching experience, was very active in the planning and implementation process. He possessed extensive knowledge on and experiences with DI strategies and received training about UbD framework. The observer was one of the researchers, possesses master's degree and knowledge about UbD framework and DI. The researchers and teacher worked collaboratively for planning UbD-based differentiated science instruction.

Data Collection Instruments

In this study, an academic achievement test was uesd to collect the quantitative data of the study, before and after the experiment. It had 14 questions. All the questions were created based on the science curriculum and its objectives. An experienced science teacher prepared the test and was given feedback by a jury of experts. After the feedback-based revision, the validity of the achievement test was examined by two science teachers, two curriculum specialists, and two assessment

specialists. The reliability coefficient of the test was .72, which indicates a strong internal consistency. Qualitative data included, the teacher interview, the student focus group interview, self-reflection papers of the students and the observer's note. The development of qualitative instruments was a collaborative process in which the researchers worked together. Relevant literature was used to provide validity. For the teacher interview (nine questions) and students' focus group interview (five questions), semi-structured interviews were carried out. Validity and reliability studies of the interview forms were done by a jury of education specialists. For the observer's notes, "the three aspects of the observable indicators of UbD" form (Wiggins & McTighe, 2005) was used. The observer provided answers for 28 items in 3-Likert type and took notes while observing the teacher, students and classroom environment.

Experimental Procedure

While planning the UbD-based instruction, the researchers and the science teacher worked together, which is a basic premise of UbD. Deciding on which unit to cover, determining the desired results of the sub-units, and matching them with the correct in-class DI activities and assessment techniques were done in a collaborative fashion. The teacher gave substantial information about the students, their academic achievement, and the resources at school to better implement the instructional design.

After the first draft of UbD-based instruction, the teacher self-assessed the unit plan by using UbD design standards rubric. Then, a jury of the science teachers, having experience in both UbD and DI assessed the unit plan and gave feedback by using the peer-evaluation rubric of UbD. Both rubrics were developed by Wiggins and McTighe (2005). Finally, the curriculum specialists reviewed the unit plans and gave feedbacks to the teacher. The final form of the unit plan was implemented within a three-week period.

The sub-units in the unit plan systematically consisted of three main components of UbD: desired results, assessment evidence, and learning plan. The desired results covered established goals, big ideas, essential questions, skills and knowledge questions. In the assessment evidence stage, assessment techniques were identified through a detailed consideration of the total plan and units. The plan placed emphasis on students' self-reflection and paper-pencil tests. At the last stage, the learning plan was developed using WHERETO acronym of UbD, tiered and station strategies from DI. All the classes started with a hook and guidance; all the students had the opportunity to explore, rethink and work in a group; and self-assessment and formative feedbacks were used in the UbD-based differentiated instruction. In the implementation phase, an academic achievement test was applied as a pre-test. After that, the earth science unit was covered during three weeks. After the experiment, the academic test was applied again as a post-test.

As it was stated before, the implementation of the learning plan lasted three weeks. The earth science unit consisted of five sub-units: rocks and mines; fossils; the soil and erosion; the water; nature monuments. Each sub-unit included a warm-up and attention-getting phase; mass-instruction, individual or group work activities, gathering, and assessment. Individual or group work activities varied from self-study to different DI techniques.

Analysis of Data

In order to determine whether there was a significant difference between pre- and post-test results, the quantitative non-parametric Wilcoxon analysis was used. The qualitative data instruments, interviews and notes, were transcribed, analyzed, and coded through content analysis technique and overlapping themes were identified. Content analysis was applied in order to identify codes and themes according to the concepts derived from the data. As Creswell (2012) stated, the reason why content analysis is applied in a research is that the researchers find concepts or themes to interpret the collected data. Within this framework, similar data were categorized under the same concepts and interpreted in a clear and organized way. Then, quantitative and qualitative were synthesized and the results were refined in an elaborate way.

The study has certain limitations. First, the implementation was conducted at a private school with a limited number of students. In addition, the teacher implemented the instructional design based on the training he received about UbD and its combination with DI. However, there might have been certain unnoticed problems during the implementation process. Although UbD suggests using performance task, there was not a performance task, which doesn't affect the assessment results. Finally, the students were usually accustomed to traditional types of instruction. The implementation might have hindered the students' will to express themselves.

Findings

The findings of the study are threefold: quantitative analysis of academic achievement test, qualitative analysis of the teacher and students' views and the observer's notes on observable indicators of UbD and DI.

The effect of UbD-based differentiated instruction on academic achievement

The purpose of this study was to investigate the effect of UbD-based differentiated science instruction on academic achievements of the students. To determine whether there was a significant difference between the pre- and post- tests results, non-parametric Wilcoxon test was administered and the related values were shown in Table 1:

Table 1

Descriptive Statistics and Wilcoxon Analysis for Pre- and Post- tests

	N	*M*	*SD*	*Mean Rank*	*Sum of Ranks*	*Z*	*p*
Pre-Test	14	60.85	15.95	1.50	3.00	-3.11	.00
Post-test	14	84.21	13.05	8.50	102.00		

The results in Table 1 indicated that there was a significant difference between pre- and post-tests results of the students in UbD-based differentiated instruction. Thus, the students got higher grades on academic achievement test after UbD-based science instruction.

As for qualitative data about the achievement of students, the students' and teacher's views were analyzed. The students' and teacher's views showed that UbD-based differentiated instruction had a positive contribution to the learning environment. In particular, the implementation helped the teacher feel more job satisfaction than ever. He expressed his feelings as below:

> "...The implementation made me feel important, more important than traditional lessons. I was the leader, responsible different groups. We experienced an interaction that was much different than normal. I felt happy when I saw that the students were happy..."

In support of the teacher's views, some students' views about learning can be seen below:

> "The lesson was good, because it was the first time I had learned so much in an enjoyable way!"
>
> "I feel very happy. I felt as if I was a scientist. I enjoyed the lesson a lot! I wish there had been much more activities..."
>
> "The activities were perfect, especially the experiment of making a fossil."

As it is clear from the teacher's and students' statements and also from quantitative data results, the UbD-based differentiated science instruction had positive learning outcomes. Both the teacher and the students expressed satisfaction with the implementation. Therefore, the qualitative data results supported the quantitative data results.

The advantages of UbD-based differentiated instruction

The teacher reported that it was an efficient way to include the students in the learning process. He said that the most important aspect of UbD-based science instruction was that the children were active in the learning process. Moreover, he commented that the activities addressed multiple sensory fields. Similarly, the students had positive feelings about active participation in the lessons. Some of their views can be seen below:

> "Making my own fossil and being a paleoanthropologist was marvelous. I took part in the activities and helped my friends."
>
> "Activity-based science lessons make me feel much more creative. In addition, I enjoy the lesson a lot!"
>
> "I believe that I learned the subject better by examining the stones. I think there should be similar activities in science lessons."

As it can be seen in the comments, the students had more pleasure by taking part in the activities. They reported that the amusement in the lessons helped them learn better.

Another important advantage of UbD-based science instruction was its social aspect. The teacher was surprised by seeing one of the most introverted students playing with her friends. He commented that being part of a team and interacting with peers helped the students become more extroverted, sociable, and relaxed in the lessons.

Although the teacher and the students had positive feelings in general, they also had some recommendations to improve the practice of UbD-based instruction. For example, some of the students said that music should be included in the implementations. In addition, they proposed that the activities should be varied and more challenging. Related comments can be seen below:

"For me, the lesson was perfect. Because the activities helped me compare the things I knew before and after the lessons. I wish there had been classical music during the implementations."

"I would like to examine the fossils we made last lesson. I think science lessons should include more experiments and activities."

"I helped my friends while playing games and making fossils. I would like to repeat the lesson."

"As part of science lessons, I would like to go out and dig the soil."

As it is clear, the UbD-based differentiated science instruction was satisfying for both the teacher and the students. Although they had some recommendations, the students agreed that the instruction was acceptable.

The disadvantages of UbD-based differentiated instruction on Turkish educational settings

Although the implementation did not receive a negative comment from the students, the teacher clarified some difficulties with implementing UbD and DI in Turkish educational settings. One of the most crucial points the teacher underlined was the annually held central exam in Turkey. He mentioned that the requirements of exam preparation could not be met with implementations that were based on individual differences. He made the following comments:

"...Such implementations should be adapted to the central exam. Although these activities are fun for the students, it is a reality that they are far from the standards to prepare them for the exam..."

The other important issue that the teacher emphasized was that the practitioners should be supported because the students were not accustomed to that kind of school implementations. He expressed his opinion in the following lines:

"It is obvious that UbD-based differentiated instruction improves the teacher a lot. However, s/he should be a good researcher to design that kind of an instruction. The design should be carried out on a professional scale by taking experts' opinion. In this way, the teacher can also add a scientific aspect to the study."

Another important point the teacher highlighted was that there might be some discipline problems during the transitions in the implementation. As Turkey's educational settings are based on traditional instruction and the class populations are not less than 20, some problems might occur during the lessons based on differentiation. The teacher recommended that two teachers co-teach during lessons that include special techniques like tiered instruction, station technique etc. In a science lesson, the laboratory teacher and science teacher can both be present in the classroom to manage the lesson in a more effective way.

In summary, the implementation was generally satisfying for the participants. They showed their pleasure and enthusiasm by adding the suggestions to improve the quality of similar studies for the future.

The Observer's Notes on the Indicators of UbD and DI

The observer noted some important points about what happened in the classroom in the light of her existing UbD and DI knowledge. UbD-based differentiated science instruction had positive impact on both the classroom settings

and the teacher's professional development. For the classroom, it functioned as an icebreaker to achieve a more interaction-based atmosphere. The lessons started with animations or similar warm-up activities. Doing experiments, researching on the computer, or hands-on activities thrilled the students. Furthermore, they expressed their feelings easily, the excitement in the classroom increased, and the noise reached the peak during the group activities. The students were quite good at writing reflections at the end of the lessons. The lessons were covered within the anticipated time.

For the teacher, the implementation was a way to utilize his background knowledge and blend it with the proposed instructional design. Unlike traditional lesson plans, he had the opportunity to work as part of a team to choose the unit, determine the assessment tools, and differentiate the content. During the implementations, he was both a good leader and a good guide for the students. He adjusted the amount of intervention professionally according to observed student need. He gave his messages clearly and summed up the lessons accordingly. He agreed that the in-class activities were consistent with the lesson objectives. In addition, he highlighted that it was important to create an individualized learning environment to guarantee the academic achievement for every student. He mentioned his opinions in the following way:

> "...The teacher is the main figure for a subject to be taught. It is important to address the students with different needs. It is quite necessary to differentiate the lesson according to learning styles, types of intelligence, or already existing knowledge. Although designing an instructional setting is essential, the teacher has a vital role in the implementation period. The scenario cannot be efficacious as long as the teacher is not a good practitioner..."

Table 2 shows the frequency which observable indicators of UbD.

Table 2
The frequencies of the observable indicators of UbD

Observable Indicators	(1)	(2)	(3)
The teacher...			
Informs students of the big ideas and essential questions, performance requirements, and evaluative criteria at the beginning of the unit or course.			x
Hooks and holds students' interest while they examine and explore big ideas and essential questions.			x
Uses a variety of strategies to promote deeper understanding of subject matter.		x	
Facilitates students' active construction of meaning (rather than simply telling)			x

Promotes opportunities for students to "unpack their thinking" -- to explain, interpret, apply, shift perspective, empathize, or self-assess (incorporates the six facets of understanding).		x	
Uses questioning, probing, and feedback to stimulate student reflection and rethinking			x
Teaches basic knowledge and skills in the context of big ideas and explores essential questions			x
Uses information from ongoing assessments as feedback to adjust instruction.	x		
Uses information from ongoing assessments to check for student understanding and misconceptions along the way		x	
Uses a variety of resources (beyond the textbook) to promote understanding			x
The students...			
Can describe the goals (big ideas and essential questions) and performance requirements of the unit or course			x
Can explain what they are doing and why (i.e., how today's work relates to the larger unit or course goals).			x
Are hooked at the beginning and remain engaged throughout the unit or course			x
Can describe the criteria by which their work will be evaluated		x	
Are engaged in activities that help them to learn the big ideas and answer the essential questions			x
Are engaged in activities that promote explanation, interpretation, application, perspective taking, empathy, and self-assessment (the six facets).		x	
Demonstrate that they are learning the background knowledge and skills that support the big ideas and essential questions			x
Have opportunities to generate relevant questions.			x
Are able to explain and justify their work and their answers		x	
Are involved in self- or peer-assessment based on established criteria and performance standards			x
Use the criteria or rubrics to guide and revise their work		x	

Set relevant goals based on feedback			x
In the classroom environment...			
The big ideas and essential questions are central to the work of the students, the classroom activity, and the norms and culture of the classroom.			x
There are high expectations and incentives for all students to come to understand the big ideas and answer the essential questions		x	
All students and their ideas are treated with dignity and respect			x
Big ideas, essential questions, and criteria or scoring rubrics are posted		x	
Samples or models of student work are made visible			x
Exploration of big ideas and essential questions is differentiated, so some students are able to delve more deeply into the subject matter than others.			x
Sub-total	1	18	54
Total	73		

Table 2 shows that the general structure of UbD-based differentiated science instruction fit the UbD framework because the point of observable indicators were 73, which was very close to the maximum point of 84. This finding indicates that the teacher and students were in the pursuit of big ideas and active involvement of knowledge construction. Moreover, the UbD-based differentiated classroom environment seems to be effective according to UbD principles.

Discussion

The findings of the study suggest that UbD-based differentiated instruction had a positive effect on students' academic achievement. This finding was supported by both UbD and DI research results. Our findings demonstrate that planning a curriculum using UbD model improves student academic achievement (Andre, 1979; Marzano, Pickering, & Pollock, 2001; Noble, 2011; Stigler & Hieber, 2004). DI research results had parallel findings about the increase in student learning and achievement while implementing DI strategies in the classroom (Campbell, Campbell, & Dickerson, 1999; Ferrier, 2007; Gamoran & Hannigan, 2000; Koeze, 2006; Lewis & Batts, 2005; McAdamis, 2001; Sondergeld & Schultz, 2008; Suarez, 2007; Tieso, 2005; Tomlinson, 2007; Tomlinson, Callahan, & Lelli, 1997). In addition to quantitative data-based findings, the qualitative data of the study indicated that the students perceived DI strategies as beneficial to their learning. Gayfer's (1991) and Avcı, Yüksel, Soyer, & Balıkçıoğlu's (2009) researches had similar and supportive findings that students in DI classroom thought that they

learned better and faster by engaging in group work and tiered instruction. The teacher's views collected for this study demonstrated that the students had better understanding about the content being taught because of the effectiveness of DI strategies. This finding was also supported by Avcı, Yüksel, Soyer, & Balıkçıoğlu (2009), stating that students learned better because they were actively engaged in their own learning process.

This favorable result is attributable to the match between the instructional strategies (DI) used and learner's characteristics and needs (Hofstein & Walberg, 1995). The findings also support the idea that students are more successful when the instruction is adapted according to students' level (Ferrier, 2007). The DI strategies enable students to construct their own knowledge by becoming actively engaged in their own learning (Duit & Treagust, 1995). In addition, the nature of the UbD-based differentiated learning environment has influence on student learning. As other researches (Halpin-Brunt, 2007; Koeze, 2007; Tomlinson, 1999; Sprenger, 2003) stated DI creates engagement as well as providing a comfortable and supportive learning environment.

Similarly, UbD's curriculum framework enables students to work on the experience indicated in an effective science education. This is why the big ideas and essential questions are central to the work of the students and classroom activity. The living nature of big ideas reflects in such a way that students are unconsciously engaged in learning while working in the group. As Voltz (2003) supported this finding with the idea that adding life happenings to the curriculum made student learning more meaningful. They gained perspectives and used empathy to be a part of "understanding community". This shows that students acquired two of the six facets of understanding during UbD-based differentiated science instruction. In addition, what provides a student with understanding depends on the activities they are engaged in. In the UbD-based differentiated instruction, the students had opportunities to generate relevant questions on science instruction. Some students were able to get in-depth understanding more than others. This is evidence of what UbD and DI offer for a science instruction.

As for the advantages of DI, the students in the UbD-based differentiated classroom enjoyed learning the content. Most important to note is that DI strategies provided students with engagement in the classroom. They enjoyed working with their friends and learned new materials by communicating about scientific issues and socializing. The researches (Smutny, 2003; Stetson, Stetson & Anderson, 2007) supported the idea that the students were excited about the activities and interested in discussing and studying the content during differentiated instruction. Furthermore, in UbD-based differentiated instruction the students maintained higher energy levels. This means that the students took ownership of their learning process.

Suggestions

As the literature expands, the expectations of educators and students increase, which, in turn diverts practitioners to pursue new ways of attracting the attention of learners and individualizing the classroom setting. UbD is a curriculum phenomenon that suggests the planning and organization of instruction on a clear basis. DI, respectively, is among the most popular ways of taking the personal expectations of students into account. The partnership of the two is crucial both for the construction and implementation of the learning plan. This study is among the initial academic

studies that attempt to combine UbD and DI. This is a partnership with the potential to foster academic achievement, active participation of the individuals and social interaction in the classroom settings. Future studies that aim to fill the gap in current research could include it can be suggested that (1) studies about the UbD-based differentiated instruction is conducted in other disciplines like mathematics or English as a second language to know more about the its effect on academic achievement, (2) more units can be developed using UbD and DI to get more accurate results about other psychological constructs, such as motivation, meta-cognition, and self-regulation.

REFERENCES

Abbati, D. G. (2012). *Differentiated Instruction: Understanding the personal factors and organizational conditions that facilitate differentiated instruction in elementary mathematics classrooms* (Unpublished doctoral dissertation). University of California at Berkeley, USA.

Afacan, Ö., & Nuhoğlu, H. (2008). Canlılar bilimi konusunda TIMSS-R (1999) sorulari ile LGS (1999) sorularinin karşilaştirmali analizi. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi (KEFAD), 9*(1) 31-43.

Andre, T. (1979). Does answering higher-level questions while reading facilitate productive learning? *Review of Educational Research, 49,* 280-318.

Anıl, D. (2009). Uluslararası öğrenci başarılarını değerlendirme programı (PISA)'ında Türkiye'deki öğrencilerin fen bilimleri başarılarını etkileyen faktörler. *Eğitim ve Bilim, 34* (152), 87-100.

Avcı S., Yüksel A., Soyer M., Balıkçıoğlu S. (2009) Şiir bilgisi konusu için tasarlanmiş farklilaştirilmiş sinif ortaminin öğrenciler üzerinde yarattiği bilişsel ve duyuşsal değişimler. *Kuram ve Uygulamada Eğitim Bilimleri*, *9*(3).

Bayraktar, Ş. (2010). Uluslararasi fen ve matematik çalişmasi (TIMSS 2007) sonuçlarina göre Türkiye' de fen eğitiminin durumu: Fen başarisini etkileyen faktörler. *Selçuk Üniversitesi Ahmet Keleşoğlu Eğitim Fakültesi Dergisi,* 30, 249-270.

Beler, Y. & Avcı, S. (2011) Öğretimin farklılaştırılmasında etkili bir strateji: Katlı Öğretim. *Ahi Evran Üniversitesi Eğitim Fakültesi Dergisi, 12*(3), 109-126.

Berberoğlu, G. (2007).Türk Bakış Açısından Pisa Araştırma Sonuçları. *Konrad Adanouer Stiftung Vakfı.* Retrieved from:http://www.konrad.org.tr/Egitimturk/07girayberberoglu.pdf

Berberoğlu, G. & Kalender, İ. (2005). Öğrenci başarısının yıllara, okul türlerine, bölgelere göre incelenmesi: ÖSS ve PİSA analizi. *Eğitim Bilimleri ve Uygulama, 4*(7), 21-35.

Bransford, J.,, Brown, A. & Cocking, R. (1999). *How people learn: Brain, mind, experience, and school.* Washington: NRC.

Brown, J. L. (2004). *Making the most of understanding by design.* Virginia: ASCD.

Campbell, L., Campbell, B., & Dickenson, D. (1999). *Teaching and learning through multiple intelligences* (2nd ed.). Needham Heights, MA: Allyn & Bacon.

Ceylan, E. (2009). PISA 2006 sonuçlarına göre Türkiye'de fen okuryazarlığında düşük ve yüksek performans gösteren okullar arasındaki farklar. *Yüzüncü Yıl Üniversitesi Eğitim Fakültesi Dergisi, 4*(2), 55-75.

Cozby, P. C. (2001). *Methods in behavioral research*. USA: Mayfield Pub. Co.

Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* USA: Pearson Education, Inc.

D'Amico, J. and Gallaway, K. (2010). *Differentiated instruction for the middle school science teacher: Grades 5-8.*. Jossey-Bass, USA.

Darling-Hammond, L. 2003. Keeping good teachers: Why it matters, what leaders can do? *Educational Leadership 60*(8):6–13.

Duit, R., & Treagust, D. F. (1995). Students' conceptions and constructivist teaching approaches. In B. J. Fraser & H. J. Walberg (Eds.), *Improving science education* (46 – 69). USA: The National Society for the Study of Education.

Ferrier, A. M. (2007). *The effects of differentiated instruction on academic achievement in a second-grade science classroom.* (Unpublished doctoral dissertation). Walden University, USA.

Gale, T. (2001). Under what conditions? Including students with learning disabilities within Australian classrooms. *Journal of Moral Education*, *30*(3), 261-272.

Gamoran, A., & Hannigan, E. (2000). Algebra for everyone? Benefits of college--preparatory mathematics for students with diverse abilities in early secondary school. *Educational Evaluation and Policy Analysis, 22*(3), 241-254.

Gamoran, A., & Weinstein, M. (1995). Differentiation and opportunity in restructured schools. *American Journal of Education, 106* (3), 385-415.

Gayfer, M. (1991). The multi-grade classroom: Myth and reality. A Canadian study. Toronto, Canada:Canadian Education Association.

Graff, N. (2011). An effective and agonizing way to learn: Backward design and new teachers' preparation for planning curriculum. *Teacher Education Quarterly, Summer*, 151-168.

Gregory, G. H. and Chapman, C. (2007). *Differentiated instructional strategies: One size doesn't fit all*. Corwin Press Inc; USA.

Grooms, G. (2010). *Investigating efforts to change educator attitudes and teaching strategies through professional development focused on the use of backward design curriculum and the principles of efficacy: Student behavior, feedback and assessments*. (Unpublished doctoral dissertation). Lindenwood University, Missouri.

Gulsvig, P. K. (2009). *Teacher candidates' experience of UbD in a social studies method course.* (Unpublished doctoral dissertation). University of North Dakota. North Dakota.

Halpin-Brunt, S. A. (2007). *Differentiated instruction practices: A case study of science teachers in a suburban middle school setting* (Unpublished doctoral dissertation. Columbia University, USA.

Harris, A. R. (2010). *Investigating efforts to change educator attitudes and teaching strategies through professional development focused on the use of backward design curriculum and the principles of efficacy: Educator behavior.* (Unpublished doctoral dissertation). Lindenwood University, Missouri.

Heacox, D. (2009). *Making differentiation a habit: How to ensure success in academically diverse classrooms.* Free Spirit Publishing Inc, USA.

Hirsch, E. D. (2003). Reading comprehension requires knowledge – of words and the world. *American Educator, 27*(1), 10-29.

Hofstein, A., & Walberg, H. J. (1995). Instructional strategies. In B. J. Fraser & H. J. Walberg (Eds.), *Improving science education* (46 – 69). USA: The National Society for the Study of Education.

Houtveen, T., & Van de Grift, W. (2001). Inclusion and adaptive instruction in elementary education. Journal of Education for Students Placed At Risk, 6(4), 389-409.

Jehlen, A. (2006). Rating NCLB: NEA members say it's hurting more than helping. *NEA Today, 7,* 24-31. Retrieved from: http://www.nea.org/neatoday/0604/coverstory.html

Kelting-Gibson, L. M. (2003). *Preservice teachers' planning and preparation practices: A comparison of lesson and unit plans developed using the backward design model and a traditional model*. (Unpublished doctoral dissertation). Montana State University, Montana

Koeze, P. A. (2007). *Differentiated instruction: The effect on student achievement in an elementary school* (Unpublished doctoral dissertation). Eastern Michigan University, USA.

Lawrence-Brown, D. (2004). Differentiated instruction: Inclusive strategies for standards-based learning that benefit the whole class. *American Secondary Education, 32,* 34–62.

Lewis, S. G., & Batts, K. (2005). How to implement differentiated instruction? Adjust, adjust, adjust. *Journal for Staff Development, 26(4),* 26-31.

Marzano, R., Pickering, D. & Pollock, J. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement.* Virginia: ASCD.

McAdamis, S. (2001). Teachers tailor their instruction to meet a variety of student needs. *Journal of Staff Development, 22*(2), 1-5.

McTighe, J. & Seif, A. (2003). Teaching for meaning and understanding: A summary of underlying theory and research. *Pennsylvania Educational Leadership, 24*(1), 6-14.

McTighe, J.& Thomas, R. S. (2003). Backward design for forward action. *Educational Leadership, 60*(5), 52-55

McTighe, J. & Wiggins, G. (2004). *Understanding by design: Professional development workbook.* Virginia: ASCD.

Meyer, C. L. (2006). *Learning to teach conceptually: Four preservice teachers' journeys.* (Unpublished doctoral dissertation). University at Albany, New York.

Noble, C. L. (2011). *How does understanding by design influence student achievement in eight grade social studies?* (Unpublished doctoral dissertation). Capella University: Wisconsin.

O'Meara, J. (2010). *Beyond differentiated instruction.* Corwin, USA.

Pardini, P. (2005). View from the classroom. *Journal of Staff Development*, *26*(4), 15.

Pianta, R., & LaParo, K. (2000). Predicting children's competence in the early school years. *Review of Educational Research*, *70*, 443-484.

Pullen, P. C., Tuckwiller, E. D., Konold, T. R., Maynard, K. L. & Coyne, M. D. (2010). A tiered intervention model for early vocabulary instruction: The effects of tiered instruction for young students at risk for reading disability. *Learning Disabilities Research & Practice, 25*(3), 110-123.

Richards, M. R. E. & Omdal, S. (2007). A quantitative study of the effects of tiered instruction on academic performance, in a secondary science course.*Journal of Advanced Academics. 20(2), 214-247.*

Savran, Z. N. (2004). PISA projesi'nin Türk eğitim sistemi açısından incelenmesi. *Gazi Üniversitesi Trük Eğitim Bilimleri Dergisi, 2*(4), 397-412.
Schmidt, W. (2004). A vision for mathematics. *Educational Leadership, 61*(5), 6-11.
Schmidt, W., Houang, R. & Cogan, L. (2002). A coherent curriculum: The case for Mathematics. *American Educator, 26*(2), 10-26.
Smutny, J. (2003). Differentiated Instruction. *Phi Delta Kappa Fastbacks, 506,* 7-47.
Sondergeld, T.A., Schultz R. (2008). Science, standards, and differentiation: It really can be fun!. *Gifted Child Today*. *31*(1), 34-40.
Sprenger, M. (2003). *Differentiation through learning styles and memory.* Thousond Oaks: Corwin Press.
Springer, R. M., Pugalee, D. & Algozzine, B. (2007). Improving mathematics skills of high school students. *The Clearing House, 81*(1), 37-44.
Stager, A. (2007). *Differentiated instruction in mathematics.*(Unpublished master thesis). Caldwell College, New Jersey.
Stigler, J. & Hieber, J. (2004). Improving mathematics teaching. *Educational Leadership, 61Educational Leadership, 61*(5), 12-16.
Stetson, R., Stetson, E. & Anderson, K. A. (2007). Differentiated Instruction, From Teachers' Experiences. *The School Administrator, 8*(64), 28-29.
Suarez D., (2007). Differentiation by challenge: Using a tiered program of instruction in mathematics. In William Powel & Ochan Kusuma Powel (Eds.), *Making the difference: differentitation in international schools,* 199-227.
Tieso, C. (2005). Th e eff ects of grouping practices and curricular adjustments on achievement. *Journal for the Education of the Gifted*, *29*, 60-89.
Tomlinson, C.A. (1999). The differentiated classroom. Responding to the needs of all learners. Alexandria: Association for Supervision and Curriculum Development.
Tomlinson, C.A. (2000). Reconcilable differences: Standards-based teaching and differentiation. Educational Leadership, 58(1), 6-11.
Tomlinson, C.A. (2001). How to differentiate instruction in mixed-ability classrooms, (2nd ed.). Alexandria: Association for Supervision and Curriculum Development.
Tomlinson, C.A. (2003). Deciding to teach them all. *Educational Leadership*, 61(2), 6-11.
Tomlinson, C. (2007). *Being an effective leader in support of differentiation: What we know from theory and practice.*ASCD Summer Conference on Differentiating Instruction, Texas, USA.
Tomlinson, C. A. & McTighe, J. (2006). *Integrating differentiated instruction and understanding by design.* Association for Supervision and Curriculum Development, USA.
Tomlinson, C. A. & Strickland, C. A. (2005). *Differentiation in practice: A resource guide for differentiating curriculum. Grades 9-12.* Association for Supervision and Curriculum Development, USA.
Tomlinson, C., & Kalbfleisch, M.L. (1998). Teach me, teach my brain: A call for differentiated classrooms. Educational Leadership, 52-55.
Tomlinson, C., Callahan, C., & Lelli, K. (1997). Challenging expectations: Case studies of high-potential, culturally diverse young children. *Gifted Child Quarterly*, *41*(2), 5-17.
Tyler, R. W. (1969). *Basic principles for curriculum and instruction.* The University of Chicago Press.

Voltz, D. (2003). Personalized contextual instruction. *Preventing School Failure, 47*(3), 138-143.
Wiggins, G. & McTighe, J. (1998). *Understanding by Design.* Pearson.
Wiggins, G. & McTighe, J. (2005). *Understanding by Design Expanded 2nd Edition.* Pearson.
Wiske, M. S. (2005). *Teaching for understanding with technology.* San Francison: Jossey Bass.
Young, S., B. (2005). *Understanding by design: An action plan for implementation* (Unpublished doctoral dissertation). University of Pennsylvania, USA.